Harnett County

Harnett NW Convenience Center RFP

Construction Documents
Project Manual

Issued for Proposal

May 2024

HDR Project No. 10400190

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COUNTY OF HARNETT
NORTH CAROLINA

REQUEST FOR PROPOSALS

NORTHWEST CONVENIENCE CENTER CONSTRUCTION
FOR
HARNETT COUNTY SOLID WASTE

Northwest Convenience Center
1979 Oakridge River Road, Fuquay-Varina, NC 27526

The County of Harnett (hereinafter referred to as "County") is issuing this Request for Proposals ("RFP") to obtain construction services for the Northwest Convenience Center – Phase 1 in accordance with the drawings and specifications contained herein. Send all inquiries regarding this RFP and request for site visits to purchasing.support@harnett.org with **NW Convenience Center RFP** in the subject line. Proposals shall be couriered (UPS, FedEx, etc.) or delivered no later than **Thursday, June 13, 2024 at 4:00p.m.** Proposals postmarked after June 13, 2024 and proposals delivered via fax or email will not be accepted. Courier or deliver all proposals in a sealed envelope indicating Proposals Enclosed, "**SW-03312024**" and your firm name to:

Deliver to: Renea Warren-Ford
Purchasing Specialist
455 McKinney Parkway
Lillington, North Carolina 27546

County reserves the right to reject any or all proposals for incompleteness, and to waive minor irregularities in the evaluation process. County also reserves the right to further negotiate minor modifications with the successful proposer upon completion of the evaluation process prior to the execution of a final contract.

Identified Property:

1. 1979 Oakridge River Road, Fuquay-Varina, NC 27526

Scope of Work:

The contractor shall provide all materials, tools, machinery, labor, and supervision necessary for the construction of the Northwest Convenience Center. Construction shall include clearing and grubbing, erosion and sediment control permitting (NDPES Construction General Permit) and implementation, stormwater improvements, on-site soil borrow area development, structural filling, gravel and paved roadways, concrete retaining wall and pads for solid waste and recycling compactors, electrical service, compactor power and site lighting, attendant building, site stabilization, fencing and gates, traffic control, and ancillary work. Compactor and hopper supply and installation will be by others, Contractor shall coordinate.

More specifically the work includes, but is not limited to the following items and quantities:

4.35	AC	Clearing and Grubbing
1	LS	Construction Entrance
1630	LF	Silt Fences and Outlets
2450	LF	Tree Protection Fencing
3500	CY	Topsoil Recovery and Stockpile
9125	CY	Soil Excavation
7870	CY	Structural Fill of On-Site Soils
1590	CY	6” Topsoil Installation
1	LS	Sediment Basin Construction and Outlet Structure
1	LS	Fine Grading and Drainage Swales
6	EA	Stone Check Dams
6	EA	Sediment Tubes
5500	SY	Erosion Control Matting
65	LF	24” RCP Culverts
200	LF	30” RCP Culverts
750	SY	Asphalt Roadway
6640	SY	Gravel Roadway and Pad
605	SY	Gravel Maintenance Road
176.50	CY	Concrete Retaining Wall
67.50	CY	Concrete Compactor Pads
1	LS	Electrical Service
1	LS	Communication Service
10	EA	Site Lights and Connections
1090	LF	Chain Link Fencing
3	EA	Swing Bar Gates
1	LS	Attendant Building

Attendant Building shall be pre-fabricated structure with 100 SF interior area to serve as an office and work station for a single facility attendant. Building shall include moisture resistant wall and roof panels, VCT flooring, laminated counter and shelving units for document storage, electrical panel with 12-pole load center for receptacles, lighting and other loads in the building, through wall combination type heating, ventilation, and air conditioning system. Building shall be equipped with telephone and data line, connections and ports. Window glazing shall provide visible line of site to incoming traffic and compactor loading areas. All accessories, trim, framed opening, flashing enclosures required to provide a completely watertight and functioning building complying with all requirements and applicable codes shall be provided. Contractor shall install the building in accordance with manufacturer's recommendations, including permanent anchoring to a concrete pad or footings.

General Conditions:

1. Intent and Execution of Documents: The drawings and specifications are complementary, one to the other. That which is shown on the drawings or called for in the specifications shall be as binding as if it were both called for and shown. The intent of the drawings and specifications is to establish the scope of all labor, materials, transportation, equipment, and any and all other things necessary to provide a complete job. In case of discrepancy or disagreement in the Contract Documents, the order of precedence shall be: Form of Contract, specifications, large-scale detail drawings, small-scale drawings.

   In such cases where the nature of the work requires clarification by the County, the County shall furnish such clarification. Clarifications and drawings shall be consistent with the intent of the Contract Documents and shall become a part thereof.

2. Substitutions: In accordance with the provisions of G.S. 133-3, material, product, or equipment substitutions proposed by the bidders to those specified herein can only be considered during the bidding phase until five (5) days prior to the receipt of bids or by the date specified in the pre bid conference, when submitted to the Designer with sufficient data to confirm material, product, or equipment equality. Proposed substitutions submitted after this time will be considered only as potential change order.

   a. Submittals for proposed substitutions shall include the following information:

   b. Name, address, and telephone number of manufacturer and supplier as appropriate.

   c. Trade name, model or catalog designation.

   d. Product data including performance and test data, reference standards, and technical descriptions of material, product, or equipment. Include color samples and samples of available finishes as appropriate.

   e. Detailed comparison with specified products including performance capabilities, warranties, and test results.

   f. Other pertinent data including data requested by the Designer to confirm product equality.

   If a proposed material, product, or equipment substitution is deemed equal by the Designer to those specified, all bidders of record will be notified by Addendum.

3. Insurance: Contractor shall secure and maintain, at their sole expense, at all times during the term of this contract:

   a. Workers' Compensation Insurance - Coverage for all paid and volunteer workers meeting the statutory requirements of The North Carolina Workers' Compensation Act, North Carolina General Statutes § 97.
   b. Commercial Automobile Liability – Coverage with limits no less than $1,000,000 per occurrence for bodily injury and property damage for any vehicle used during

performance of contract services, including coverage for owned, hired, and non-owned vehicles.

c. Commercial General Liability Insurance - Bodily injury and property damage liability as will protect contractor from claims of bodily injury or property damages. The amounts of such insurance coverage shall not be less than $1,000,000.00 per occurrence and $3,000,000.00 aggregate coverage.

Contractor, prior to commencement of any work or event, shall furnish to County proof of compliance with the insurance coverage requirements. County shall be named as an additional insured on all policies of insurance, except workers' compensation, specified above. Contractor upon request by County shall furnish a certificate of insurance from an insurance company, licensed to do business in the State of North Carolina and acceptable to County verifying the existence of any insurance coverage required by County. The certificate will provide for sixty (60) days advance notice in the event of termination or cancellation of coverage.

4. Indemnification: To the fullest extent permitted by laws and regulations, the contractor shall indemnify and hold harmless County and its officials, agents, and employees from and against all claims, damages, losses, and expenses, direct, indirect, or consequential (including but not limited to fees and charges of engineers or architects, attorneys, and other professionals and costs related to court action or arbitration) arising out of or resulting from the performance of this Contract or the actions of the contractor or its officials, employees, or contractors under the contract. This indemnification shall survive the termination of the contract.

5. Governing Laws: This contract is made under and shall be governed by and construed in accordance with the laws of the State of North Carolina. The Contractor shall comply with all applicable federal, State and local laws, statutes, ordinances and regulations.

6. Assignment: No assignment of the Contractor's obligations or the Contractor's right to receive payment hereunder shall be permitted. However, upon written request approved by the County and solely as a convenience to the Contractor, the County may: (1) forward the Contractor's payment check directly to any person or entity designated by the Contractor, and (2) include any person or entity designated by Contractor as a joint payee on the Contractor's payment check. In no event shall such approval and action obligate the County to anyone other than the Contractor, and the Contractor shall remain responsible for fulfillment of all contract obligations.

7. County's Right to Do Work: If, during the progress of the work or during the period of guarantee, the contractor fails to prosecute the work properly or to perform any provision of the contract, the County, after seven (7) days' written notice sent by certified mail, return receipt requested, to the contractor from the designer, may perform or have performed that portion of the work. The cost of the work may be deducted from any amounts due or to become due to the contractor, such action and cost of same having been first approved by the designer. Should the cost of such action of the County exceed the amount due or to become due the contractor, then the contractor or his surety, or both, shall be liable for and shall pay to the County the amount of said excess.

8. Cleaning Up and Restoration of Site: The Contractor shall keep the sites and surrounding area reasonably free from rubbish at all times and shall remove debris from the site from time to time or when directed to do so by the County. Before final inspection and acceptance of the project, the Contractor shall thoroughly clean the sites, and completely prepare the project and site for use by the County.

   At the end of construction, the Contractor shall oversee and implement the restoration of the construction site to its original state. Restoration includes but not limited to walks, drives, lawns, trees and shrubs, corridors, stairs and other elements shall be repaired, cleaned or otherwise restored to their original state.

9. Guarantee: The contractor shall unconditionally guarantee materials and workmanship against patent defects arising from faulty materials, faulty workmanship or negligence for a period of twelve (12) months following the final acceptance of the work and shall replace such defective materials or workmanship without cost to the County.

   Where items of equipment or material carry a manufacturer's warranty for any period in excess of twelve (12) months, then the manufacturer's warranty shall apply for that particular piece of equipment or material. The contractor shall replace such defective equipment or materials, without cost to the County, within the manufacturer's warranty period.

   Additionally, the County may bring an action for latent defects caused by the negligence of the contractor, which is hidden or not readily apparent to the County at the time of beneficial occupancy or final acceptance, whichever occurred first, in accordance with applicable law.

10. Standards: All manufactured items and/or fabricated assemblies subject to operation under pressure, operation by connection to an electric source, or operation involving a connection to a manufactured, natural, or LP gas source shall be constructed and approved in a manner acceptable to the appropriate State inspector which customarily requires the label or re-examination listing or identification marking of appropriate safety standard organization, such as the American Society of Mechanical Engineers for pressure vessels; the Underwriters Laboratories and/or National Electrical Manufacturers Association for electrically operated assemblies; or the American Gas Association for gas operated assemblies, where such approvals of listings have been established for the type of device offered and furnished. Further, all items furnished shall meet all requirements of the Occupational Safety and Health Act (OSHA), and State and federal requirements relating to clean air and water pollution.

    All equipment and products must be independent third party tested and labeled before final connections to County services or utilities.

11. Taxes:

a. North Carolina sales tax and use tax, as required by law, do apply to materials entering into state work and such costs shall be included in the bid proposal and contract sum.

b. Local option sales and use taxes, as required by law, do apply to materials entering into state work as applicable and such costs shall be included in the bid proposal and contract sum.

12. Performance Bond: Each contractor shall furnish a performance bond and payment bond executed by a surety company authorized to do business in North Carolina. The bonds shall be in the full contract amount. Bonds shall be executed in the form bound with these specifications.

    All bonds shall be countersigned by an authorized agent of the bonding company who is licensed to do business in North Carolina.

13. Contractor's Affidavit: The final payment of retained amount due the contractor on account of the contract shall not become due until the contractor has furnished to the County an affidavit signed, sworn and notarized to the effect that all payments for materials, services or subcontracted work in connection with the contract have been satisfied, and that no claims or liens exist against the contractor in connection with this contract. In the event that the contractor cannot obtain similar affidavits from subcontractors to protect the contractor and the County from possible liens or claims against the subcontractor, the contractor shall state in his affidavit that no claims or liens exist against any subcontractor to the best of his (the contractor's) knowledge, and if any appear afterward, the contractor shall save the County harmless.

14. Equal Opportunity Clause: The non-discrimination clause contained in Section 202 (Federal) Executive Order 11246, as amended by Executive Order 11375, relative to equal employment opportunity for all persons without regard to race, color, religion, sex or national origin, and the implementing rules and regulations prescribed by the secretary of Labor, are incorporated herein.

    The contractor(s) agree not to discriminate against any employee or applicant for employment because of physical or mental disabilities in regard to any position for which the employee or applicant is qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified individuals with such disabilities without discrimination based upon their physical or mental disability in all employment practices.

15. Minority Business Participation: Harnett County establishes a ten percent (10%) goal for participation by minority business in total value of work for this project but is not required. Identification of HUB Certified / Minority Business Participation should be attached to the contractor's proposal.

16. Sedimentation Pollution Control Act of 1973: Any land-disturbing activity performed by the contractor(s) in connection with the project shall comply with all erosion control measures set forth in the contract documents and any additional measures which may be required in order to ensure that the project is in full compliance with the Sedimentation Pollution Control Act of 1973, as implemented by Title 15, North Carolina Administrative Code, Chapter 4, Sedimentation Control, Subchapters 4A, 4B and 4C, as amended (15 N.C.A.C. 4A, 4B and 4C).

Upon receipt of notice that a land-disturbing activity is in violation of said act, the contractor(s) shall be responsible for ensuring that all steps or actions necessary to bring the project in compliance with said act are promptly taken.

The contractor(s) shall be responsible for defending any legal actions instituted pursuant to N.C.G.S. 113A-64 against any party or persons described in this article.

To the fullest extent permitted by law, the contractor(s) shall indemnify and hold harmless the County, the designer and the agents, consultants and employees of the County and designer, from and against all claims, damages, civil penalties, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from the performance of work or failure of performance of work, provided that any such claim, damage, civil penalty, loss or expense is attributable to a violation of the Sedimentation Pollution Control Act. Such obligation shall not be construed to negate, abridge or otherwise reduced any other right or obligation of indemnity which would otherwise exist as to any party or persons described in this article.

17. E-Verify: The contractor understands that E-Verify is the federal program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program used to verify the work authorization of newly hired employees pursuant to federal law in accordance with §64-25(5) of the North Carolina General Statutes. Provided that Contractor is a person, business entity, or other organization that transacts business in this State and that employs 25 or more employees in this State, then contractor understands and certifies that they shall verify the work authorization of the employee through E-Verify in accordance with §64-26(a) of the North Carolina General Statutes. Contractor further certifies that their subcontractors comply with E-Verify pursuant to federal law, and contractor will ensure compliance with E-Verify by any subcontractors subsequently hired by contractor.

Proposal Format:

To facilitate review of the Proposal by the County, it is requested that submissions conform to the following format:

1. Coversheet: List Proposal Statement, the name of the Proposer, and the name, address and telephone number of a contact person for questions concerning the Proposal submitted.

2. Project Understanding: Provide a narrative response describing the Proposer's understanding of the goals and objectives of the Project.

3. Qualifications Statement: Provide a brief profile of proposer and describe existing contracts on hand and resource availability. Provide examples of related experience for a minimum of three related projects within the last 10 years and include construction costs and reference contact information.

4. Project Schedule: Provide a high-level project schedule. Assume a Notice to Proceed date of July 8, 2024.

5. Lump Sum Fee: Provide a lump sum fee proposal for all work and costs associated with the construction of the proposed convenience center as described in the Project Manual and Drawings issued by HDR Engineering, Inc. of the Carolinas.

6. Proposer shall also include a preliminary Schedule of Values with the proposal for review by the County. The Schedule of Values shall subdivide the Work into its respective parts and include the values for all items comprising the Work. The final Schedule of Values to be furnished following contract award would serve as the basis for monthly progress payments made to Contractor throughout the Work.

7. Minority participation must be solicited for any subcontracting and efforts must be documented with the proposal. Upon completion of the project, a report must be submitted to the Department of Administration, Office of Historically Underutilized Business. The report must include the type of the project, total dollar amount of the project, dollar value of minority business participation on each project, and documentation of efforts to recruit minority participation.

8. Other Supporting Data: Include any other information you feel to be relevant to the selection of your firm.

Criteria for Review of Proposals:

1. Proposals will be evaluated and reviewed by County staff. Listed below are some of the criteria that may be used by the County in making a selection.

    a. Evaluation of the Proposer's ability to successfully complete scope of work according to the drawings, specifications and requirements as specified in this Request for Proposals;
    b. Proposed lump sum price, schedule of values, and project schedule;
    c. Demonstrated experience of the Proposer for similar projects; and
    d. Other factors determined to be relevant.

2. Contract will be awarded to the "lowest responsible bidder, taking into consideration quality, performance and the time specified for the performance of the contract.

County Responsibilities:

1. Provide a one-time pre-proposal inspection of the project site.

2. Provide access to the property.

3. Provide one key contact person to ensure all parameters of work are accomplished and assist the contractor as needed.

4. Provide payment to the contractor in monthly installments based on reviewed and approved payment applications.

5. Provide part-time construction observation by the engineer of record to confirm work is being completed in accordance with the contract documents and to coordinate with the contractor for clarification on items of work.

Contractor Responsibilities:

1. Coordinate with utilities for the extension of electrical utilities.

2. Provide one-year warranty on all construction to cover any and all repairs due to poor workmanship or defective materials

3. Obtain pertinent permits from required sources.

4. Provide quality control inspection and testing as specified in the Project Manual and Drawings.

Award of Contract

All submissions timely filed shall be promptly evaluated by County. Upon receipt of such notification the successful proposer shall immediately enter into final negotiations with County so that a contract may be executed within the shortest possible time. Contractor shall be required to furnish Performance and Payment Bonds at 100% of the contract value. Failure to promptly begin negotiations in good faith may result in disqualification and selection of another proposer.

EXECUTION OF PROPOSAL

DATE:_____

The Potential Contractor certifies the following by placing an "X" in all blank spaces:

___ That this proposal was signed by an authorized representative of the firm.

___ That the potential Contractor has determined the cost and availability of all materials and supplies associated with performing the services outlined herein.

___ That all labor costs associated with this project have been determined, including all direct and indirect costs.

___ That the potential Contractor agrees to the conditions as set forth in this **Request for Proposal** with no exceptions.

Therefore, in compliance with the foregoing **Request for Proposal**, and subject to all terms and conditions thereof, the undersigned offers and agrees, if this proposal is accepted within thirty (30) days from the date of the opening, to furnish the services for the prices quoted within the timeframe required.

CONTRACTOR_____ADDRESS_____

CITY, ST. & ZIP_____PHONE_____FAX_____

BY_____TITLE_____

_

(Signature)

_____

_____

Type or Printed Name Federal Identification Number

THIS PAGE MUST BE COMPLETED AND SUBMITTED AS A PART OF YOUR PROPOSAL.

STATE OF NORTH CAROLINA

AFFIDAVIT

COUNTY OF HARNETT

****

I, _____(the individual attesting below), being duly authorized by and on behalf of _____ ("Employer") after first being duly sworn hereby swears or affirms as follows:

1. Employer understands that E-Verify is the federal E-Verify program operated by the United States Department of Homeland Security and other federal agencies, or any successor or equivalent program used to verify the work authorization of newly hired employees pursuant to federal law in accordance with NCGS §64-25(5).

2. Employer is a person, business entity, or other organization that transacts business in this State and that employs 25 or more employees in this State. (mark Yes or No)

   a. YES _____, or

   b. NO _____

3. Employer understands that Employers Must Use E-Verify. Each employer, after hiring an employee to work in the United States, shall verify the work authorization of the employee through E-Verify in accordance with NCGS§64-26(a).

4. Employer's subcontractors comply with E-Verify pursuant to federal law, and Employer will ensure compliance with E-Verify by any subcontractors subsequently hired by Employer.

This ____ day of _____, 202__.

_____

Signature of Affiant
Print or Type Name: _____

State of North Carolina County of _____

Signed and sworn to (or affirmed) before me, this the _____

day of _____, 202__.

My Commission Expires:

_____

_____

Notary Public

(Affix Official/Notarial Seal)

LS14-369

Identification of HUB Certified/ Minority Business Participation

I,

_____

(Name of Bidder)

do hereby certify that on this project, we will use the following HUB Certified/ minority business as construction subcontractors, vendors, suppliers or providers of professional services.

Firm Name, Address and Phone #	Work Type	*Minority Category	**HUB Certified Y/N)

*Minority categories: Black, African American (**B**), Hispanic (**H**), Asian American (**A**) American Indian (**I**), Female (**F**) Socially and Economically Disadvantaged (**D**)

**** HUB Certification with the state HUB Office required to be counted toward state participation goals.**

The total value of minority business contracting will be ($)

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Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid Attach to Bid

Harnett County AFFIDAVIT A – Listing of Good Faith Efforts

County of _____

(Name of Bidder)

Affidavit of

I have made a good faith effort to comply under the following areas checked:

Bidders must earn at least 50 points from the good faith efforts listed for their bid to be considered responsive.

- ❑ **1 – (10 pts)** Contacted minority businesses that reasonably could have been expected to submit a quote and that were known to the contractor, or available on State or local government maintained lists, at least 10 days before the bid date and notified them of the nature and scope of the work to be performed.
- ❑ **2 --(10 pts)** Made the construction plans, specifications and requirements available for review by prospective minority businesses, or providing these documents to them at least 10 days before the bids are due.
- ❑ **3** – **(15 pts)** Broken down or combined elements of work into economically feasible units to facilitate minority participation.
- ❑ **4 – (10 pts)** Worked with minority trade, community, or contractor organizations identified by the Office of Historically Underutilized Businesses and included in the bid documents that provide assistance in recruitment of minority businesses.
- ❑ **5** – **(10 pts)** Attended prebid meetings scheduled by the public owner.
- ❑ **6** – **(20 pts)** Provided assistance in getting required bonding or insurance or provided alternatives to bonding or insurance for subcontractors.
- ❑ **7 – (15 pts)** Negotiated in good faith with interested minority businesses and did not reject them as unqualified without sound reasons based on their capabilities. Any rejection of a minority business based on lack of qualification should have the reasons documented in writing.
- ❑ **8** – **(25 pts)** Provided assistance to an otherwise qualified minority business in need of equipment, loan capital, lines of credit, or joint pay agreements to secure loans, supplies, or letters of credit, including waiving credit that is ordinarily required. Assisted minority businesses in obtaining the same unit pricing with the bidder's suppliers in order to help minority businesses in establishing credit.
- ❑ **9** – **(20 pts)** Negotiated joint venture and partnership arrangements with minority businesses in order to increase opportunities for minority business participation on a public construction or repair project when possible.
- ❑ **10** - **(20 pts)** Provided quick pay agreements and policies to enable minority contractors and suppliers to meet cash-flow demands.

The undersigned, if apparent low bidder, will enter into a formal agreement with the firms listed in the Identification of Minority Business Participation schedule conditional upon scope of contract to be executed with the Owner. Substitution of contractors must be in accordance with GS143-128.2(d) Failure to abide by this statutory provision will constitute a breach of the contract.

The undersigned hereby certifies that he or she has read the terms of the minority business commitment and is authorized to bind the bidder to the commitment herein set forth.

Date: _____ Name of Authorized Officer:

_____

SEAL

Signature: _____

Title: _____

State of _____, County of

_____

Subscribed and sworn to before me this _____ day of _____ 20 _____

_____ Notary Public _____

_____

My commission expires _____

_____

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Definition of various types of Submittals.
2. Coordination requirements for Submittals.
3. General provisions concerning Submittals.
4. Schedule of Submittals.
5. Contractor's preparation of Submittals, including:
    a. Numbering.
    b. Marking.
    c. Organization and content.
    d. Proposed "or-equals", substitutes, and deviations from Contract requirements.
    e. Electronic Documents Submittals.
    f. Contractor's review and approval of each Submittal.
    g. Resubmittals.
6. Contractor's transmittal of Submittals, including transmittal letters, transmittal and delivery method, and delivery of Samples, Closeout Submittals, and Maintenance Materials Submittals.
7. Engineer's review, including:
    a. Timing.
    b. Meaning of Engineer's Submittal action code(disposition) assigned.
    c. Delivery of Engineer's responses on Submittals.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, services, incidentals, and other effort necessary to furnish Shop Drawings, product data Submittals, Samples, and other Submittals in accordance with the Contract Documents.
2. This Section's Article, "General Provisions Concerning Submittals" includes a summary of the Contract Documents' locations of Submittals requirements.
3. Shop Drawings, product data Submittals, Samples, and other Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Engineer's approval or acceptance, as applicable, of a Submittal does not alter or modify the Contract Documents.
4. Engineer and Owner have the right to rely on Contractor's representations and certifications made regarding each Submittal.

1.2 REFERENCES

A. References – Introduction:

1. This Article presents definitions and terminology used in this Section and throughout the Contract Documents.
2. Applicability of the Term "Submittals": Where reference is made to Shop Drawings, product data Submittals, Samples, or other Submittals in this Section and

elsewhere in the Contract Documents, the term “Submittals”, as defined in the Contract Documents, is intended. The foregoing applies regardless of whether such term is indicated with an initial capital letter, unless context of the subject provision clearly indicates otherwise.

3. Types of Submittals:
    a. Submittal types are classified as follows: (1) Action Submittals, (2) Informational Submittals, (3) Closeout Submittals, and (4) Maintenance Materials Submittals.
    b. Type of each required Submittal is indicated in the associated Specifications section. When Submittal type is not clearly indicated in the associated Specifications section, Submittal will be classified as indicated in this Article. Submit request for interpretation when Contractor is uncertain of required Submittal type.

B. Action Submittals:

1. Action Submittals require an explicit, written approval or other appropriate action by Engineer (or other entity to whom the Submittal is required to be furnished, in accordance with the Contract Documents) before Contractor may release the associated item(s) for raw materials procurement, fabrication, production, and shipping.
2. Unless otherwise indicated in the Contract Documents, Action Submittals include the following:
    a. Shop Drawings.
    b. Product data.
    c. Samples.
    d. Testing plans for quality control activities required by the Contract Documents.
    e. Delegated Designs: Delegated design professional’s “instruments of service” Submittals required by the Contract Documents.
3. General Conditions’ requirements for Shop Drawings and Samples hereby apply to all Action Submittals.

C. Informational Submittals:

1. Informational Submittals are so indicated in the Contract Documents. Unless otherwise indicated, Informational Submittals include certifications, evaluation reports, results of source quality control activities, results of field quality control activities, Supplier instructions, reports of Suppliers’ visits to the Site, sustainable design Submittals (that are not Closeout Submittals), delegated design Submittals that are not “instruments of service” Submittals, qualifications statements, and others.
2. Informational Submittals, when submitted in accordance with the Contract and indicating full compliance with the Contract Documents, do not require explicit response from Engineer (or other entity to whom the Submittal is to be delivered); Engineer’s (or other entity’s) acceptance thereof will be indicated in the Engineer’s Submittals log. Copy of Engineer’s Submittals log is available to Contractor upon Contractor’s written request.
3. When Informational Submittal does not indicate full compliance with the Contract Documents, Engineer (or other entity to which Submittal is to be delivered) will indicate the non-compliance in a written response to Contractor.

D. Closeout Submittals:

1. Closeout Submittals are so indicated in the Contract Documents and are, in general, required before the associated Work is completed, unless earlier submittal is required by the Contract Documents.
2. Unless indicated otherwise in the Contract Documents, Closeout Submittals include maintenance contracts, operation and maintenance data, warranties, bonds (other than performance and payment bonds required prior to the start of construction), record documents, sustainable design closeout Submittals, software, keys, and others.
3. Closeout Submittals are processed in the same manner as described above for Informational Submittals.

E. Maintenance Materials Submittals:

1. Maintenance materials include spare parts, extra materials, tools, and similar items required to be furnished in accordance with the Contract Documents.
2. Furnish required physical maintenance materials, delivered to Owner or facility manager (if other than Owner), as applicable, at the location(s) indicated in the Contract Documents, for the corresponding required Maintenance Materials Submittals.
3. Maintenance Materials Submittals are documentation of delivery to Owner's or facility manager, and their acceptance of, required physical maintenance materials.
4. Maintenance Materials Submittals are processed in the same manner as described above for Informational Submittals.

F. Additional Terms:

1. The following terms have the meanings indicated below, regardless of whether such terms are indicated using initial capital letters, and apply to singular and plural of each:
   a. "Product data" means illustrations, standard schedules, performance charts, Supplier's published instructions, brochures, diagrams, and other information furnished by Contractor to illustrate or describe materials or equipment for some portion of the Work. In general, product data are manufacturers' pre-published information on the items proposed to be incorporated into the Work. Product data includes manufacturer's catalog pages and similar documents with contractor-made markings and indications of proposed products and proposed options.
   b. The term "Shop Drawings", defined in the General Conditions, is supplemented by the following: Shop Drawings include: (1) fabrication and assembly drawings, usually having a title block, or (2) schedules, prepared specifically for the Project. Here, "schedules" means a Project-specific summary of systems and components, such as a schedule of HVAC equipment, schedules of doors and door hardware, or windows, or a schedule of paint systems by room and surface, or other, similar Project information in a tabular format. In contrast, construction Progress Schedules, Schedules of Submittals, and Schedules of Values are not Shop Drawings.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Furnish Submittals well in advance of need for the associated material or equipment, or procedure (as applicable), in the Work and with ample time necessary for delivery of materials and equipment and to implement procedures following Engineer's approval or acceptance of the associated Submittal.

2. Work covered by a Submittal will not be included in payments by Owner until approval or acceptance (as applicable) of related Submittals has been obtained in accordance with the Contract Documents.

1.4 GENERAL PROVISIONS CONCERNING SUBMITTALS

A. Locations of Requirements:

1. Requirements concerning Submittals are generally located as follows:
   a. General Conditions, as may be modified by the Supplementary Conditions, applicable to the Project.
   b. This Section, which presents general requirements for Submittals applicable to the Project.
   c. The “Submittals” Article of the various Specifications sections, which indicates the required Submittals for the associated Work. Furnish all Submittals required by the Contract Documents regardless of whether explicitly indicated in the associated Specifications’ “Submittals” Article.

B. This Section augments and supplements the requirements of the General Conditions, as may be modified by the Supplementary Conditions, relative to Submittals.

1.5 SCHEDULE OF SUBMITTALS

A. Informational Submittals: Submit the following:

1. Schedule of Submittals:
   a. Timing:
      1) Furnish Schedule of Submittals within time frames indicated in the General Conditions, as may be modified by the Supplementary Conditions.
      2) Submit updated Schedule of Submittals with each submittal of the updated Progress Schedule.
   b. Content: In accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section. Requirements for content of preliminary Schedule of Submittals and subsequent Submittals of the Schedule of Submittals are identical. Identify on Schedule of Submittals all Submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Clearly indicate Submittals that are on the Project’s critical path. Indicate the following for each Submittal:
      1) Date by which Submittal will be received by Engineer.
      2) Whether Submittal will be for a substitution or “or-equal”.
      3) Date by which Engineer’s response is required. Allow not less than 14 days for Engineer’s review, starting on Engineer’s actual receipt of each Submittal. Allow increased time for large or complex Submittals.
      4) For Submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of others (if any).
   c. Prepare Schedule of Submittals.
   d. Coordinate Schedule of Submittals with the Progress Schedule.
   e. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate Submittals on the Project’s critical path, or that places extraordinary demands on Engineer for time and resources, is unacceptable. Do not include Submittals not required by the Contract Documents.
   f. In preparing Schedule of Submittals:

1) Considering the nature and complexity of each Submittal, allow sufficient time for reviews and revisions.
2) Allow reasonable time for: Engineer's review and processing of Submittals, for Submittals to be revised and resubmitted, and for returning Submittals to Contractor.
3) Identify and accordingly schedule Submittals that are expected to have long anticipated review times.

1.6 PREPARATION OF SUBMITTALS

A. Prior to Submittal Preparation:

1. The General Conditions, as may be modified by the Supplementary Conditions, address Contractor's responsibility for submitting for Owner's acceptance identification of Subcontractors and Suppliers. Obtain Owner's acceptance before entering into subcontracts and purchase orders for the Work.
2. Comply with the Contract Documents relative to terms and conditions of subcontracts and purchase orders for the Work.
3. Contractor's responsibilities for the following are set forth in the General Conditions, as may be modified by the Supplementary Conditions, and as may be augmented elsewhere in the Contract Documents:
   a. Obtaining field measurements and dimensions.
   b. Determining and verifying required quantities.
   c. Verifying compatibility of materials.
   d. Apportioning the Work among Subcontractors, Suppliers, and Contractor.
   e. Reconciling required materials, equipment, and other Contract requirements with Contractor's means, methods, techniques, sequences, and procedures of construction and with Contractor's safety and protection programs and precautions incident thereto.
   f. Reviewing applicable provisions of the Contract Documents and obtaining from Engineer necessary interpretations or clarifications.

B. Submittal Identification:

1. Submittal Number: Shall be a unique number assigned to each individual Submittal. Assign Submittal numbers as follows:
   a. First part of Submittal number shall be the applicable Specifications section number, followed by a hyphen.
   b. Second part of Submittal number shall be a three-digit number (sequentially numbered from 001 through 999) assigned to each separate Submittal furnished under the associated Specifications section.
   c. Example: Submittal number for the third Submittal furnished for Section 31-12-19 - Geotextiles, would be "31 32 19-003".
2. Review Cycle Number: Each resubmittal of a given Submittal shall be indicated with a lower-case letter designation:
   a. No letter designation for initial (first) submittal of the Submittal number.
   b. "a" shall indicate first resubmittal of the Submittal number.
   c. "b" shall indicate second resubmittal of the Submittal number.
3. Examples:

Example Description	Submittal Identification

	Submittal No.	Review Cycle
Initial (first) review cycle of the third Submittal furnished under Section 31 32 19 – Geotextiles	31 32 19-003	
Second review cycle (first resubmittal) of third Submittal furnished under Section 31 32 19 - Signage	31 32 19-003	a

C. Marking of Submittals:

1. Mark on each page of each Submittal and each individual component submitted with Submittal number and applicable Specifications paragraph.
2. Mark each page of each Submittal with the Submittal page number.
3. Each Shop Drawing sheet shall have title block with complete identifying information satisfactory to Engineer.
4. For product data Submittals, operation and maintenance data Submittals, and other Submittals:
    a. Mark options to be furnished using broad, dark arrows or “clouds” clearly drawn around the relevant text or diagrams. Do not use highlighter for indicating options and features.
    b. Indicate options and features not furnished using clear strikeouts through the text or diagrams.

D. Submittal Organization and Content – General:

1. Page or Sheet Size; Furnish Submittals with one or more of the following page or sheet sizes: (a) 8.5 IN by 11 IN; (b) 11 IN by 17 IN; (c) 22 IN by 34 IN; unless another sheet size is acceptable to Engineer.
2. Language: All parts of each Submittal shall be in the English language.
3. Units of Measurement: Clearly indicate units of measurement on Shop Drawings, product data Submittals, record documentation, and operation and maintenance data Submittals.
4. Organize each Submittal logically to facilitate ease of understanding and review.
5. To the extent practicable, arrange Submittal information in same order as requirements are written in the associated Specifications section.
6. Each Submittal shall cover Work under only one Specifications section.
7. To the extent practicable, package together Submittals for the same Specifications section. Do not furnish required information piecemeal.
8. For large or complex Submittals, include a title page and table of contents.
9. Include appropriately labeled fly sheets to separate distinct parts of each Submittal.
10. Ensure legibility of all pages in each Submittal.
11. Minimize extraneous and unnecessary information in Submittals for materials and equipment. Do not submit information not relevant to the Submittal and associated requirements of the Contract Documents.
12. Contractor’s, Subcontractor’s, and Supplier’s written comments on Shop Drawings and product data diagrams shall be colored green
13. Do not submit under Specifications sections with title that include “Basic Requirements”, unless the subject material or equipment is specified, in total, in a Specifications section with the words, “Basic Requirements” in its title.

E. Electronic Documents Submittals:

1. Format: Electronic Documents Submittals shall be “portable document format” (.PDF) files unless expressly required otherwise by applicable provisions of the Contract Documents.
2. Electronic Documents Submittals must be electronically searchable when delivered to Engineer and other recipients.
3. Organization and Content:
    a. Each Electronic Documents Submittal shall be one file; do not divide individual Submittals into multiple Electronic Documents files each unless file size will exceed 20 MB.
    b. When Submittal is large or contains multiple parts, furnish PDF file with suitably titled electronic bookmark for each section of the Submittal.
    c. Content shall be identical to paper or other original Submittal. First page of each Electronic Documents Submittal shall be transmittal letter required in this’s Paragraph 1.7.A.
4. Quality and Legibility: Electronic Documents Submittal files shall be made from the original and shall be clear and legible. Markings applied by Contractor, Subcontractor, or Supplier shall be clear, distinct, and readily apparent. Electronic Documents file shall be full size of original documents. Properly orient all pages for convenient reading on a computer display; do not furnish pages sideways or upside-down..
5. Provide sufficient internet service, software, and systems for Contractor with capability appropriate for transmitting the necessary files and receiving responses from Engineer or other entities.
6. Check not less than once per day for distribution of Electronic Documents Submittals responses and related Electronic Documents correspondence.

F. Proposed “Or-Equals”, Substitutes, and Deviations from Contract Requirements:
    1. “Or-Equals”:
        a. Contractor’s request for approval of “or-equals” is to be presented via the associated Action Submittal(s) and shall include the information required in provisions governing “or-equals”.
        b. Expressly and prominently indicate, “Proposed Or-Equal” on the associated Action Submittals when Submittal is for an “or-equal”.
        c. Submittals requesting approval of an “or-equal” but not accompanied by the required, supplemental information will be deemed incomplete by Engineer and returned to Contractor without approval.
    2. Substitutes:
        a. Requests for approval of substitutes shall comply with relevant provisions of the Contract Documents.
        b. Contractor’s request for approval of substitute is separate from the associated Action Submittal(s). Action Submittals that request approval of a substitute when a separate, formal substitution request (furnished in accordance with the Contract Documents) was not previously furnished to Engineer, followed by formal approval in via an appropriate contract modification (typically either a Field Order or Change Order), will be deemed by Engineer as non-compliant with the Contract Documents and will be returned to Contractor without approval.
        c. Contractor is solely responsible for delays incurred due to substitutes proposed via Submittals that have not been previously duly approved via an appropriate Contract modification.

d. Action Submittals for items or procedures approved via an appropriate Contract modification shall include a copy of the Contract modification in which the substitute was approved.

3. Submittals with Proposed Deviations from Contract Requirements:
   a. When Submittal proposes deviations from requirements of the Contract Documents, the Submittal shall clearly and expressly indicate each proposed deviation.
   b. Also comply with this Section's provision, in the Article below, on Contractor's transmittal letter expressly alerting Engineer to the proposed deviations.
   c. Comply with requirements of the Contract regarding substitutes and "or-equals".
   d. When deviation is proposed, also appropriately revise text of Contractor's approval, from that required below in this Article.
   e. When Submittal includes deviations from Contract requirements and either the Submittal itself, Contractor's transmittal letter, or both, do not comply fully with Contract requirements for indicating deviations in Submittals and giving separate written notice thereof, Engineer's approval of such deviations will be deemed null and void unless Engineer's written response to the Submittal has expressly acknowledged such deviation and indicated Engineer's approval thereof.
   f. Contractor is solely responsible for delays and costs incurred due to any and all Submittals with deviations from Contract requirements that were not properly, expressly indicated and approved in accordance with the Contract Documents. Deviations not duly approved in accordance with the Contract Documents may be deemed defective Work. Contractor is solely responsible for remedying defective Work and all associated cost and time impacts.

G. Contractor's Approval of Submittals:

1. Contractor's Review: Before transmitting Submittals to Engineer, review each Submittal to:
   a. Ensure proper coordination of the Work.
   b. Determine that each Submittal is in accordance with Contractor's desires.
   c. Verify that Submittal contains sufficient information for Engineer to determine compliance with the Contract Documents.
2. Incomplete or inadequate Submittals will be returned without detailed review by Engineer.
3. Contractor's Approval Stamp and Signature:
   a. Each Submittal furnished shall bear Contractor's approval stamp (or facsimile thereof) and signature, as evidence that the Submittal has been reviewed and approved by Contractor and verified as complete and in accordance with the Contract Documents.
   b. Submittals without Contractor's approval and signature (as required by the contract Documents) will be returned to Contractor without further review by Engineer and deemed incomplete.
   c. Engineer reserves the right to reject as incomplete Submittals where Contractor's approval signature appears computer-generated or reproduced without the active involvement or review of Contractor's signatory.
   d. Contractor's approval shall contain the following text:

      Project Name: _____

Contractor's Name: _____
Contract Designation: _____
Date: _____

---------- *Reference* ----------

Submittal Title: _____
Specifications:
Section: _____
Page No.: _____
Paragraph No.: _____
Drawing No.: _____ of _____
Location of Work: _____

Submittal No. and Review Cycle: _____
Coordinated by Contractor with Submittal Nos.: _____
_____

I hereby certify that Contractor has satisfied Contractor's obligations under the Contract Documents relative to Contractor's review and approval of this Submittal, including: (1) reviewed and coordinated the Submittal with other Submittals and with the requirements of the Work and the Contract Documents; (2) determined and verified all: field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal, (b) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work, and (c) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto; (3) confirmed the Submittal is complete with respect to all related data included in the Submittal; and (4) clearly and expressly indicated all proposed deviations (if any) from the requirements of the Contract Documents both in the Submittal itself and in the Submittal's transmittal letter. Accordingly, this Submittal is hereby approved for Contractor by:

Approved for Contractor by: _____

H. Resubmittals:

1. Refer to the General Conditions, as may be modified by the Supplementary Conditions, for requirements regarding resubmitting required Submittals.
2. In addition to limits on the quantity of resubmittals, as indicated in the General Conditions, Contractor shall furnish Submittals with such completeness, accuracy, and compliance with the Contract Documents to obtain Engineer's approval or acceptance, as applicable, without the total quantity of Submittals furnished, including all initial Submittals and all resubmittals, exceeding 150% of the number of Submittals indicated on the Schedule of Submittals initially accepted by Engineer, plus a corresponding percentage of the quantity of Submittals required by Change Orders, Work Change Directives, and Field Orders.
3. Do not increase the scope of prior review cycle of the same Submittal.
4. Indicate on Contractor's transmittal letter how Submittal was revised from previous review cycle of the Submittal and where the revisions or corrections are located within the resubmittal.
5. Expressly address and provide response for all components previously transmitted by Engineer on prior review cycles of the subject Submittal. Where resubmittal

lacks complete response to Engineer's prior comments, Engineer may deem such resubmittal as incomplete and return it to Contractor without further review.

6. Where part of the Submittal's prior review cycle was expressly approved or accepted, as applicable, by Engineer, do not include such items in subsequent resubmittals.
7. Indicate, "Not Yet Resolved—To Be Resubmitted at a Later Date" for any items not approved in prior review cycle of the Submittal for items not included in the subject resubmittal. Engineer reserves the right to deem incomplete Submittals "Not Approved" or "Revise and Resubmit". Furnishing incomplete or partial resubmittals is discouraged.
8. Resubmittal of Previously Approved or Accepted Items:
    a. Do not resubmit on a given item previously approved or accepted, as applicable, by Engineer, without Engineer's advance consent. Consent will be given for bona-fide unavailability of a previously approved or accepted item where Contractor has acted in good faith in a timely manner with due diligence to comply with the Contract Times.
    b. Destroy or conspicuously mark "SUPERSEDED" on all documents having previously received Engineer's approval or acceptance, as applicable, that are superseded by a resubmittal.

1.7 TRANSMITTAL OF SUBMITTALS BY CONTRACTOR

A. Contractor's Transmittal Letters for Submittals:

1. Furnish separate transmittal letter with each Submittal. Use transmittal form attached to this Section (as Exhibit 01 33 00-A) unless other transmittal form is acceptable to Engineer at the start of the Project's construction.
2. When transmittal form other than this Section's Exhibit 01 33 00-A is acceptable to Engineer, at beginning of each transmittal, include a reference heading indicating: Contractor's name, Owner's name, Project designation, Contract designation, transmittal number, and Submittal number (with review cycle).
3. "Or-Equals": When the Submittal is proposing an "or-equal", expressly so indicate on transmittal form submitted by Contractor.
4. Proposed Deviations from Contract Requirements: When the Submittal proposes deviations from requirements of the Contract Documents, transmittal letter shall specifically describe each proposed deviation:

B. Submittal Delivery Method:

1. This provision presents general requirements for delivery or all Submittals unless otherwise required elsewhere in the Contract Documents.
2. Furnish Submittals as Electronic Documents.
3. Furnish Submittals to Engineer and each other entity indicated in the Contract Documents as receiving a Submittal directly from Contractor.
4. Address Submittals to Engineer as follows: HDR, 555 Fayetteville Street, Suite 900, Raleigh, NC 27601, to attention of Jeffrey Murray, Jeffrey.Murray@hdrinc.com.

C. Closeout Submittals –Transmittal and Delivery:

1. Furnish the following Closeout Submittals in accordance with general requirements for transmitting and delivering Submittals, indicated above in this Article: maintenance contracts; warranty bonds (when required) and other bonds required for specific materials, equipment, or systems; warranty documentation; and sustainable design closeout documentation (when required). On documents such

as maintenance contracts and bonds, include on each document furnished original ("wet") signature of entity issuing said document. When original "wet" signatures are required, furnish such Submittals to Engineer both on original paper and as Electronic Documents, and to other entities furnish as indicated above in this Article for general requirements for Submittals.

D. Maintenance Materials Submittals – Delivery:

1. Deliver physical maintenance materials required by the Contract Documents in accordance with applicable provisions of the Contract.
2. Submit documentation of delivery of (Maintenance Materials Submittals) in accordance with general requirements for Submittals as indicated in this Section.

1.8 ENGINEER'S REVIEW OF SUBMITTALS

A. This Article applies to review of all Submittals by Engineer or other entity to whom the Contract Documents require such Submittal be furnished.

B. Timing:

1. Timing of Engineer's review will be in accordance with the Schedule of Submittals accepted by Engineer.
2. When Submittal is delivered to Engineer on a date other than that indicated in the Schedule of Submittals accepted by Engineer, duration of Engineer's review may differ from that indicated in the Schedule of Submittals, based on Engineer's availability and resources. Engineer will make good-faith effort to furnish responses to Submittals in a timely manner.
3. Contractor is responsible for communicating to Engineer when a Submittal is on the Project's critical path.

C. Engineer's Review:

1. Markings:
   a. Comments or responses marked directly on Submittal by Engineer (or other entity reviewing Submittal) will be colored red.
   b. Engineer may also present narrative comments on a comment sheet inserted by Engineer into the Submittal or included on Engineer's transmittal letter for the Submittal. Such comments will be in black text. When a separate comment sheet is included by Engineer, such sheet will be clearly identified as Engineer's comments.
2. Engineer's review and disposition assigned to Submittal are subject to the following:
   a. Submittal disposition is subject to: Engineer's comments on the Submittal; disclaimer language on Engineer's Submittal transmittal letter; Engineer's Submittal review stamp (when used) or equivalent (when used); and this provision.
   b. Engineer's review is only for general compatibility with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, and for general compliance with the information given in the Contract Documents.
   c. Contractor shall be solely responsible for complying with the Contract Documents, as well as with Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations. Contractor is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and

techniques of construction; safety precautions and programs incident thereto; and for coordinating the work of all trades.

d. Engineer is not responsible for resubmittals not yet furnished by Contractor or tracking Contractor's progress on resubmittals.

3. Documents not required by the Contract Documents but nonetheless furnished by Contractor as submittals will not be reviewed by Engineer.

D. Meaning of Submittal disposition Assigned by Engineer:

1. Action Submittals:

a. "Approved" (Action Code A): Upon return of Submittal marked "Approved", order, ship, or fabricate materials and equipment included in the Submittal (pending Engineer's approval or acceptance, as applicable, of production-related qualifications statements and certifications, and required source quality control Submittals) or otherwise proceed with the Work in accordance with the Submittal and the Contract Documents.

b. "Approved as Noted" (Action Code B): Upon return of Submittal marked "Approved as Noted", order, ship, or fabricate materials and equipment included in the Submittal (pending Engineer's approval or acceptance, as applicable, of production-related qualifications statements and certifications, and required source quality control Submittals) or otherwise proceed with the Work in accordance with the Submittal and the Contract Documents, and in accordance with Engineer's comments and notes indicated in Engineer's Submittal response

c. "Revise and Resubmit" (Action Code C): Upon return of Submittal marked "Revise and Resubmit", make the revisions necessary and indicated and resubmit to Engineer for approval.

d. "Not Approved" (Action Code D): This disposition indicates material or equipment that cannot be approved. "Not Approved" disposition may also be applied to Submittals that are incomplete. Upon return of Submittal marked "Not Approved", repeat initial submittal procedure utilizing approvable material or equipment, with a complete Submittal clearly indicating all information required.

2. Informational, Closeout, and Maintenance Materials Submittals:

a. "Accepted" (Action Code F): Information included in Submittal complies with the applicable requirements of the Contract Documents and is acceptable. No further action by Contractor is required relative to such Submittal, and the Work covered by the Submittal may proceed. Materials and equipment with Submittals with this disposition may be shipped or operated, as applicable. Submittals assigned "Accepted" by Engineer (or other reviewing entity) does not indicate Engineer's acceptance of the associated Work, which is indicated only as set forth in the General Conditions.

b. "Not Acceptable" (Action Code G): Submittal, or part thereof, does not indicate full compliance with applicable requirements of the Contract Documents and is not acceptable. Provide labor, materials, equipment, services, and incidentals necessary to properly and accurately revise Submittal and resubmit to indicate acceptability and compliance with the Contract Documents

3. Other:

a. "Submittal Not Reviewed" (Action Code E): Documents so marked by Engineer are not required by the Contract Documents. Submittals may also be marked with this disposition when information in the document was previously reviewed and approved or accepted by Engineer, as applicable.

E. Distribution of Engineer's Responses:

1. Unless otherwise indicated in the Contract Documents, Engineer will distribute written responses (as Electronic Documents) to Submittals to the following:
   a. Contractor.
   b. Owner.
   c. Engineer's file.
2. Engineer's acceptance of Informational Submittals, Closeout Submittals, and Maintenance Materials Submittals will be recorded in Engineer's Submittal log. Copy of Engineer's Submittals log is available from Engineer upon written request of Owner or Contractor. If no such request is received by Engineer, Engineer will distribute copy of Engineer's Submittals log once per month (when Submittals have been received or acted on by Engineer). Engineer may distribute copy of Engineer's Submittals log as an Electronic Document or as handout at construction progress meetings.
3. Paper copies of Engineer's Submittal responses will not be distributed unless otherwise required by the Contract Documents or otherwise agreed to by Engineer.
4. Contractor is responsible for forwarding Engineer's Submittals responses to Subcontractors and Suppliers as appropriate, and for coordinating the Work of all trades.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The documents listed below, following this Section's "End of Section" designation, are part of this Specifications Section:

1. "Exhibit 01 33 00-A – Transmittal for Submittal No. __" (one page).

END OF SECTION

Exhibit 01 33 00-A

Transmittal for Submittal No. _____-_____

Project Name:		Date Received:	
Project Owner:		Checked By:	
Contractor:	HDR Engineering, Inc.	Log Page:	
Address:	Address:	HDR No.:	
		Spec Section:	
		Drawing/Detail No.:	
Attn (Contractor):	Attn (HDR):	Review Cycle	
Date Transmitted by Contractor:	Date of Engineer's Response Transmittal:		

Item No.	Submittal No.	Description (indicate number of copies where paper copies of physical Samples are returned)	Manufacturer	Supplier Dwg or Data No.	Engineer's Disposition (Action Code) *
1					
2					
3					
4					

Contractor's Remarks *(insert text)*:

Engineer's Remarks *(insert text)*: :

* **Legend for Action Code** indicated above, assigned by Engineer:

Action Submittal:
- A – Approved
- B – Approved as Noted
- C – Revise and Resubmit
- D – Not Approved
- E – Submittal Not Reviewed

Informational, Closeout, or Maintenance Materials Submittal:
- F – Accepted (this code normally recorded in Engineer's Submittals log).
- G – Not Acceptable

Engineer's Disclaimer (for Submittals that do not involve delegated design):

a. Submittal action code is subject to: Engineer's comments on the Submittal, comment sheets (if any), and this transmittal letter; disclaimer language on Engineer's Submittal review stamp or equivalent; and Specifications Section 01 33 00 – Submittal Procedures.

b. Engineer's review is only for general compatibility with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, and for general compliance with the information given in the Contract Documents.

c. Contractor shall be solely responsible for complying with the Contract Documents, as well as with Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations. Contractor is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the work of all trades.

Reviewed for HDR by:	**Date of Engineer's Review:**

Distribution: Contractor ☐ File ☐ Field ☐ Owner ☐ Other ☐

SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. General quality control.

B. Workmanship.

C. Manufacturer's instructions.

D. Manufacturer's certificates.

E. Manufacturer's field services.

1.2 RELATED REQUIREMENTS

A. Division 00 - Bidding Requirements, Contract Forms, & Conditions of the Contract.

B. Section 01 33 00 - Submittals.

1.3 QUALITY CONTROL, GENERAL

A. The Contractor will maintain construction quality control (CQC) over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. The Contractor shall conduct 100 percent of the CQC testing and surveying necessary for completion of the Work and incur all costs associated with CQC except as noted herein.

1.4 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

B. Perform work by persons qualified to produce workmanship of specified quality.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.5 MANUFACTURER'S INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from Design Engineer before proceeding.

1.6 MANUFACTURER'S CERTIFICATES

A. When required by individual Specification Section, submit manufacturer's certificate, in duplicate, that products meet or exceed specified requirements.

1.7 MANUFACTURER'S FIELD SERVICE

A. When specified in respective Specification Sections, require manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to make appropriate recommendations.

B. Representative shall submit written report to Design Engineer listing observations and recommendations.

PART 2 - PRODUCTS – (NOT USED)

PART 3 - EXECUTION – (NOT USED)

END OF SECTION

SECTION 01 45 33

SPECIAL INSPECTIONS AND TESTING PROGRAM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contractor responsibilities for special inspection and testing.
2. Special Inspection program and reporting requirements.
3. Attachment A to this Specification Section includes the Submittal of Special Inspections.
4. Attachment B to this Specification Section includes Special Inspector qualifications, reporting requirements, and material specific inspections and tests.
    a. This information is for the Contractor reference only and is not part of the Contract Documents.
    b. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.
    c. The Service Provider(s) responsible for the Owner-provided Services will be selected after Contract award.

B. Purpose:

1. This Document was developed to address the requirements of the 2015 International Building Code IBC, section 1704.1, including:
    a. One or more special inspectors will be hired by the Owner or the Owner's Agent to provide inspections during constructions on the types of work listed under Section 1704.
2. A Statement of Special Inspections will be submitted to the Building Code Official as a condition for permit issuance. This statement is included as Attachment A to this Specification. Attachment B includes a complete list of materials and work requiring special inspections, the inspections to be performed and a list of the minimum qualifications of the individuals, approved agencies or firms intended to be retained for conducting such inspections.

C. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.

1.2 DEFINITIONS

A. Special Inspector: Representative of the Owner approved inspection agency designated for that portion of the work.

B. Testing Agency: Approved agency, not affiliated or hired by the Contractor, which is responsible for the materials testing requirements of the project including but not limited to concrete cylinder breaks, soils testing, and masonry materials testing.

C. Statement of Special Inspections: Document provided to the Building Code Official outlining special inspections and tests to be done on the project and frequency of required test.

D. Soils Engineer or Geotechnical Engineer: For the purposes of Special Inspection "Soils Engineer," "Geotechnical Engineering," and "Special Inspector" shall be interchangeable as pertains to the Division 31 specifications.

E. NICET: National Institute for Certification in Engineering Technologies.

1.3 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with testing agency personnel, special inspector, and agents of the Building Code Official and provide access to the work.

1. Providing access to the work shall include all labor and facilities to perform inspections and tests as listed in the specifications for the duration of the inspections or tests involved.
2. Provide means to obtain and handle samples taken on site.

B. Attend a pre-construction meeting to coordinate and clarify inspection and testing procedures, requirements.

C. Notify special inspector and/or testing agency of work to be inspected/tested minimum of 24 HRS prior.

D. Work for which special inspections are required shall remain accessible and exposed for the purposes of special inspections until completion of required special inspections.

E. Any portion of work that is not in conformance shall be corrected and re-inspected. Such portions of the work shall not be covered or concealed until authorized by Owner's Representative.

F. Work to be inspected should be complete at time of inspector's arrival on-site.

G. Payment for Special Inspection services will be in accordance with the following:

1. Payment described below is for the Testing Agency and Special Inspector costs and does not include the Contractor's costs listed in Paragraph 1.3 A.
2. After Contractor notification, inspector arrives at site and performs inspection within the timeframe defined in Item 4 below.
   a. Inspection reveals work is satisfactory.
   b. Owner pays all costs associated with this inspection.
3. After Contractor notification, inspector arrives at site and performs inspection within the timeframe defined in Item 4 below.
   a. Inspection reveals work is deficient.
   b. Contractor corrects deficiencies within timeframe defined in Item 4) below.
   c. Work is re-inspected and work is satisfactory.
   d. Owner pays all costs associated with this inspection.
4. After Contractor notification, inspector arrives at site and work is not ready for inspection when inspector arrives.
   a. Inspector will remain on-site for a maximum of 2 HRS awaiting the completion of the work.
   b. If work is not ready for inspection at the end of this period, inspector will be dismissed until Contractor requests re-inspection.
   c. All costs associated with this inspection trip will be charged to the Contractor.
5. After Contractor notification, inspector arrives at site and performs inspection within the timeframe defined above.
   a. Inspection reveals work is deficient.

b. Contractor attempts to correct deficiencies within 2 HR timeframe and calls for re-inspection.
c. Work is re-inspected and found to still be deficient.
d. Inspector will be dismissed.
e. All costs associated with this inspection trip will be charged to the Contractor.

6. Owner will pay for "passing" soils on the Project. Costs of corrective actions and cost of failed test areas requiring retesting are the sole responsibility of the Contractor. For additional specific payment requirements for soils see the respective Division 31 Section.

H. Special Inspection is intended to be an independent quality assurance. Special Inspections shall not relieve the Contractor of any quality assurance, quality control, workmanship, or warranty responsibilities. Contractor's own personnel shall review all work to be inspected for conformance with Contract Documents prior to calling for inspection.

1.4 REPORTING DUTIES AND AUTHORITY

A. A pre-construction meeting to coordinate and clarify inspection, testing, and procedural requirements will be held.

1. The meeting is to be attended by:
a. Owner.
b. Engineer.
c. Building Code Official or designee.
d. Testing Agency and Special Inspectors.
e. General Contractor.
f. Appropriate Sub-contractor(s).

B. Special Inspector shall report all deficient work to the Contractor as soon as possible.

1. Deficient work that has been covered up or concealed prior to re-inspection shall be reported to the Engineer and the Building Code Official.

C. Special Inspector does not have authority to stop work or modify the requirements of the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

ATTACHMENT A TO SECTION 01 45 33

SUBMITTAL OF SPECIAL INSPECTIONS

Statement Date:

Project Name:
Project Address:
Owner:
Registered Design Professional in Responsible Charge (DPRC):

The Statement of Special Inspections (Statement) is submitted as a condition for permit issuance in accordance with the Special Inspection requirements of the Building Code. The Special Inspection program is outlined in Specification Section 01 45 33 and Attachments A and B. A detailed explanation of the requirements for Special Inspections and Testing can be found in specification Section 01 45 33 of the Project Manual in conjunction with the Technical Specifications for each material.

Bi-weekly Special Inspection reports will be submitted to the DPRC and the Building Official. Discovered discrepancies will be brought to the immediate attention of the Contractor for correction. If the discrepancies are not corrected, the discrepancies will be brought to the attention of the DPRC and the Building Official. Only documents that are prepared and signed or sealed by the Special Inspectors (SI) are valid.

The SI is responsible for verifying all information on each document prior to signing or sealing and directly forwarding it to the DPRC and Building Official. The SI is responsible for verifying all inspectors under his supervision maintain current certifications during the course of the project. At the conclusion of each individual Special Inspection type, the SI will complete a Final Report.

The Special Inspection program does not relieve the Contractor or any other entity of any contractual duties, including quality control, quality assurance, or safety. The Contractor is solely responsible for construction means, methods, and job site safety. Failure to adhere to the SI program as outlined herein may result in a stop work notice being issued by the Building Official.

Respectfully submitted,
Design Professional in Responsible Charge,

_____
Type or Print Name

_____ License # _____
Expires: _____

_____ _____
Signature Date

END OF ATTACHMENT A

ATTACHMENT B TO SECTION 01 45 33

SPECIAL INSPECTIONS, INSPECTOR QUALIFICATIONS AND REPORTING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 05 05 - Concrete Testing and Inspection.
4. Section 31 23 00 - Earthwork.

1.2 QUALIFICATIONS

A. Qualifications stated here are the minimum recommended by the Engineer. If the Building Code Official has more stringent qualifications, the more stringent qualifications will take precedence.

B. All Special Inspections and Testing to be done under the direction of a Professional Engineer or Registered Architect registered in the State of North Carolina herein referred to as Registered Professional for Special Inspections (RPSI).

C. Soil, concrete, masonry, mortar, grout, steel and aluminum related testing.

1. The Testing Agency shall have a minimum of 10 years' experience in the testing of these materials.
2. The Testing Agency's technician(s) conducting this testing:
   a. Shall have a minimum of five years' experience in the testing of soil, concrete, mortar, grout, steel and aluminum as appropriate.
3. Concrete related work:
   a. International Code Council certification for Reinforced Concrete and American Concrete Institute Concrete Field Testing Technician – Grade 1.

D. Special Structural Inspections:

1. Professional Engineers or Architects, licensed in the State of North Carolina, may perform special inspections in accordance with their license qualifications.
2. Other individuals, working under the direct supervision of a licensed engineer and meeting the following qualifications, may perform special inspections.
3. Soils related work:
   a. NICET Level II Certification in geotechnical engineering technology/construction; or
   b. Registered Geologist; or
   c. Engineer Intern under the direct supervision of a Licensed Professional Engineer.
4. Concrete related work:
   a. International Code Council certification for Reinforced Concrete Special Inspector or American Concrete Institute Concrete Construction Special Inspector.
   b. Alternatively, may be an Engineer Intern under the direct supervision of a Licensed Professional Engineer.
5. Masonry related work:
   a. Shall be certified by the International Code Council or American Concrete Institute for structural masonry and one year of related experience.
   b. Alternatively, may by an Engineer Intern with a minimum of two years appropriate training.

6. Steel and aluminum related work:
    a. Frame and material verification IBC Table 1704.3, Items 3 and 6:
        1)
    b. Welding:
        1) American Welding Society as a Certified Welding Inspector; or
        2) International Code Council Structural Steel and Welding Certification and American Welding Society Qualified and one year of related experience; or
        3) NDT Level II or II Certificate (for non-destructive testing only).
    c. High strength bolting:
        1) International Code Council Structural Steel and Welding Certification and one year related experience.
        2) Alternatively, may be an Engineer Intern with appropriate training.

1.3 REPORTING DUTIES AND AUTHORITY

A. Reporting requirements for special inspector per IBC 2015 for Building System Related Work.
    1. Comply with requirements of IBC Section 1704.1.2.
    2. Provide written documentation of all inspections and testing.
        a. Include exact location of work.
        b. If testing of specimens is included, include detailed information on storage and curing of specimens prior to testing.
    3. Furnish inspection and test reports to the Contractor, the Engineer's Project Manager and the Owner's on-site representative.
        a. Indicate that work inspected was done in conformance with approved construction documents.
        b. Immediately report any discrepancies to the Contractor for correction.
        c. If the discrepancies are not corrected in a timely fashion, notify the Engineer's Project Manager and Owner's on-site representative.
    4. Issue an electronic report summarizing all inspections, corrective action notifications and resolution of discrepancies and non-conforming work every two weeks (14 calendar days).
        a. Copy will be available to:
            1) Engineer's Project Manager.
            2) Owner.
            3) The Building Code Official.
            4) General Contractor.
    5. At the end of the Project, the RPSI shall compile all test reports for each inspected material and for each Special Inspector and summarize into a single PDF and submit to the Engineer and Building Code Official.
        a. Final summary report to be signed and sealed by a Registered Professional for Special Inspections stating:
            1) The required Special Inspections have been performed.
            2) All discrepancies have been resolved except as specifically stated in the summary report.

B. Special Inspector shall report all deficient work to the Contractor as soon as possible.
    1. Deficient work that has been covered up or concealed prior to re-inspection shall be reported to the Engineer and the Building Code Official.

C. Special Inspector does not have authority to stop work or modify the requirements of the Contract Documents.

1.4 MATERIAL SPECIFIC SPECIAL INSPECTIONS AND TESTS

A. Material specific requirements for special inspection and testing are listed in the technical specifications listed below. Special inspection and testing requirements will be located in each appropriate technical specification under "SOURCE QUALITY CONTROL", "FIELD QUALITY CONTROL" and/or "QUALITY ASSURANCE" as appropriate for each material.

1.5 SOILS

A. Special Inspection/testing will be provided per IBC Section 1704.7 and Table 1704.7 as required to determine that the site has been prepared in accordance with the approved soils report, and to verify the allowable soil bearing pressure, materials, compaction densities, trenching and backfill and conformance to the project Specifications.

B. Inspection/testing requirements are listed separately in Specification Division 31 and are indicated as the work to be done by the Geotechnical Engineer, Testing Agency, or Special Inspections and Testing Provider.

1.6 CONCRETE

A. Special Inspection and testing will be provided per IBC Table 1704.4. Inspection is required for material verification, reinforcing steel, embedded bolts, mechanical splices, concrete tests, welding of reinforcing, concrete placement and curing, and waterstop placement.

B. Inspection and testing requirements are listed separately in Specification Section 03 05 05 and are indicated as the work to be done by the Special Inspector or Testing Agency.

C. .

1.7 STEEL, STAINLESS STEEL, AND ALUMINUM

A. Special Inspection will be provided for structural steel and aluminum per IBC Section 1704.2, 1704.3 and Table 1704.3. Inspection is required for material verification, high-strength bolting, welding and other work noted on the Contract Documents.

B. Inspection/testing requirements are listed separately in Section 05 50 00 and are indicated as the work to be done by the Special Inspector. Inspection requirements listed are applicable to aluminum, stainless steel, and structural steel.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF ATTACHMENT B

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SECTION 01 65 50
PRODUCT DELIVERY, STORAGE, AND HANDLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Scheduling of product delivery.
2. Packaging of products for delivery.
3. Protection of products against damage from:
    a. Handling.
    b. Exposure to elements or harsh environments.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.

C. Payment:

1. No payment will be made to Contractor for equipment or materials not properly stored and insured or without approved Shop Drawings.
    a. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

1.2 DELIVERY

A. Scheduling: Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.

B. Packaging: Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.

C. Identification: Clearly and fully mark and identify as to manufacturer, item, and installation location.

D. Protection and Handling: Provide manufacturer's instructions for storage and handling.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PROTECTION, STORAGE AND HANDLING

A. Manufacturer's Instruction:

1. Protect all products or equipment in accordance with manufacturer's written directions.
    a. Store products or equipment in location to avoid physical damage to items while in storage.
    b. Handle products or equipment in accordance with manufacturer's recommendations and instructions.
2. Protect equipment from exposure to elements and keep thoroughly dry.

3.2 STORAGE FACILITIES

A. Temporary Storage Facility:

1. Provide a weatherproof temporary storage facility specifically for the purpose of providing for protection of products and equipment.

a. Size facility to accommodate anticipated storage items.

2. Equip facility with lockable doors.
3. Provide methods of storage of products and equipment off the ground.
4. Locate facility on-site where shown on the Drawings or in location approved by Engineer.
5. Remove facility from site prior to Substantial Completion.

3.3 FIELD QUALITY CONTROL

A. Inspect Deliveries:

1. Inspect all products or equipment delivered to the site prior to unloading.
   a. Reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.

B. Monitor Storage Area: Monitor storage area to ensure suitable temperature and moisture conditions are maintained as required by manufacturer or as appropriate for particular items.

END OF SECTION

SECTION 01 77 19
CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for:

1. Substantial Completion.
2. Final inspection.
3. Request for final payment and acceptance of the Work.

1.2 SUBSTANTIAL COMPLETION

A. Substantial Completion – General:

1. Prior to requesting inspect no for Substantial Completion, perform the following for the substantially completed Work:
   a. Materials and equipment for which Substantial Completion is requested shall be fully ready for their intended use, including full operating and monitoring capability in automatic, manual, and other operating modes set forth in the Contract Documents.
   b. Permanent provisions for safety and protection, shown and indicated in the Contract Documents and associated with the substantially completed Work or for personnel accessing and using the substantially completed Work, shall be in place and ready for their intended use.
   c. Complete field quality control Work, including inspections and testing at the Site, indicated in Specifications sections for individual materials and equipment items and related Contract Documents. Submit results of, and obtain Design Engineer's acceptance of, field quality control tests and inspections required by the Contract Documents.
   d. Complete checkout and startup requirements of the Specifications for the various materials and equipment in the substantially completed Work, and related Contract Documents.
   e. Cleaning for Substantial Completion shall be completed.
   f. Spare parts, tools, and extra materials shall be delivered and accepted in accordance with the Contract Documents and documentation of Owner's acceptance thereof has been submitted to Design Engineer in acceptable form.
   g. Training of the facility's operations and maintenance personnel shall be completed in accordance with the Contract Documents.
   h. Obtain and submit to Design Engineer all required permits, inspections, and approvals of authorities having jurisdiction for the substantially completed Work to be occupied and used by Owner.
   i. Complete other tasks that the Contract requires be completed prior to Substantial Completion.

2. Procedures for requesting and documenting Substantial Completion are in the General Conditions, as may be modified by the Supplementary Conditions.
3. Sample letter for Contractor's request for inspection for Substantial Completion is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project and the needs of Contractor's request.

4. Unless decided otherwise by Owner and Design Engineer, form of certificate of Substantial Completion will be EJCDC C-625, “Certificate of Substantial Completion” (2018 edition or later), prepared by Design Engineer.
5. Refer to the Agreement for requirements regarding consent of surety to partial release of or reduction in retainage.

1.3 FINAL INSPECTION

A. Final Inspection – General:

1. Prior to requesting final inspection, verify that all the Work is fully complete and ready for final payment. Partial checklist for this purpose is attached to this Specifications section.
2. Sample letter for Contractor to request final inspection is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project.
3. Procedures for requesting and documenting the final inspection are in the General Conditions, as may be modified by the Supplementary Conditions, and as augmented in this Specifications section.

1.4 REQUEST FOR FINAL PAYMENT AND ACCEPTANCE OF THE WORK

A. Procedure:

1. After successful completion of the final inspection, submit request for final payment in accordance with the Agreement and General Conditions, as may be modified by the Supplementary Conditions, and using procedure specified in this Specifications section.
2. Acceptance of the Work:
    a. Upon Design Engineer’s concurrence that the Work is complete and ready for final payment (as a result of the final inspection and other communications between the parties and Design Engineer) and receipt of the final Application for Payment, accompanied by other required Contract closeout documentation, all in accordance with the Contract Documents, Design Engineer will issue to Owner and Contractor a notice of acceptability of the Work, in accordance with the General Conditions, as may be modified by the Supplementary Conditions.
    b. Unless decided otherwise by Owner and Design Engineer, form of acceptance will be EJCDC C-626, “Notice of Acceptability of Work”, (2018 edition or later).
    c. Nothing other than receipt of such notice of acceptability from Design Engineer constitutes acceptance of the Work.
    d. Receipt of Design Engineer’s notice of acceptability of the Work does not relieve Contractor of Contractor’s continuing obligations under the Contract, including correction period obligations, warranty obligations, indemnification obligations, insurance requirements, and Contractor’s other obligations following acceptance of the Work by Design Engineer and final payment. Such obligations shall commence and remain in effect as indicated elsewhere in the Contract Documents.

B. Request for final payment shall include:

1. Documents required for progress payments.
2. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.

3. List, on Contractor's letterhead, of all Change Proposals, Claims, and disputes that Contractor believes are unsettled. If there are no such Change Proposals, Claims, or disputes, so indicate in writing.
4. Consent of Surety to Final Payment:
    a. Acceptable form includes AIA G707, "Consent of Surety to Final Payment" (1994 or later edition), or other form acceptable to Owner.
5. Releases of Liens:
    a. Submit complete and legally effective releases (satisfactory to Owner) of all Liens filed in connection with the Work, regardless of whether such Lien was filed by Contractor, Subcontractor, or Supplier.
    b. Each release of Lien shall be signed by an authorized representative of the entity submitting the release of Lien, and shall include Contractor's, Subcontractor's, or Supplier's (as applicable) corporate seal, when applicable.
6. Waivers of Lien Rights:
    a. Submit legally-binding waivers of rights to file Liens, acceptable to Owner, as required in the General Conditions (as may be modified by the Supplementary Conditions) from Contractor and each Subcontractor and Supplier that furnished or provided labor, material, or equipment totaling $1,000 or more for the Work.
    b. Furnish final list of Subcontractors and Suppliers indicating final amount of the associated subcontract or purchase order for each. Include on the list all lower-tier Subcontractors and Suppliers retained by higher-tier Subcontractors and Suppliers.
    c. Each waiver of Lien rights shall be signed by an authorized representative of the entity submitting waiver of Lien rights, and shall include Contractor's, Subcontractor's, or Supplier's (as applicable) corporate seal, when applicable.
    d. Waiver of Lien rights may be conditional upon receipt of final payment.
    e. Required Affidavits: Submit the following:
        1) Affidavit of payment of debts and claims, submitted by Contractor. Acceptable form includes AIA G706, "Contractor's Affidavit of Payment of Debts and Claims" (1994 or later edition), or other form acceptable to Owner, and;
        2) Affidavit of release of Liens, submitted by Contractor. Acceptable form includes AIA G706A, "Affidavit of Release of Liens" (1994 or later edition).
        3) Each affidavit shall be signed by an authorized representative of Contractor and shall bear Contractor's corporate seal, as applicable.
    f. In the event Contractor is unable to obtain one or more required waivers of Lien rights, recourse is set forth in the General Conditions, as may be modified by the Supplementary Conditions.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The documents listed below, following this Specification section's "End of Section" designation, are part of this Specifications section:

1. Sample letter for Contractor's use in requesting inspection for Substantial Completion (two pages).

2. Sample partial checklist to identify readiness for final inspection (four pages).
3. Sample letter for Contractor's use in requesting final inspection (one page).

B. In the model language of the attached sample letters for Contractor to request inspection for Substantial Completion and the final inspection, italicized language in brackets, e.g., "[insert date]" indicates instructions to the drafter of the letter and often indicates specific information to be inserted by Contractor; do not include bracketed, italicized text in the final version of the letter(s) prepared for the Project. Non-italicized language in brackets is optional language; use the appropriate language to complete the actual letter for the Project and edit where required to suit the specific circumstances.

END OF SECTION

SAMPLE LETTER FOR CONTRACTOR'S USE IN REQUESTING INSPECTION FOR SUBSTANTIAL COMPLETION

SENT VIA E-MAIL AND U.S. CERTIFIED MAIL/RETURN RECEIPT REQUESTED

[Date]

[Name of Engineer's contact person]
HDR
[Street address]
[City, state, postal code]

Subject:
[Project name, Contract designation]
Request for Inspection for Substantial Completion

Dear [addressee]:

In our opinion, [all of] [or] [a portion of] the Work under the above-referenced Contract is substantially complete as of [insert month, day, year on which Substantial Completion was achieved]. [The specific portion of the Work that we believe is substantially complete is [insert identification of that portion of the Work that is substantially complete].]

Enclosed is our listing of uncompleted Work items ("punch list"). In accordance with Paragraph 15.03.A of the General Conditions, we hereby request: (1) That the Engineer schedule and perform the inspection for Substantial Completion as soon as possible, and (2) Issuance of the certificate of Substantial Completion.

In accordance with Paragraph 15.03.D of the General Conditions, upon Substantial Completion, we propose the following relative to apportionment of responsibilities between the Owner and the Contractor:

1. Security, Protection, Insurance:
    a. Site Security: [insert proposal; address whether Owner or Contractor will be responsible for security of the Site].
    b. Protection of the Substantially Completed Work: [insert proposal; address whether Owner or Contractor will be responsible for protection].
    c. Property Insurance: [insert proposal; typically Owner assumes responsibility for property insurance upon Substantial Completion]
2. Operation and Maintenance:
    a. Operation: [insert proposal; address whether Owner or Contractor will be responsible for operating the substantially completed Work].
    b. Maintenance: [insert proposal; address whether Owner or Contractor will be responsible for maintaining the substantially completed Work].
3. Utilities: [for each of the following, indicate whether Owner or Contractor will be responsible for utilities and services, or whether responsibility will be shared; if shared, indicate proposed cost-sharing]
    a. Electricity: [insert proposal].
    b. Natural Gas/Fuel/Heating: [insert proposal].

c. Water Supply: [insert proposal].

d. Wastewater: [insert proposal].

e. Communications (Telephone, Internet, Video): [insert proposal].

In accordance with Paragraph 15.08.A of the General Conditions, we understand that the Contract's correction period for the Work covered by the certificate of Substantial Completion commences on the Substantial Completion date documented in said certificate. [Drafter: Also see Paragraph 15.04 ("Partial Utilization") of the General Conditions and, where necessary, edit this paragraph of the letter accordingly.]

Should you have questions or comments regarding this notice, please contact [the undersigned] [or] [insert other contact person's name], at [insert telephone number and e-mail address].

Sincerely,

[Contractor's company name]

[Signatory name]
[Signatory's title]

Attachments:
Preliminary list of uncompleted Work items ("punch list"; [##] pages)

Copies:
[Owner's project manager]

SAMPLE PARTIAL CHECKLIST TO IDENTIFY READINESS FOR FINAL INSPECTION

Project: _____
Contract: _____
Contractor: _____

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
1. All Submittals, including all Shop Drawings and Samples, approved or accepted by Engineer	☐		☐	☐	☐		
Remarks:							
1. Final services completed by Suppliers, including submittal of "Manufacturer Field Service Report"	☐		☐	☐	☐		
Remarks:							
2. Final Work completed by Subcontractors	☐		☐	☐	☐		
Remarks:							
3. Permits closed out and regulatory compliance transitioned from construction to operations	☐		☐	☐	☐		
Remarks:							
4. All outstanding change issues are addressed and all Change Proposals submitted	☐		☐	☐	☐		
Remarks:							

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
5. All Change Proposals and Claims are resolved	☐		☐	☐	☐		
Remarks:							
6. All defective Work of which Contractor is aware has been corrected in accordance with the Contract Documents	☐		☐	☐	☐		
Remarks:							
7. Issues related to Constituents of Concern and potential Hazardous Environmental Condition have been fully addressed	☐		☐	☐	☐		
Remarks:							
8. All spare parts, tools, and extra materials have been furnished in accordance with the Contract Documents, and documentation thereof submitted to Engineer	☐		☐	☐	☐		
Remarks:							
9. All final operations & maintenance manuals have been submitted and accepted by Engineer	☐		☐	☐	☐		
Remarks:							
10. Manufacturer warranties and software license(s) furnished	☐		☐	☐	☐		
Remarks:							

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
11. Instruction and training of operations and maintenance personnel is complete and records of training submitted	☐		☐	☐	☐		
Remarks:							
12. MBE/WBE/DBE/VBE compliance report(s) submitted (when applicable)	☐		☐	☐	☐		
Remarks:							
13. All field engineering Submittals, including survey data, furnished	☐		☐	☐	☐		
Remarks:							
14. All Work on “punch list” is complete in accordance with the Contract Documents	☐		☐	☐	☐		
Remarks:							
15. All record documents submitted to and accepted by Engineer	☐		☐	☐	☐		
Remarks:							
16. Contractor is fully demobilized from the Site	☐		☐	☐	☐		
Remarks:							
17. All Site restoration is complete	☐		☐	☐	☐		
Remarks:							
18. Final cleaning of all work areas is complete	☐		☐	☐	☐		

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
Remarks:							
19. Releases of Liens and waivers of Lien rights (or acceptable alternative) obtained from Subcontractors and Suppliers	☐		☐	☐	☐		
Remarks:							
20. Evidence of Contractor liability insurance furnished for correction period	☐		☐	☐	☐		
Remarks:							
21. All other required Contract closeout documents obtained	☐		☐	☐	☐		
Remarks:							
Remarks:							
22. All other Work and documentation required prior to final payment is complete and provided in accordance with the Contract Documents	☐		☐	☐	☐		
Remarks:							

SAMPLE LETTER FOR CONTRACTOR'S USE IN REQUESTING FINAL INSPECTION

SENT VIA E-MAIL AND U.S. CERTIFIED MAIL/RETURN RECEIPT REQUESTED

[Date]

[Name of Engineer's contact person]
HDR
[Street address]
[City, state, postal code]

Subject:
[Project name, Contract designation]
Request for Final Inspection

Dear [addressee]:

The Work under the above-referenced Contract is complete and ready for final payment as of [insert month, day, year on which final completion was achieved]. In accordance with Paragraph 15.05 of the General Conditions, we hereby request that the Engineer schedule and perform the final inspection as soon as possible. Upon successful completion of the final inspection, we will submit our final Application for Payment accompanied by the required Contract closeout documentation in accordance with the Contract Documents.

Should you have questions or comments regarding this notice, please contact [the undersigned] [or] [insert other contact person's name], at [insert telephone number and e-mail address].

Sincerely,

[Contractor's company name]

[Signatory name]
[Signatory's title]

Attachments:
None

Copies:
[Owner's project manager]

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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 Owner provided testing.
3. Acceptance criteria for concrete.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 21 00 - Reinforcement.
4. Section 03 31 30 - Concrete, Materials and Proportioning.
5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
6. Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.

1.2 RESPONSIBILITY AND PAYMENT

A. Owner 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. Owner will pay for services defined in Paragraph 1.2A.1.

B. Hire a qualified testing agency to perform the following testing and provide test results to the Engineer.

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. Reimburse Owner for testing services defined in Paragraphs 1.2A.2., 1.2A.3., 1.2A.4. and 1.2A.5.

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. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. 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 along with other submittal data as required for fly ash by Specification Section 03 31 30.
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 and any other data required by Specification Section 03 31 30 to establish concrete mix design.

3. 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: Five 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) 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.
4. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

A. See below.

1. Special Inspections listed are for the Contractor reference only and is not part of the Contract Documents.
2. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.

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 PCT of adhesive anchors 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.

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 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. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 or requirements of the Contract Drawings or approved Shop Drawings.

c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.

d. Curing time and procedure not meeting requirements of this Specification Section.

e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.

f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.

g. 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 PCT) 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 PCT of specified strength and no single core is less than 75 PCT 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

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SECTION 03 11 13
FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formwork requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 05 05 - Concrete Testing and Inspection.
4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
5. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

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. 347R, Guide to Formwork for Concrete.

B. Qualifications:

1. Formwork, shoring and reshoring to be designed by a licensed professional engineer currently registered or having a minimum of three years of experience in this type of design work.
   a. Above qualifications apply to slabs and beams not cast on the ground.

C. Miscellaneous:

1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
2. Design requirements:
   a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
      1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
   b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
3. For slabs and beams not cast on the ground, develop a procedure and schedule for removal of shores [and installation of reshores] and for calculating the loads transferred to the structure during this process in accordance with ACI 347R.
   a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon. Calculations shall be performed by a licensed professional engineer.
   b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
      1) The structural system that exists.
      2) Effects of all loads during construction.

3) Strength of concrete.
4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

B. SCC: Self-Consolidating Concrete.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for the requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Manufacturer and type of proposed form ties.

B. Samples:

1. A 12 IN SQ sample of each of the following form finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms for Surfaces Exposed to View:

1. Wood forms:
   a. 5/8 or 3/4 IN 5-ply [faced] structural plywood of concrete form grade.
   b. Built-in-place or prefabricated type panel.
2. Metal forms:
   a. Metal forms may be used except for aluminum in contact with concrete.
   b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:

1. Wood or metal sufficiently tight to prevent leakage.
2. Do not use aluminum forms.

2.2 ACCESSORIES

A. Form Ties:

1. Commercially fabricated for use in form construction.
   a. Field fabricated ties are unacceptable.
2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
3. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.
4. Cone size:
   a. 3/4 IN minimum diameter cones on both ends.
   b. Depth of cone not to exceed the concrete reinforcing cover.

5. Provide ties with built-in waterstops in all walls that will be in contact with [process liquid during plant operation] [below grade soil].
6. Through-wall ties that are designed to be entirely removed are not allowed in all walls that will be in contact with liquids during plant operation.

B. Form Release Material:

1. If project contains self-consolidating concrete, provide reactive, vegetable based product, not barrier type.

C. Void Forms:

1. Constructed from double faced corrugated cardboard or fiberboard which is wax impregnated and laminated with moisture-resistant adhesive.
2. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:

1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
   a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
2. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.

1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 FT apart.

C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:

1. Conform to ACI 117.
2. Variation from plumb:
   a. In lines and surfaces of columns, piers, walls, and in risers.
      1) Maximum in any 10 FT of height: 1/4 IN.
      2) Maximum for entire height: 1/2 IN.
   b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
      1) Maximum in any 20 FT length: 1/4 IN.
      2) Maximum for entire length: 1/2 IN.
3. Variation from level or from grades specified:
   a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
      1) Maximum in any 10 FT of length: 1/4 IN.
      2) Maximum in any bay or in any 20 FT length: 3/8 IN.

3) Maximum for entire length: 3/4 IN.

b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:

1) Maximum in any bay or in 20 FT length: 1/4 IN.

2) Maximum for entire length: 1/2 IN.

4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:

a. Maximum in any bay: 1/2 IN.

b. Maximum in any 20 FT of length: 1/2 IN.

c. Maximum for entire length: 1 IN.

5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.

6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 IN.

7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 IN, +1/2 IN.

8. Footings and foundations:

a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.

b. Misplacement or eccentricity:

1) 2% of footing width in direction of misplacement but not more than 2 IN.

c. Thickness:

1) Decrease in specified thickness: 5%.

2) Increase in specified thickness: No limit except that which may interfere with other construction.

9. Variation in steps:

a. In a flight of stairs:

1) Rise: +1/8 IN.

2) Tread: +1/4 IN.

b. In consecutive steps:

1) Rise: +1/16 IN.

2) Tread: +1/8 IN.

10. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and benchmarks to be used for reference purposes to check tolerances.

11. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.

12. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.

1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.

2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.

F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 FT wide.

1. Brace and tie formwork to maintain correct position and shape of members.

G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.

1. Securely brace forms against lateral deflection.
2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.

1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength.

1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.

1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
2. Locate reshores directly under a shore position above.

H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

3.5 FIELD QUALITY CONTROL

A. Special Inspection:

1. See Section 01 45 33.
2. See Section 03 05 05.

END OF SECTION

SECTION 03 15 19
ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for all cast-in-place anchor bolts, anchor rods, reinforcing anchorage adhesive, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
2. Design of all concrete anchors not indicated on the Drawings including, but not limited to, installation of anchors into concrete for the following structural and nonstructural components:
    a. Structural members and accessories.
    b. Metal, wood, and plastic fabrications.
    c. Architectural components.
    d. Mechanical and electrical equipment and components.
    e. Plumbing, piping, and HVAC work.
    f. All other components requiring attachment to concrete.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 05 05 - Concrete Testing and Inspection.
2.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
    a. 318, Building Code Requirements for Structural Concrete and Commentary.
    b.
    c. 355.2, Seismic Testing of Post-Installed Concrete and Masonry Anchors in Cracked Concrete.
    d. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
    a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
3. American Institute of Steel Construction (AISC):
    a. 303, Code of Standard Practice for Steel Buildings and Bridges.
4. ASTM International (ASTM):
    a. A36, Standard Specification for Carbon Structural Steel.
    b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
    c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
    f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
    g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
    h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

i. F436, Standard Specification for Hardened Steel Washers.
j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
k. F594, Standard Specification for Stainless Steel Nuts.
l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
m. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

5. ICC Evaluation Service (ICC-ES):
   a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

B. Qualifications:

1. Anchor designer for Contractor-designed post-installed anchors and cast in place anchorage shall be a professional [structural] [civil] engineer licensed in the State that the Project is located in.
2. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.

C. Post-installed anchors and related materials shall be listed by the following agencies:

1. ICC-ES.
2. Engineer approved equivalent.

1.3 DEFINITIONS

A. Adhesive Anchors:

1. Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
2. Includes anchors using acrylics, epoxy and other similar adhesives.

B. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.

C. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.

D. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.

E. Galvanizing: Hot-dip galvanizing per ASTM A123, ASTM A153 or ASTM F2329 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

F. Hardware: As defined in ASTM A153.

G. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

H. MPII: Manufacturer’s printed installation instructions.

I. Mechanical Anchors:

1. Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
2. Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
3. Drop-in anchors and other similar non-ICC ES approved anchors are not allowed.

J. Post-Installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
    a. Acknowledgement that submitted products meet requirements of referenced standards.
    b. Manufacturer material data sheet for each anchor.
        1) Clearly indicate which products on the data sheet are proposed for use on the Project.
    c. Manufacturer's printed installation instructions.
    d. Current ICC-ES report for each post-installed anchor system indicating the following:
        1) Certification that anchors meet all requirements indicated in this Specification.
        2) Performance data showing that anchor is approved for use in cracked concrete.
        3) Seismic design categories for which anchor system has been approved.
        4) Required installation procedures.
        5) Special inspection requirements for installation.
    e. Contractor Designed Anchors:
        1) Show diameter and embedment depth of each anchor.
        2) Indicate compliance with ACI 318, Appendix D ACI 318, Chapter 17.
        3) Design tension and shear loads used for anchor design.
        4) Engineering design calculations:
            a) Indicate design load to each anchor.
            b) Develop anchor forces based on Design Criteria listed herein and/or manufacturer’s design information.
            c) Sealed and signed by contractor’s professional [structural] engineer.
            d) Calculations will be submitted for information purposes only.
        5) Type of post-installed anchor system used.
            a) Provide manufacturer's ICC-ES report for the following:
                (1) Mechanical anchorage per ICC-ES AC193.
                (2) Adhesive anchorage per ICC-ES AC308.

B. Samples:

1. Representative samples of concrete anchors may be requested by Engineer. Review will be for type and finish only. Compliance with all other requirements is exclusively the responsibility of the Contractor.

C. Informational Submittals:

1. Certification of qualifications for each installer of post-installed anchors.
    a. Indicate successful completion or certification for each type of approved post-installed anchor as required by the Contract Documents.
    b. Provide one of the following for each type of anchor, as required by this specification section:
        1) Letter from manufacturer documenting successful training completion [for mechanical anchors only].
        2) Certification of completion for Engineer approved program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer’s or distributor’s packaging undamaged and complete with installation instructions.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

C. Protect and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast-in-place Concrete Anchors:

1. Building and nonbuilding structures, unless otherwise specified:
   a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized [or non-galvanized] threaded rods.
   b. ASTM A307, Grade A for galvanized headed bolts.
   c. For Submerged or used in enclosed tankage, ASTM F593, Type 316.
2. All other cast-in-place concrete anchors for equipment:
   a. Stainless steel with matching nut and washer.
   b. Submerged application: ASTM F593, Type 316.
   c. Non-submerged application: ASTM F593, Type 304 or Type 316 anchors and washers

B. Post-Installed Mechanical and Adhesive Concrete Anchors:

1. Stainless steel with matching nut and washer.
2. Submerged application: ASTM F593, Type 316.
3. Non-submerged application: ASTM F593, Type 304 or Type 316, with ASTM A563 nuts coated after torquing.

C. Reinforcement: See Section 03 21 00.

D. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.

E. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.

F. Washers:

1. ASTM F436 unless noted otherwise, finish to match bolt.
2. If stainless steel anchorage is being used for cast-in-place anchorage, furnish washers of the same material and alloy as in the accompanying anchorage.
3. Plate washers: Minimum [1/2] [3/4] IN thick fabricated ASTM A36 square plates as specified or required.
4. Follow manufacturer's requirements for all post-installed anchorage.

G. Nuts:

1. ASTM A563 for all cast-in-place anchorage.
2. If stainless steel anchorage is being used for cast-in-place anchorage in submerged or enclosed tankage, nuts shall meet ASTM F594 and be the matching material and alloy as in the accompanying anchorage.
3. Follow manufacturer's requirements if using post-installed anchorage.

H. Galvanizing Repair Paint:

1. High zinc dust content paint for regalvanizing welds and abrasions.
2. ASTM A780.
3. Zinc content: Minimum 92% in dry film.
4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

I. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.2 CONTRACTOR DESIGNED ANCHORAGE

A. Manufacturers:

1. Post-installed anchor systems for the listed manufacturers will be considered only if a current ICC-ES evaluation report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section and if the anchor system is approved by the Engineer.
    a. Hilti.
    b. Dewalt.
    c. Simpson Strong-Tie.

B. Design the anchorage when any of the following occur:

1. Design load for concrete anchorage is shown on the Drawings.
2. When specifically required by the Contract Documents.
3. When an anchorage is required but not specified in the Drawings.

C. Anchorage Design Loads:

1. Determine all of the design loads, including wind and seismic loads, per the building code.
    a. Anchorage of equipment and non-structural components: Use the actual dead and operating loads provided by the manufacturer.
    b. Additional support requirements for utilities: See appropriate Specification Section.

D. When Contract Drawings indicate an anchor diameter or length, design shall incorporate these as “minimums.” Design these anchors and provide all necessary documentation as required herein.

E. Cast-in-Place Concrete Anchors:

1. Provide the material, nominal diameter, embedment length, spacing, edge distance and design capacity to resist the calculated load based on the requirements given in the building code including ACI 318, Appendix D[, ACI 318, Chapter 17] [, ACI 350, Appendix E].
2. Design assuming cracked concrete.

F. Post-installed Concrete Anchors:

1. Provide the manufacturer’s system name/type, nominal diameter, embedment depth, spacing, minimum edge distance, cover, and design capacity to resist the specified [or calculated] load based on requirements given in the building code, [ACI 318, Appendix D][ACI 318, Chapter 17][, ACI 350, Appendix E] and current ICC-ES report, for the anchor to be used.
2. Design assuming cracked concrete.

2.3 ENGINEER DESIGNED ANCHORAGE

A. When the size, length and details of anchorages are shown on Contract Structural Drawings, Contractor design of anchorage is not required [unless otherwise indicated].

B. Manufacturers:

1. Additional newer post-installed anchor systems for the listed manufacturers will be considered only if a current evaluation agency report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section, the anchor system is certified by ICC-ES for cracked concrete conditions, and if approved by the Engineer.
2. Mechanical Anchors:
    a. Hilti:
        1) Kwik Bolt TZ (ICC-ES ESR-1917).
3. Adhesive Concrete Anchors:

a. Hilti:
    1) HIT RE 500 V3 (ICC ESR-3814).
4. Concrete Screw Anchors:
    a. Hilti:
        1) Kwik HUS-EZ Screw (ICC-ES ESR-3027).
5. Submit request for substitution in accordance with Specification Section 01 25 13.
    a. Substitution request to indicate the proposed anchor has at least the same tension and shear strength as the specified anchor installed as indicated in the Contract Drawings.
    b. Calculations to be stamped by a Professional Engineer registered in the state that the Project is located in.

PART 3 - EXECUTION

3.1 GENERAL

A. Cast-in-Place Anchorage:

1. Use where anchor rods or bolts are indicated on the Drawings, unless another anchor type is approved by the Engineer.
2. Provide concrete anchorage as shown on the Drawings or as required to secure components to concrete.

B. Adhesive Anchorage:

1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
2. May be used where subjected to vibration or where buried or submerged.
3. Do not use in overhead applications or sustained tension loading conditions such as utility hangers.
4. Contact Engineer for approval when anchors will not be installed in compliance with MPII

C. Mechanical Anchorage:

1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
2. Do not use where subjected to vibration.
3. May be used in overhead applications.
4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.

D. Do not use powder actuated fasteners and other types of bolts and fasteners not specified herein for structural applications unless approved by the Engineer or specified in Contract Documents.

3.2 PREPARATION

A. Provide adequate time to allow for proper installation and inspection prior to placing concrete for cast-in-place concrete anchorage.

B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed.

1. Notify Engineer of conditions detrimental to proper and timely completion of work.
2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

C. Special Inspection is required in accordance with the building code for all concrete anchorage.

1. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).

2. See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section for additional requirements.

D. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors at no additional expense to the Owner.

1. Follow such procedures to assure acceptable installation.
2. Adhesive anchors must be installed in concrete aged a minimum of 21 days.

3.3 INSTALLATION

A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.

1. Tack welding of anchorage is prohibited.
2. Chase threads as required and coat the projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
3. Anchorage location tolerance shall be in accordance with AISC 303.
4. Provide steel or durable wood templates for all column and equipment anchorage.
    a. Templates to be placed above top of concrete and not impede proper concrete placement and consolidation.

B. Unless noted or specified otherwise:

1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
    a. Provide dissimilar materials protection per Specification Section 09 96 00.
2. Provide washers for all anchorage.
3. Where exposed, extend threaded anchorage [a maximum of 3/4 IN and] a minimum of 1/2 IN above the top of the fully engaged nut.
    a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.

C. Do the following after nuts are snug-tightened down:

1. If using post-installed anchorage, follow MPII.
2. Upset threads of anchorage to prevent nuts from backing off.
    a. Provide double nut or lock nut in lieu of upset threads for items that may require removal in the future.
3. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn beyond snug tight to prevent nuts from backing off.
4. If two nuts are used per concrete anchor above the base plate, tighten the top nut an additional 1/8 turn to "lock" the two nuts together.
5. If using post-installed anchorage, follow MPII.

D. Assure that embedded items are protected from damage and are not filled in with concrete.

E. Secure architectural components such that it will not be aesthetically distorted and fasteners will not be overstressed from expansion, contraction, or installation.

F. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

G. Repair damaged galvanized surfaces in accordance with ASTM A780.

1. Prepare damaged surfaces by abrasive blasting or power sanding.
2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions and ASTM A780.

H. For post-installed anchors, comply with the MPII on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar.

1. Use hammer drills to create holes.

2. Properly clean out the hole per the ICC-ES reports utilizing a non-metallic fiber bristle brush and compressed air or as otherwise required to remove all loose material from the hole prior to installing the anchor in the presence of the Special Inspector.

3.4 FIELD QUALITY CONTROL

A. Special Inspection:

1. See Section 01 45 33.
2. See Section 03 05 05.

B. Field Inspection and Testing

1. Owner reserves the right to inspect and test completed anchorage at a minimum of 10% (for large quantity) to 25% (smaller quantity) to 100% (very small project quantity).
2. Such testing shall conform to requirements of ACI 355.2 and/or ACI 355.4 as applicable.
3. Failed anchors shall be satisfactorily replaced at no cost to Owner.

3.5 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

END OF SECTION

SECTION 03 21 00
REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforcing bar requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 05 05 - Concrete Testing and Inspection.
4. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
   a. SP 66, ACI Detailing Manual.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
   d. 318, Building Code Requirements for Structural Concrete.
2. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   e. A970, Standard Specification for Headed Steel Bars for Concrete Reinforcement.
   f. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
3. Concrete Reinforcing Steel Institute (CRSI):
   a. Manual of Standard Practice.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Mill certificates for all reinforcing.
   d. Manufacturer and type of proprietary reinforcing mechanical splices.
3. Qualifications of welding operators, welding processes and procedures.
4. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing supports.
5. Sufficient reinforcing details to permit installation of reinforcing.

6. Reinforcing details in accordance with ACI SP 66 and ACI 315.
7. Locations where proprietary reinforcing mechanical splices are required or proposed for use.
8. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
    a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.
    b. Where multiple types of supports for reinforcing steel (such as chairs, runners, bolsters, and other types of supports) will be used in the Work, clearly indicate on the Shop Drawings the support types and materials of supports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Reinforcing adhesive anchors:
    a. See Specification Section 03 15 19.
2. Reinforcing mechanical splices:
    a. Lenton Rebar Splicing by Erico, Inc.
    b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
    c. Bar-Grip Systems by Barsplice Products, Inc.

B. No like, equivalent or "or-equal" item [or substitution] is permitted.

C. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.

B. Reinforcing Bars to be Welded: ASTM A706, Grade 60, deformed.

C. Smooth Dowel Bars:

1. All locations: ASTM A36, with metal end cap to allow longitudinal movement equal to joint width plus 1 IN.

D. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125 PCT of the yield strength of the reinforcing bars being spliced.

E. Headed Deformed Bars:

1. ASTM A970, Class A.

2.3 ACCESSORIES

A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:

1. Metal fabrications with plastic-coated tips in contact with forms.
    a. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
    a. 100 PCT non-metallic, non-corrosive.

b. Required for all walls and elevated construction exposed to liquid containing structures.

B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

A. Tolerances:

1. Conforms to ACI 117, expect as modified herein.
2. Sheared lengths: +1 IN.
3. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
4. All other bends: +0 IN, -1/2 IN.

B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship reinforcing to jobsite with attached plastic or metal tags.

1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
2. Mark numbers on tags to be so placed that the numbers cannot be removed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:

1. Conform to ACI 117, except as modified herein.
2. Reinforcing placement:
   a. Clear distance to formed surfaces: +1/4 IN.
   b. Minimum spacing between bars: -1/4 IN.
   c. Top bars in slabs and beams:
      1) Members 8 IN deep or less: +1/4 IN.
   d. Crosswise of members: Spaced evenly within +1 IN.
   e. Lengthwise of members: +2 IN.
3. Minimum clear distances between reinforcing bars:
   a. Beams, walls and slabs: Distance equal to bar diameter or 1 IN, whichever is greater.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:

1. For reinforcing: Class B splice meeting the requirements of ACI 318.
2. For welded wire reinforcement:
   a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN.
   b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 318.
3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.
   a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

D. Welding:

1. Welding reinforcing is not permitted.

E. Placing Reinforcing:

1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
3. Reinforcing support:
    a. Uncoated reinforcing:
        1) Support reinforcing and fasten together to prevent displacement by construction operations.
            a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
            b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
            c) Reinforcement shown on the Contract Documents may not be repositioned for use a support for reinforcement. Additional drop bars may be provided for support of reinforcing,
        2) Reinforcing supported on ground:
            a) Slab on grade and other members with only one mat of reinforcing:
                (1) Provide metal bar supports with bottom plate.
                (2) Do not use concrete blocks to support slab-on-grade reinforcing.
            b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
        3) Reinforcing supported on formwork:
            a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
            b) All other formed surfaces:
                (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
                (2) Only tips in contact with the forms need to be plastic coated.
4. Support reinforcing over cardboard void forms by means of concrete supports which will not puncture or damage the void forms during construction nor impair the strength of the concrete members in any way.
5. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 IN.
    a. Place spacer bars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
6. Extend reinforcement to within 2 IN of concrete perimeter edges.
    a. If perimeter edge is formed by earth or stay-in-place forms, extend reinforcement to within 3 IN of the edge.
7. To assure proper placement, furnish templates for all column vertical bars and dowels.
8. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.
    a. Do not bend reinforcing by means of heat.
9. Do not tack weld reinforcing.
10. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:

1. Notify Engineer whenever the specified clearances between bars cannot be met.
2. Do not place any concrete until the Engineer submits a solution to reinforcing congestion problem.
3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
4. If bars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of reinforcing.
5. No cutting of reinforcing shall be done without written approval of Engineer.

B. Special Inspection:

1. See Section 01 45 33.
2. See Section 03 05 05.

END OF SECTION

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SECTION 03 31 30
CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 05 05 - Concrete Testing and Inspection.
4. Section 03 15 19 - Anchorage to Concrete.
5. Section 03 21 00 – Reinforcement.
6. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
7. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
   a. CT-13, Concrete Terminology.
   b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   c. 212.3R, Chemical Admixtures for Concrete.
   d. 232.2R, Use of Fly Ash in Concrete.
2. ASTM International (ASTM):
   a. C33, Standard Specification for Concrete Aggregates.
   b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   d. C150, Standard Specification for Portland Cement.
   e. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
   f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
   h. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
   i. C494, Standard Specification for Chemical Admixtures for Concrete.
   j. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   k. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   l. C1116, Standard Specification for Fiber-Reinforced Concrete.
   m. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
   n. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
   o. C1399, Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete.

p. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).

q. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

B. Supplementary Cementitious Materials (SCM): Fly ash, silica fume and ground granulated blast furnace slag.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's instructions.
   c. Concrete mix designs as required by Specification Section 03 05 05.
   d. Manufacturer and type of proposed admixtures.
   e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
3. Certifications:
   a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
   b. Certification that the SCM meet the quality requirements stated in this Specification Section, and SCM supplier's certified test reports for each shipment of SCM delivered to concrete supplier.
   c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
   d. Certification of aggregate gradation.
   e. Certification of coarse aggregate impurities as relates to alkali-silica reactivity per ASTM C33, Appendix X.
   f. Certification of shrinkage test results.
4. Test reports:
   a. Cement and SCM mill reports for all cement to be supplied.
   b. Provide test results for alkali-silica reactive impurities on coarse aggregates per referenced ASTM standards.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:

1. Store cement and SCM in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
4. Do not use frozen or partially frozen aggregates.
5. Do not use bottom 6 IN layer of stockpiled material in contact with ground.
6. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.

a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers are acceptable:

1. Non-shrink grout:
   a. BASF Corporation.
   b. Euclid Chemical Company.
   c. Five Star Products, Inc.
   d. Sika Corporation.
2. Epoxy grout:
   a. BASF Corporation.
   b. Five Star Products, Inc.
   c. Euclid Chemical Company.
   d. Sika Corporation.
3. Synthetic fibers:
   a. GCP Applied Technologies, Inc.
   b. BASF Corporation.
   c. Euclid Chemical Company.
   d. Sika Corporation.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 MATERIALS

A. Cement:

1. ASTM C150, Type I/II.
2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. SCM:

1. Fly Ash:
   a. ASTM C618, Class F or Class C.
   b. Non-staining.
   c. Suited to provide hardened concrete of uniform light gray color.
   d. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.
   e. Produced by source approved by the State Highway Department in the state where the Project is located for use in concrete for bridges.
   f. Evaluate and use in accordance with ACI 232.2R.
2. Cement and SCM type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:

1. Air entraining: ASTM C260.
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.

4. All concrete mixes require the use of water reducers to maintain the specified water-to-cement ratios without additional cement.
5. SCM: Per above.
6. Admixtures to be chloride free.
    a. Do not use calcium chloride.
7. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.
8. Provide admixtures certified by manufacturer to be compatible with other admixtures.
9. Shrinkage reducing admixtures:
    a. Admixture used to reduce the shrinkage of Portland Cement concrete.
    b. Utilize at dosage necessary to help achieve required shrinkage value stated herein.
    c. Similar to:
        1) Eclipse 4500 by GCP Applied Technologies, Inc.
        2) Conex by Euclid Chemical Co.
        3) MasterLife SRA 20 or MasterLife CRA 007 by BASF Corporation.

D. Water:

1. Potable.
2. Clean and free from deleterious substances.
3. Free of oils, acids and organic matter.

E. Aggregates for Normal Weight Concrete:

1. ASTM C33.
2. Fine and coarse aggregates to be regarded as separate ingredients.
3. Provide aggregates approved for bridge construction by the Department of Transportation of the State the project is located.
4. Coarse aggregate:
    a. Use only washed aggregates.
    b. Coarse aggregate sieve analysis:
        1) Per Table 1 IN the PART 2 MIXES Article.
5. Fine aggregates to be natural, not manufactured.
6. Do not use aggregates that may be deleteriously reactive when combined with alkalis in cement.
    a. Evaluate proposed aggregates for potential deleterious expansion due to alkali silica reactivity per ASTM C33 (Appendix X), ASTM C227, ASTM C1260, ASTM 1293, or ASTM C1567.

F. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement in accordance with ASTM C1218:

1. Prestressed concrete: 0.06.
2. All concrete: 0.10.

G. Sand Cement Grout (referred to as "Grout" on the Drawings):

1. Approximately three parts sand, one part Portland cement, 6 ±1 PCT entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
    a. Provide sand in accordance with requirements for fine aggregate for concrete.
2. Minimum 28 day compressive strength:
    a. 3000 PSI.
    b. Shall be at least strength of parent concrete when used at construction joints.

H. Non-shrink Grout:

1. Non-shrink, nonmetallic, noncorrosive, and nonstaining.
    a. Conform to ASTM C1107.

ASTM C1107, Grade B.

2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
3. Grout to produce a positive but controlled expansion.
    a. Mass expansion shall not be created by gas liberation or by other means.
4. Minimum 28 day compressive strength: 7,000 PSI.
5. Acceptable manufacturers:
    a. BASF Admixtures, Inc. "Masterflow, 713".
    b. Euclid Chemical "NS Grout".
    c. Sika Corporation "Sika Grout 212".
    d. Sauereisen, Inc. "F-100 Level Fill Grout".
    e. Set Products, Inc. "Set Non-Shrink Grout".
    f. The Upco Corp "Upcon".
    g. L&M "Crystex".

I. Non-shrinking Metallic Grout acceptable manufacturers:

1. BASF Admixtures, Inc "MasterFlow 885".
2. Bates "Protalico Ready-to-Use."
3. Sika "Kemox P."
4. Sonneborn "Ferrolithe G Redi-Mixed"

2.3 MIXES

A. General:

1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
2. Ready-mixed concrete shall conform to ASTM C94/C94M.
3. All concrete to be normal weight concrete weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Concrete Mixes: Refer to Table 1 below.

C. Air Entrainment:

1. Provide air entrainment in concrete resulting in a total air content percent by volume per Table 1 below.
    a. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures.

D. Slump:

1. Measure slump at point of discharge into concrete members.
2. Walls and columns:
    a. 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
    b. Slump shall be obtained by use of mid-range or high-range water reducer conforming to ASTM C494.
3. All other members:
    a. Concrete using a water reducer per ASTM C494: 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.

b. Concrete without a water reducer per ASTM C494: 5 IN maximum, 1 IN minimum measured at point of discharge into the concrete member.

4. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
5. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
   a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ration is not exceeded.
6. Slump may be adjusted in the field through the use of water reducers.
   a. Coordinate dosage and mixing requirements with concrete supplier.
7. Slump tolerances shall comply with the requirements of ACI 117.

E. Proportioning:

1. General:
   a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
   b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
2. Normal weight concrete target cementitious materials contents and maximum water cementitious ratios per Table 1 below.
   a. Target cementitious materials contents are intended to provide a crack free, durable finished product, not one with excessive strength
3. SCM:
   a. Fly ash:
      1) For cast-in-place concrete only, a maximum of 25 PCT by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
      2) If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.
4. Water reducing, retarding, and accelerating admixtures:
   a. Use in accordance with manufacturer's instructions.
   b. Add to mix at batching plant.
   c. Use water-reducing or high-range water reducing admixture in concrete, as required, for placement and workability.
      1) Water reducers are required to maintain specified maximum water to cement ratios.
5. High range water reducers (superplasticizers):
   a. Use required for:
      1) All concrete to be pumped except slabs on grade.
      2) All concrete for water containing structures.
      3) Other concrete members at Contractor’s option.
   b. Maximum concrete slump before addition of admixture to be 3 IN maximum slump after addition to be 8 IN.
6. Micro Fiber:
   a. Dosage:
      1) Determined by Contractor and concrete supplier as required to meet the specified minimum average residual strength.
      2) Per ASTM C1399 and ASTM C1609.

3) Under no circumstances shall dosage be less than:
   a) 4 LBS per cubic yard when used in concrete slabs on metal deck per SDI 31.
   b) 3 LBS per cubic yard for all specified locations.

b. Provide Micro Fiber in the following concrete members:
   1) .

c. Uniformly disperse in concrete mixtures as indicated on Drawings.

d. Use for.

7. Concrete mix proportioning methods for normal weight concrete:
   a. Method 1:
      1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
      2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
      3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 PCT specified.
      4) For each water cement ratio or cement content, make at least three trial strength tests for specified test age, and cure in accordance with ASTM C192.
         a) Cylinder size: Per ASTM C31.
         b) Test for strength at 28 days in accordance with ASTM C39.
            (1) Quantity of cylinders per trial strength test:
               (a) 6 IN DIA cylinders: Two.
               (b) 4 IN DIA cylinders: Three.
      5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
      6) From this curve select water cement ratio or cement content to be used to produce required average strength.
      7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
      8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
      9) See paragraph hereafter for definition of required average strength.
   b. Method 2:
      1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
      2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.
      3) Field test records to represent materials, proportions and conditions similar to those specified.
         a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
         b) Field test records shall meet the requirements of ACI 318, Paragraph 5.3.
      4) Required concrete proportions may be established by interpolation between the strengths and proportions of two or more test records each of which meets the requirements of this Specification Section.
8. Required average strength to exceed the specified 28 day compressive strength by the amount determined or calculated in accordance with ACI 318, Chapter 5 using the standard deviation of the proposed concrete production facility as described in ACI 318, Chapter 5.

F. Flowable Fill :

1. A mixture of cement, fly ash, fine sand, water and air having a consistency which will flow under a very low head.
2. Flowable Fill and Controlled Low-Strength Material are synonymous.
3. Approximate quantities of each component per cubic yard of mixed material:
   a. Cement (Type I or II): 50 LBS.
   b. Fly ash: 200 LBS.
   c. Fine sand: 2,700 LBS.
   d. Water (approximate): 420 LBS.
   e. Air content (approximate): 10 PCT.
4. Actual quantities shall be adjusted to provide a yield of 1 CUYD with the materials used.
5. Approximate compressive strength should be 85 to 175 PSI.
6. Fine sand shall be an evenly graded material having not less than 95 PCT passing the No. 4 sieve and not more than 5 PCT passing the No. 200 sieve.

G. Allowable Shrinkage:

1. Per Table 1 when tested in accordance with ASTM C157 at 28 Days.
2. Continue testing to 64 weeks for informational purposes.

TABLE 1

TYPE OF CONCRETE	28 DAY COMPRESSIVE STRENGTH	W/C RATIO	TARGET TOTAL CEMENT	SCM	ASTM C33 Size No.	AIR CONTENT	ALLOWABLE SHRINKAGE LIMIT
Normal weight lean concrete	3000 PSI	0.45	517	Note 1	7	[5-1/2 to 8] [0 to 2]	[None]
Normal weight concrete fill [utility encasement concrete]	3000 PSI	0.45	517	Note 1	57	[4-1/2 to 7-1/2]	[None]
Normal weight concrete topping	4000 PSI	0.45	564	Note 1	7	5-1/2 to 8	None
Normal weight all concrete	5000 PSI	0.45	564	Note 1	57 67	4-1/2 to 7-1/2	0.048 PCT

Table 1 Notes:

1. If fly ash or GGBFS is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to meet total target cement requirement.

2.4 SOURCE QUALITY CONTROL

A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanness and grading on samples secured from aggregates at point of batching.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Special Inspection:

1. See Specification Section 01 45 00.
2. See Specification Section 03 05 05.

B. Perform concrete tests per Specification Section 03 05 05.

1. Perform a strength test on all concrete to which water or superplasticizer, above the amount stated in the approved concrete mix design, has been added.
   a. Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

END OF SECTION

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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 01 45 33 – Special Inspections and Testing Program.
2. Section 03 05 05 - Concrete Testing and Inspection.
3. Section 03 11 13 - Formwork.
4. Section 03 21 00 - Reinforcement.
5. Section 03 31 30 - Concrete, Materials and Proportioning.
6. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

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 Engineer.

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.
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 -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/M^2 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. Vapor Retarder: See Specification Section 07 26 00.

J. Sand cement grout, non-shrink grout and epoxy grout: See Specification Section 03 31 30 for this non-structural material and use.

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.

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.
    a. See Specification Section 03 11 13.
3. Remove earth, snow, ice, water, and other extraneous/foreign materials from areas that will receive concrete.
4. Secure reinforcement in place.
    a. See Specification Section 03 21 00.
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 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.
4. Addition of water at the jobsite:

a. See Specification Section 03 31 30 for specified water cement ratio and slump.

b. Do not exceed maximum specified water cement ratio or slump.

c. Incorporate water by additional mixing equal to at least half of total mixing required.

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.

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. Wall vertical construction joints:
1) 40 FT maximum centers.
2) At wall intersections, 4 FT minimum from corner.
b. 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.
2. Water retaining structures:
a. Wall vertical construction joints:
1) 30 FT maximum centers.
2) At wall intersections, 6 FT minimum from corner.
b. Wall horizontal construction joints: 22 FT centers.
c. 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.
d. Elevated slab construction joints:
1) Placements to be approximately square and not to exceed [4000] SQFT.
2) Maximum side dimension of a slab pour to be less than:
a) Twice the length of the short side.
b) 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 as shown on Drawings.
    a. See Specification Section 07 92 00 for requirements.

F. Waterstops - General:

1. Waterstop to be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
2. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer unless shown on Drawings.
3. 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.
4. 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.

G. 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.

H. 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. See Specification Section 03 35 00.

B. 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. For surfaces of non-water bearing structures, 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,
        1) See Section 03 11 13.
    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 except Type III, high early strength concrete for which period shall be at least three days.
    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.

3.8 FIELD QUALITY CONTROL

A. Special Inspections per building code:

1. See Section 01 45 33 and 03 05 05.

END OF SECTION

SECTION 03 35 00

CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete finishing and repair of surface defects.
2. Chemical Sealers.
3. Polymer Modified Cementitious Coating.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 11 13 - Formwork.
4. Section 03 31 30 - Concrete, Materials and Proportioning.
5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

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. 303R, Guide to Cast-in-Place Architectural Concrete Practice.
   d. 308, Standard Practice for Curing Concrete.
2. ASTM International (ASTM):
   a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
   b. C150, Standard Specification for Portland Cement.
   c. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   e. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   f. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
   g. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
   h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   i. D4259, Standard Practice for Abrading Concrete.
   j. E1155, Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
   k. E1486, Standard Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria.
3. International Concrete Repair Institute (ICRI):
   a. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
4. National Council Highway Research Program (NCHRP):

a. 244, Concrete Sealers for the Protection of Bridge Structures.

5. The Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:

1. Chemical Sealer CS-2:
   a. Applicator shall be factory trained and approved, in writing, by the manufacturer to apply the product.
   b. Applicator shall have a minimum of five years of experience successfully applying materials specified.

1.3 DEFINITIONS

A. Vertical Surface Defects:

1. Any void in the face of the concrete deeper than 1/8 IN, such as:
   a. Tie holes.
   b. Air pockets (bug holes).
   c. Honeycombs.
   d. Rock holes.
2. Scabbing:
   a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
3. Foreign material embedded in face of concrete.
4. Fins 1/16 IN or more in height.

B. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

C. Other words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Certifications:
   a. Certification of aggregate gradation.
   b. Certification of manufacturer experience qualifications and performance history.
   c. Certification of applicator's qualifications.
      1) Refer to Qualifications paragraph.
      2) Provide manufacturer's written approval of applicators.
      3) Provide references substantiating specialty experience.

B. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Bonding Agents:
    a. BASF Master Builders Solutions.
    b. Euclid Chemical Co.
    c. Laticrete - L&M Construction Chemicals.
2. Chemical Sealers:
    a. BASF Master Builders Solutions.
    b. Euclid Chemical Co.
    c. Laticrete - L&M Construction Chemicals.
    d. Tnemec Chemprobe.
3. Polymer Modified Cementitious Coating:
    a. Aquafin International.
    b. BASF Master Builders Solutions.
    c. Euclid Chemical Co.
4. Patching Mortar:
    a. BASF Master Builders Solutions.
    b. Euclid Chemical Co.
    c. Laticrete - L&M Construction Chemicals.
    d. Sika Corporation.

2.2 MATERIALS

A. Chemical Sealer CS-1:

1. High solids, water-based solution containing acrylic copolymers.
    a. ASTM C1315, Type I, Class A.
    b. Non-yellowing UV resistant.
    c. VOC Content: <200 G/L.
2. USDA approved as a concrete floor sealer.
3. Euclid Chemical Super Diamond Clear VOX.

B. Chemical Sealer CS-2:

1. Water based chemical solution containing a blend of silicate and siliconate polymers designed to seal, harden and dustproof concrete floors.
2. VOC Content: 0 G/L.
3. Performance of treated concrete floor:
    a. Coefficient of Friction:
        1) Dry: 0.81.
        2) Wet: 0.72.
    b. Liquid repellency, RILEM Method 11.4:
        1) ≥ 1 mL.
4. Euclid Chemical Euco Diamond Hard.

C. Chemical Sealer CS-3:

1. Clear, penetrating, breathable, waterborne silane-siloxane solution.
2. VOC content: ≤50 G/L.
3. Odorless.
4. Flash point: >200 DEGF.
5. Water absorption: 85 PCT reduction per NCHRP 244.
6. Chloride penetration: 82 PCT reduction per NCHRP 244.
7. Euclid Chemical Baracade WB 244.

D. Patching Mortar: Trowelable cementitious repair mortar for vertical, overhead, and horizontal repairs.

1. Portland cement-based, rapid set repair mortar for interior or exterior use.
2. Compressive Strength, ASTM C109:
   a. Minimum 3000 PSI at 7 days.
   b. Minimum 5000 PSI at 28 days.
3. Freeze Thaw Durability, ASTM C666: 96.75 PCT at 300 Cycles.
4. Shrinkage, ASTM C157: 0.069 PCT.
5. Euclid Chemical Speed Crete Red Line.

E. Bonding Agents:

1. For use only on concrete surfaces not receiving liquid water repellent coating:
   a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
      1) BASF Master Builders MasterEmaco A 660.
      2) Euclid Chemical Co. Flex-Con.
      3) Laticrete L&M Everbond.
2. For use only on concrete surface receiving liquid water repellent:
   a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.

F. Cement:

1. ASTM C150, Type II Portland for areas exposed to sewage.
2. ASTM C150, Type I/II Portland elsewhere.

G. Aggregate:

1. Sand: Maximum size #30 mesh sieve.
2. For exposed aggregate finish surfaces: Same as surrounding wall.

H. Water: Potable.

I. Polymer modified cementitious coating:

1. Polymer modified Portland cement based coating for concrete and masonry.
   a. Waterproof.
   b. Resistant to both positive and negative hydrostatic pressure.
   c. Breathable.

J. Nonshrink Grout: See Specification Section 03 31 30.

2.3 MIXES

A. Bonding Grout: One part cement to one part aggregate.

B. Patching Mortar:

1. One part cement to 2-1/2 parts aggregate by damp loose volume.

a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation:

1. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
2. Prepare surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
   a. Provide concrete surface profile (CSP) in accordance with ICRI 310.2:
      1) Areas to receive Repair Mortar:
         a) Areas larger than 1 SF or deeper than 1/4 IN Abrasive blast, scarify or needle scale to CSP No. 6-8.
   b. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
   c. No featheredges will be permitted.
   d. Rinse surface with clean water to remove all dust, dirt, debris, loosened concrete, laitance, and other contaminants.

B. Preparation of Bonding Grout Mixture:

1. Mix cement and aggregate.
2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
3. Add bonding agent/water mixture to cement/aggregate mixture.
4. Mix to consistency of thick cream.
5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.

C. Preparation of Patching Mortar Mixture:

1. Mix specified patching mortar per manufacturer’s published recommendations.
2. For repairs exceeding 2 IN in depth, mix with clean, pre-dampened 3/8 IN pea gravel in accordance with the manufacturer’s recommendations.

D. Polymer modified cementitious coating:

1. Mix in accordance with manufacturer's recommendations using bonding agent acceptable to coating manufacturer.

3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DEGF.

1. If necessary, enclose and heat area to between 50 and 70 DEGF during repair of surface defects and curing of patching material.
   a. Use only clean fuel, indirect fired heating apparatus.
   b. Exhaust combustion byproducts outside of work area.

B. Chemical Sealer Application:

1. General:
   a. Immediately prior to Substantial Completion, thoroughly clean floor in accordance with ASTM D4258 and prepare to receive chemical sealer.
      1) Remove previously applied membrane curing compounds.

2) Remove soil, oils, stains, discoloration, or any other imperfection having a negative impact on the appearance of the finished floor.

b. Apply product to floor areas indicated on the Drawings.

c. Apply in accordance with manufacturer's published installation instructions.

2. Chemical Sealer (CS-1):

a. Apply two uniform coats at rate recommended by manufacturer.

1) Apply using manufacturer’s recommended equipment with a fan-tip nozzle.

2) Do not allow material to puddle.

b. Allow first coat to completely dry before applying second coat.

c. Spotted or mottled appearances will not be accepted.

3. Chemical Sealer (CS-2):

a. Apply two uniform coats at rate recommended by manufacturer.

1) Scrub the material into the floor using a mechanical scrubber.

a) Keep the surface wet for not less than 30 minutes.

b) Continue scrubbing in accordance with manufacturer’s application instructions.

c) After material has thickened, but not more than 60 minutes after application, remove all excess liquid.

2) Thoroughly rinse with clean water to remove all residue.

a) Damp mop with clean water to remove any streaks.

b) Do not allow residue to dry on floor surface.

3) Do not track material onto untreated surfaces.

b. After rinsing, allow floor to dry completely and apply second coat following the same procedures.

c. Final floor finish shall have uniform sheen without streaking, stains or white residue.

4. Chemical Sealer (CS-3):

a. Apply uniform coats at rate recommended by manufacturer.

1) Apply with fine, uniform spray or microfiber pad.

b. Allow floor to dry completely and remove any dried residue using hot water and mild citric acid.

c. Final floor finish shall be uniform, free of residue, and shall repel water.

d. Apply additional coat(s) as necessary to achieve water repellent finish.

C. Repairing Surface Defects:

1. This method is to be used on vertical concrete surfaces as indicated in the Concrete Finishes for Vertical Wall Surfaces paragraph of this Specification Section and similar concrete surfaces not otherwise specified to receive another finish or coating.

2. Fill and repair surface defects and tie-holes using patching mortar mix specified in the MATERIALS Article in PART 2.

a. Prime exposed reinforcing steel, embeds or other steel surfaces with primer as recommended by patching mortar manufacturer.

b. Scrub bond coat:

1) Wet substrate to a saturated surface dry (SSD) condition.

2) Mix patching mortar to a scrub coat or slurry consistency per manufacturer’s published recommendations and apply to entire area.

c. As an alternate to the scrub bond coat, concrete may be primed with manufacturer’s recommended epoxy primer.

d. Patching Mortar Application:

1) Mix and apply Patching Mortar per manufacturer’s recommendations within the open time of the product scrub coat or any bonding agents.

2) Finish to level of surrounding concrete surface utilizing techniques recommended by manufacturer.

3. Consolidate patching mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
4. Leave undisturbed until mortar has stiffened before finishing level with surrounding surface.
   a. Do not use steel tools in finishing a patch in a formed wall which will be exposed to view.
5. Cure patching mortar in accordance with ACI 308.

D. Concrete Finishes for Vertical Wall Surfaces:

1. General:
   a. Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
   b. Finish numbers not listed are "Not Used".
2. Finish #1 - As cast rough form finish:
   a. Selected forming materials are not required.
   b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
   c. Repair the following surface defects using patching mortar specified in PART 2:
      1) Tie holes.
      2) Honeycombs deeper than 1/4 IN.
      3) Air pockets deeper than 1/4 IN.
      4) Rock holes deeper than 1/4 IN.
   d. Chip or rub off fins exceeding 1/4 IN in height.
   e. Provide at unexposed surfaces such as:
      1) Foundations.
      2) Below-grade walls not to be waterproofed.
      3) Concealed surface of concrete back-up wythe in cavity wall construction.
      4) Where scheduled in the CONCRETE FINISH SCHEDULE Article in PART 3 of this Specification Section.
3. Finish #2 - As cast form finish:
   a. Form facing material shall produce a smooth, hard, uniform texture.
      1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
   b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
      1) Chip or rub off fins exceeding 1/8 IN in height.
      2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
         a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum across the entire surface.
            (1) For contiguous repair areas larger than 1 SF or deeper than 1/4 IN Abrasive blast, scarify or needle scale to CSP No. 6-8.
         b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
         c) No feather edges will be permitted.
      3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
      4) Repair the following surface defects using patching mortar specified in PART 2:
         a) Tie holes.

b) Honeycombs deeper than 1/4 IN or larger than 1/4 IN DIA.
c) Air pockets deeper than 1/4 IN or larger than 1/4 IN DIA.
d) Rock holes deeper than 1/4 IN or larger than 1/4 IN DIA.
e) Scabbing.

5) Brush blast repaired areas to match adjacent surface texture.

c. Provide this finish for:
1) Interior walls of [pipe galleries][, pump rooms][, tipping floors].
2) Underside of horizontal elements adjacent to the finished surface.
3) Exposed surfaces not specified to receive another finish.
4) Where scheduled in the CONCRETE FINISH SCHEDULE Article in PART 3 of this Specification Section.

4. Finish #3 - Grout rubbed finish:
a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.

b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section and repair all surface defects.
c. Begin finish operation one day after form removal.
d. Wet surface and rub with carborundum brick or other abrasive until uniform color and texture is achieved.
e. Grout application:
1) Wet surface to prevent absorption of water from grout.
2) Apply grout uniformly over entire surface.
a) Completely fill bugholes, voids or other blemishes.

f. Immediately following application of grout, float the surface with a cork float, scouring the wall vigorously.
g. Finish wall with sponge rubber float.
1) Remove all excess grout.
2) Do not remove grout from holes or depressions.

h. Allow wall to dry thoroughly and then rub vigorously with burlap to completely remove any dried grout film.
i. Provide this finish for:
1) Interior walls, columns and appurtenant surfaces where indicated on Room Finish Schedule on the Drawings.
2) Underside of horizontal elements adjacent to the finished surface.
3) Where scheduled in the CONCRETE FINISH SCHEDULE Article in PART 3 of this Specification Section.

j. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

5. Finish #4 - Polymer modified cementitious coating:
a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.

b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.

1) Chip or rub off fins exceeding 1/8 IN in height.
2) Abrasive blast and repair surface defects in accordance with Concrete Finish #2.

c. Apply decorative coating to entire surface.
1) As a mixing liquid for the coating, use bonding agent and water mixture as recommended by coating manufacturer.
2) Apply two (2) coats at 2 LBS per square yard per coat.
a) During application of first coat, complete fill all voids, depressions or other surface imperfections.

d. When second coat is set, float to a uniform texture with a sponge float.

e. Provide this finish on all exposed to view:
1) Exterior building surfaces not otherwise indicated to receive [an Architectural Abrasive Blast Finish].
2) Interior walls, columns and similar vertical surfaces where indicated on Room Finish Schedule on the Drawings.
3) Underside of horizontal elements adjacent to the finished surface.
4) Where scheduled in the CONCRETE FINISH SCHEDULE Article in PART 3 of this Specification Section.

f. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

6. Finish #5 - Smooth form finish:

a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.

b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
1) Chip or rub off all fins and protrusions.
2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum.
b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
c) No featheredges will be permitted.
3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.

c. Repair the following surface defects using patching mortar specified in PART 2:
1) Tie holes.
2) Honeycombs, air pockets, rock holes and other holes deeper than 1/16 IN or larger than 1/16 IN DIA.
3) Scabbing.

d. Provide this finish for:
1) Interior walls, columns and similar vertical surfaces where indicated on Room Finish Schedule on the Drawings.
2) Underside of horizontal elements adjacent to the finished surface.
3) Where scheduled in the CONCRETE FINISH SCHEDULE Article in PART 3 of this Specification Section

e. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

7. Finish #6 - Cork floated finish:
    a. Form facing material shall produce a smooth, hard, uniform texture.
        1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
    b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section and repair all surface defects.
    c. Remove formwork as soon as possible, within 2 to 3 days of placement where possible.
    d. Mix one part Portland cement and one part fine sand with bonding agent/water mixture to produce a stiff mortar.
    e. Dampen wall surface.
    f. Apply mortar with rubber float or trowel, filling all surface voids.
    g. Compress mortar into voids using slow speed grinder or stone.
    h. If the mortar surface dries too rapidly to permit compaction and finishing, apply a small amount of water using a fog spray.
    i. Produce the final texture with a cork float using a swirling motion.
    j. Provide this finish on all surfaces which are to be painted or to remain exposed as cork floated finish where noted and at Contractor's option in lieu of Finish #5.
    k. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.
8. Finish #7 - Architectural abrasive blasted:
    a. Form facing material shall produce a smooth, hard, uniform texture.
        1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
        2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.
    b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
        1) Chip or rub off fins exceeding 1/8 IN in height.
        2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
            a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum.
            b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
            c) No featheredges will be permitted.
        3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
    c. Repair all surface defects using patching mortar specified in PART 2:
        1) Repair the following surface defects:
            a) Honeycombs, air pockets, rock holes and other holes deeper than 1/4 IN or larger than 1/8 IN DIA.
            b) Scabbing.
        2) Do not fill tie-holes.
        3) Abrasive blast wall in accordance with ACI 303R to achieve a [light] [medium] [heavy] aggregate exposed surface.
        4) Repair all newly exposed defects and damaged repairs.
        5) Brush blast to blend appearance to match adjacent area.
    d. Provide this finish on all exposed to view:
        1) Exterior building surfaces, including:
            a) Cast-in-place walls and columns.

2) Interior walls, vertical surfaces and exposed underside of cast-in-place stairs and landings, including:
   a) Elevator shaft walls.
   b) Cast in place stairs [01-STR01].
3) Where scheduled in the CONCRETE FINISH SCHEDULE Article in PART 3 of this Specification Section

e. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

E. Concrete Finishes for Horizontal Slab Surfaces:

1. General:
   a. Tamp concrete to force coarse aggregate down from surface.
   b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
   c. Dusting of surface with dry cement or sand during finishing processes not permitted.
2. Unspecified slab finish:
   a. When type of finish is not indicated, use following finishes as applicable:
      1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
      2) Surfaces intended to receive roofing[, except future floors,] or waterproofing membranes: Floated finish.
      3) Floors [and roof surfaces which are future floors intended as walking surfaces or for reception of floor coverings]: Ttroweled finish.
      4) Garage floors and ramps: Broom or belt finish.
      5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom or belt finish.
      6) All slabs to receive a floated finish before final finishing.
3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
4. Floated finish:
   a. After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, do no further work until ready for floating.
   b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.
      1) Use wood or cork float.
   c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
5. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
   a. Refloat slab immediately to a uniform texture.
6. Troweled finish:
   a. Float finish surface to true, even plane.
   b. Power trowel, and finally hand trowel.
   c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
   d. Perform additional trowelings by hand after surface has hardened sufficiently.
   e. Final trowel when a ringing sound is produced as trowel is moved over surface.
   f. Thoroughly consolidate surface by hand troweling.
   g. Finish in accordance with the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

1) Leave finished surface essentially free of trowel marks, uniform in texture and appearance.

h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering.

7. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.

3.3 FIELD QUALITY CONTROL

A. Tolerances:

1. Finished floor slabs:
   a. Provide Floor Flatness (F_F) and Floor Levelness (F_L) in accordance with ACI 117.
      1) Measure in accordance with ASTM E1155.
   b. Slabs not indicated to be sloped:
      1) F_F: Equal or greater than 35.
      2) F_L: Equal or greater than 25.
   c. Slabs indicated to be sloped or curved:
      1) Measure in accordance with ASTM E1486.
      2) Provide slopes or curves as indicated on the Drawings.
   d. Slabs indicated to receive polished concrete floor:
      1) F_F: Equal or greater than 45.
      2) F_L: Equal or greater than 35.
      3) Refer to Room Finish Schedule on Drawings.
2. Horizontal surfaces other than finished floor slabs, including but not limited to, top of footings, top of walls, concrete fill in tankage, channels and similar applications:
   a. Gap between a 10 FT straightedge placed anywhere and the finished surface shall not exceed:
      1) Class A tolerance: 1/4 IN.
      2) Class B tolerance: 3/8 IN.
      3) Class C tolerance: 1/2 IN.
   b. Accumulated deviation from intended true plane of finished surface shall not exceed 1/2 IN.

B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.

1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

C. Provide services of manufacturer's technical representative:

1. A certified manufacturer's representative experienced in the use of the products used shall be present on a full-time basis to observe and oversee all operations associated with the installation.
2. Contractor, along with manufacturer, shall be fully responsible for the proper application, including all means and methods incidental thereto necessary for a sound, secure and complete installation.
3. Manufacturer's representative shall be present for installation of:
   a. Dry-shake Hardener.
   b. Heavy-duty Metallic Aggregate Topping.

3.4 PROTECTION

A. All horizontal slab surfaces receiving chemical sealer shall be kept free of traffic and loads for minimum of 72 HRS following installation of sealer.

3.5 CONCRETE FINISH SCHEDULE

DRAWING NO.	STRUCTURE NAME	SURFACE TO BE FINISHED	FINISH NO.

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
2. Design of all temporary bracing not indicated on Drawings.
3. Design of systems and components, including but not limited to:
   a. Stairs.
   b. Landings.
   c. Ladders.
   d. Modular framing system.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 00 05 - Concrete.
4. Section 03 15 19 - Anchorage to Concrete.
5. Section 03 31 30 - Concrete, Materials and Proportioning.
6. Section 05 12 00 - Structural Steel.
7. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Aluminum Association (AA):
   a. ADM 1, Aluminum Design Manual.
2. American Association of State Highway and Transportation Officials (AASHTO):
   a. HB, Standard Specifications for Highway Bridges.
3. American Institute of Steel Construction (AISC):
   a. 325, Manual of Steel Construction.
   b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
4. The American Ladder Institute (ALI):
   a. A14.3, Ladders - Fixed - Safety Requirements.
5. American Society of Civil Engineers (ASCE):
   a. 7, Minimum Design Loads for Buildings and Other Structures.
6. ASTM International (ASTM):
   a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   b. A36, Standard Specification for Carbon Structural Steel.
   c. A47, Standard Specification for Ferritic Malleable Iron Castings.
   d. A48, Standard Specification for Gray Iron Castings.
   e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   f. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.

g. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
i. A197, Standard Specification for Cupola Malleable Iron.
j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
n. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
o. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
p. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
q. A536, Standard Specification for Ductile Iron Castings.
r. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
s. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
u. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
v. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
w. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A992, Standard Specification for Steel for Structural Shapes.
z. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
aa. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
bb. B26, Standard Specification for Aluminum-Alloy Sand Castings.
cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
dd. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
ee. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
ff. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
gg. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
hh. F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
ii. F467, Standard Specification for Nonferrous Nuts for General Use.
jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

ll. F835, Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.

mm. F879, Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.

nn. F1789, Standard Terminology for F16 Mechanical Fasteners.

oo. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

7. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code - Steel.
   c. D1.2, Structural Welding Code - Aluminum.
   d. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.
   b. AMP 555, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
   c. MBG 531, Metal Bar Grating Manual.
9. NACE International (NACE).
10. Nickel Development Institute (NiDI):
    a. Publication 11 007, Guidelines for the welded fabrication of nickel-containing stainless steels for corrosion resistant services.
11. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

B. Qualifications:

1. Qualify welding procedures and welding operators in accordance with AWS.
2. Fabricator shall have minimum of 10 years of experience in fabrication of metal items specified.
3. Engineer for contractor-designed systems and components: Professional structural engineer licensed in the State of.
4. NACE certified inspector shall have minimum of two years of experience performing inspections as indicated.
   a. Have a current Level III coating inspector certification.

1.3 DEFINITIONS

A. Fasteners: As defined in ASTM F1789.

B. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

C. Hardware: As defined in ASTM A153/A153M.

D. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of
2. Qualifications:
    a. NACE inspector qualifications.
3. Fabrication and/or layout drawings and details:
    a. Submit drawings for all fabrications and assemblies.
        1) Include erection drawings, plans, sections, details and connection details.
    b. Identify materials of construction, shop coatings and third party accessories.
4. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
    c. Provide manufacturer's standard allowable load tables for the following:
        1) Grating and checkered plate.
        2) Castings, trench covers and accessories.
        3) Modular framing systems.
5. Contractor designed systems and components:
    a. Certification that manufactured units meet all design loads specified.
    b. Shop Drawings and engineering design calculations:
        1) Indicate design live loads.
        2) Sealed by a licensed professional engineer, registered in the State of [_____].
        3) Engineer will review for general compliance with Contract Documents.
    c. Contractor designed systems and components include the following:
        1) Metal Stairs and associated landings.
        2) Concrete Filled Steel Pan Stairs.
        3) Ladders [and associated landings].
        4) Gates.
        5) Steel checkered plate].
        6) Aluminum checkered plate.

B. Informational Submittals:

1. Certification of welders and welding processes.
    a. Indicate compliance with AWS.
2. NACE certification of surface preparation.
3. NACE certification of paint application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Abrasive stair nosings (embedded in concrete stairs):
    a. American Safety Tread.
    b. Balco.

2. Headed studs and deformed bar anchors:
    a. Nelson Stud Welding Div., TRW Inc.
    b. Stud Welding Products, Inc.
3. Mechanical anchor bolts:
    a. See Section 03 15 19.
4. Epoxy adhesive anchor bolts:
    a. See Section 03 15 19.
5. Concrete screw anchors:
    a. See Section 03 15 19.
6. Castings, trench covers and accessories:
    a. Neenah Foundry Co.
    b. Deeter Foundry Co.
    c. Barry Craft Construction Casting Co.
    d. McKinley Iron Works.
7. Aluminum ladders:
    a. Any manufacturer capable of meeting the requirements of this Specification Section.
8. Galvanizing repair paint:
    a. Clearco Products Co., Inc.
    b. ZRC Products.
9. Modular framing system:
    a. Unistrut Building Systems.
    b. B-Line Systems.
    c. Kindorf.
    d. Superstrut.
10. Ladder safety extension post:
    a. Bilco.

2.2 MATERIALS

A. Steel:

1. Structural:
    a. W-shapes and WT-shapes: ASTM A992, Grade 50.
    b. All other plates and rolled sections: ASTM A36.
2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
3. Structural tubing:
    a. ASTM A500, Grade B (46 KSI minimum yield).
4. Bolts, high strength:
    a. ASTM F3125, Grade A325.
5. Nuts, high strength:
    a. ASTM A563.
6. Washers (hardened):
    a. ASTM F436.
    b. Provide two (2) washers with all bolts.
7. Bolts and nuts (unfinished):
    a. ASTM A307, Grade A.
8. Welding electrodes: AWS D1.1, E70 Series.
9. Steel forgings: ASTM A668.

B. Iron:

1. Ductile iron: ASTM A536.
2. Gray cast iron: ASTM A48 (minimum 30,000 PSI tensile strength).
3. Malleable iron: ASTM A47, ASTM A197.

C. Stainless Steel:

1. Stainless steel in welded applications: Low carbon 'L' type.
2. Minimum yield strength of 30,000 PSI and minimum tensile strength of 75,000 PSI.
   a. Bars, shapes: ASTM A276, Type [304].
   b. Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 304 or 316.
   c. Strip, plate and flat bars: ASTM A666, Type 304 or 316.
   d. Bolts and nuts: ASTM F593, Type 304 or 316.
3. Minimum yield strength of 25,000 PSI and minimum tensile strength of 70,000 PSI.
   a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L or 316L.
4. Welding electrodes: In accordance with AWS for metal alloy being welded.

D. Aluminum:

1. Alloy 6061-T6, 32,000 PSI tensile yield strength minimum.
   a. ASTM B221 and ASTM B308 for shapes including beams, channels, angles, tees and zees.
   b. Weir plates, baffles and deflector plates, ASTM B209.
2. Alloy 6063-T5 or T6, 15,000 PSI tensile yield strength minimum.
   a. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.
3. ASTM B26 for castings.
4. ASTM F468, alloy 2024 T4 for bolts.
5. ASTM F467, alloy 2024 T4 for nuts.
6. Electrodes for welding aluminum: AWS D1.2, filler alloy 4043 or 5356.

E. Washers: Same material and alloy as found in accompanying bolts and nuts.

F. Embedded Anchor Bolts:

1. See Specification Section 03 15 19.

G. Mechanical Anchor Bolts and Adhesive Anchor Bolts:

1. See Specification Section 03 15 19.

H. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.

I. Deformed Bar Anchors: ASTM A1064 with a minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.

J. Iron and Steel Hardware: Galvanized in accordance with ASTM A153/A153M when required to be galvanized.

K. Galvanizing Repair Paint:

1. High zinc dust content paint for regalvanizing welds and abrasions.
2. ASTM A780.
3. Zinc content: Minimum 92% in dry film.
4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

L. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.3 MANUFACTURED UNITS

A. Ladders:

1. General:
    a. Fully welded type.
        1) All welds to be full penetration welds, unless otherwise specified.
    b. All ladders of a particular material shall have consistent construction and material shapes and sizes unless noted otherwise on the Drawings.
    c. Design ladder in accordance with OSHA Standards, ANSI A14.3, ASCE 7 and the building code.
    d. Ladders shall be designed to support a minimum concentrated live load of 300 LBS at any point to produce the maximum stress in the member being designed.
        1) Apply additional 300 LB loads for each section of ladder exceeding 10 FT.
    e. Maximum allowable stresses per AA ADM 1.
    f. Maximum lateral deflection: Side rail span/240 when lateral load of 100 LBS is applied at any location.
2. Material:
    a. Aluminum.
    b. Finish:
        1) Mill.
3. Rails:
    a. Round pipe or rectangular tubing:
        1) Round pipe:
            a) 1-1/2 IN nominal diameter.
            b) Schedule 80.
        2) Rectangular tubing:
            a) Cross-section: 3 by 2 IN maximum.
            b) Thickness: 0.125 IN minimum.
    b. Spacing:
        1) Minimum clear distance between rails to be 18 IN.
        2) Step-through ladder extensions: 24 IN, clear minimum, 30 IN maximum.
        3) Ladders equipped with ladder safety system: 36 IN clear.
    c. Provide cap at exposed top and bottom of side rails.
        1) Provide weep holes as necessary to prevent the accumulation of moisture within hollow members.
    d. Extend side rails of step-through ladders a minimum of 42 IN above the landing.
4. Rungs:
    a. Minimum 1 IN DIA or 1 IN square solid bar.
        1) Integral non-slip finish on all sides.
            a) Non-slip finish: Coarse knurling or extruded serrations.
            b) Shop or field-applied grit tape and cap type non-slip finishes are not acceptable.
    b. Rungs shall penetrate inside wall of side rails.
        1) Do not extend rungs beyond the outside face of the side rail.
        2) Provide fillet weld all around rung at inside face of side rail and plug weld at outside face of side rail.
    c. Rung spacing:

1) Equally spaced not less than 10 IN and not more than 14 IN as measured between the centerlines of the rungs.
    a) Ladder rungs and steps in elevator shafts shall be spaced not less than 6 IN and not more than 16.5 IN as measured between the centerlines of the rungs.
2) Top rung shall be level with landing or platform.
    a) Where top of ladder terminates at grating cover, floor access door, roof hatch or similar condition; locate top rung as close as practicable to, but not more than 6 IN below, adjacent walking surface.

5. Brackets:
    a. Angle or bent plate brackets welded to side rails:
        1) 3/8 IN by 2-1/2 IN by length required.
        2) Provide punched holes for 3/4 IN bolts or anchors.
        3) Minimum distance from centerline of rung to wall or any obstruction: 7 IN.
        4) Maximum spacing: 4 FT OC.
    b. For floor supported ladders, provide 3/8 by 2-1/2 by 4 IN rectangular bracket or 3/8 by 6 by 6 IN square plate welded to rails with punched holes for 3/4 IN bolts.
        1) Provide wall brackets on floor supported units if vertical run is over 4 FT.
6. Landings:
    a. Construct landing, railing and all supports of same material as the ladder.
    b. Design live load for landing platform and supporting structure:
        1) 100 PSF, uniform load.
        2) 300 LBS concentrated load on 4 IN square area.
        3) All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
        4) Maximum deflection: 1/300 of span under a superimposed live load of 100 PSF.
    c. Grating:
        1) Per this Specification Section.
    d. Structural support: Channel or tubular sections with bracing, plates, angles, etc., to support guardrail and grating and to support landing from the side of the [structure] [building wall].
        1) Weld or bolt all connections using [stainless steel] [galvanized] bolts, nuts and washers.
    e. Guardrails:
        1) Match ladder side rails.
            a) Space intermediate rails equally between top rail and top of kickplate.
        2) Provide 4 IN high x 3/8 IN thick toeboard each side of landing.
7. Gates:
    a. Constructed of same material and sizes as the railing system.
    b. Hinges:
        1) Stainless steel.
        2) Heavy-duty, self-closing.
    c. Gate stop:
        1) [Aluminum] [Galvanized steel] [Stainless steel].
8. Ladder safety extension post:
    a. Telescoping tubular [aluminum] [galvanized steel] [stainless steel] section that automatically locks into place when fully extended.
    b. Non-ferrous corrosion-resistant spring and hardware.
    c. Factory assembled with all hardware necessary for mounting to ladder.

d. Bilco "LadderUp" safety post.

9. Deflector plate:
    a. For aluminum ladders: Minimum 0.0625 IN aluminum plate, ASTM B209.
    b. For stainless steel ladders: Minimum 0.0625 IN stainless steel plate, ASTM A666.
    c. For steel ladders: Minimum 0.0625 IN steel plate, ASTM A6.
    d. Profile as shown on Drawings.
    e. Fabricate to shapes and sizes required to meet OSHA Standards.

B. Bollards:

1. 8 IN DIA extra strength steel pipe, ASTM A53.
    a. Galvanized.
    b. See Specification Section 09 96 00 for painting requirements.

C. Abrasive Stair Nosings:

1. Exterior cast-in-place concrete stairs:
    a. One piece cast aluminum with wing anchors.
    b. Diamond abrasive pattern.
    c. Babcock Davis "BSTCA-C3W".
2. Interior stairs:
    a. Two component consisting of an embedded subchannel and an abrasive tread plate [with integral photoluminescent strip].
    b. Subchannel: 6063-T5 extruded aluminum.
        1) Complete with concrete anchors.
    c. Tread plate:
        1) 6063-T5 extruded aluminum.
        2) Solid epoxy abrasive filler.
            a) Color: [Safety yellow] [Black] [Gray] [To be selected by Engineer].
    d. [Balco "DXH-330"] ["DXH-330-PL-100"].
    e. Finish: Mill.
3. Length:
    a. Concrete stairs and landings:
        1) 4 IN less than overall stair width.
        2) Where tread mounted railing post occurs, hold nosing back 4 IN clear from railing centerline.
    b. Concrete filled metal pan stairs: Full length of tread.
    c. Concrete landings at metal stairs: 4 IN less than clear width between stringers.

D. Heavy-Duty Castings, Trench Covers, and Accessories:

1. Prefabricated, [cast iron ASTM A48] [or ductile iron ASTM A536] [or cast aluminum ASTM B26].
2. Design load: AASHTO HS-20 wheel loading for indicated span.
3. Machine horizontal mating surfaces.

E. Access Cover:

1. Tank type manhole frame and solid lid: ASTM A48 or ASTM A536, cast iron.
2. Unless shown otherwise, design of cover shall be such that top of frame extends several inches above slab to prevent surface water from entering tank.
3. Equip lid with four stainless steel screws to secure lid to frame.

F. Loose Lintels:

1. Steel, ASTM A36 or ASTM A572 Grade 50, sizes as indicated on Drawings.
2. Hot-dip galvanized per ASTM A123/A123M.

G. Modular Framing System:

1. Materials:
   a. Steel: ASTM A1011, carbon steel, Grade 33.
      1) Hot-dipped galvanized, ASTM A123 or ASTM A153.
   b. Aluminum: ASTM B221 or ASTM B209.
   c. Stainless steel: ASTM A666.
   d. Fiberglass: See Specification Section 06 82 00.
2. Channels and inserts:
   a. Steel or stainless steel: Minimum 12 GA.
   b. Aluminum: Minimum 0.080 IN.
   c. Channels to have one side with a continuous slot with in-turned lips.
      1) Width: 1-5/8 IN.
      2) Depth and configuration as necessary for loading conditions.
3. Fittings: Same material as system major components.
4. Fasteners:
   a. Nuts: Toothed groves in top of nuts to engage the in-turned lips of channel.
   b. Bolts: Hex-head cap screws.
   c. Same material as system major components.
5. End caps:
   a. At each exposed end of each piece mounted on walls, or guardrails, or suspended from framing 7 FT or less above the floor or platform.
      a) Plastic for all exposed ends 7 FT or more above floor or platform.
      b) Plastic or metallic for all other exposed ends.
6. Schedule:
   a. Interior wet areas: Stainless steel.
      1) Including the following rooms or areas:
   b. Interior corrosive areas: [Fiberglass] [Stainless steel].
      1) Including the following rooms or area:
   c. Exterior areas: Stainless steel.
   d. All other areas not listed above: Hot-dipped galvanized steel.
7. Provide dissimilar materials protection in accordance with Specification Section 09 96 00.
8. Repair all cut ends or otherwise damaged areas of galvanized steel in accordance with ASTM A780.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.

1. Grind smooth all rough welds and sharp edges.
   a. Round all corners to approximately [1/32 - 1/16] IN nominal radius.

C. Provide drilled or punched holes with smooth edges.

1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Shop Connections:

1. Welds to be continuous fillet type unless indicated otherwise.

2. Full penetration butt weld at bends in stair stringers and ladder side rails.
3. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1/A5.1M.
4. Weld aluminum in accordance with AWS D1.2.
5. Weld stainless steel in accordance with AWS D1.6 [and NiDI 11 007].
    a. Treat all welded areas in accordance with ASTM A380.
6. All headed studs to be welded using automatically timed stud welding equipment.
7. Grind smooth welds that will be exposed.

E. Passivate stainless steel items and stainless steel welds after they have been ground smooth[, where indicated on Drawings].

1. ASTM A380.

F. Conceal fastenings where practicable.

G. Fabricate work in shop in as large assemblies as is practicable.

H. Tolerances:

1. Rolling:
    a. ASTM A6.
    b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specification.
2. Fabrication tolerance:
    a. Member length:
        1) Both ends finished for contact bearing: 1/32 IN.
        2) Framed members:
            a) 30 FT or less: 1/16 IN.
            b) Over 30 FT: 1/8 IN.
    b. Member straightness:
        1) Compression members: 1/1000 of axial length between points laterally supported.
        2) Non-compression members: ASTM A6 tolerance for wide flange shapes.
    c. Specified member camber (except compression members):
        1) 50 FT or less: -0/+1/2 IN.
        2) Over 50 FT: -0/+1/2 IN (+1/8 IN per 10 FT over 50 FT).
        3) Members received from mill with 75% of specified camber require no further cambering.
        4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
        5) Camber shall be measured in fabrication shop in unstressed condition.
    d. At bolted splices, depth deviation shall be taken up by filler plates.
        1) At welded joints, adjust weld profile to conform to variation in depth.
        2) Slope weld surface per AWS requirements.
    e. Finished members shall be free from twists, bends and open joints.
        1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

I. Fabricate grating, checkered plate, stairs, ladders and accessories using aluminum [prime painted steel] [galvanized steel] [stainless steel] unless shown otherwise on Drawings.

1. Finish:

a. Mill, unless noted otherwise.
b. Coat surfaces in contact with dissimilar materials.
1) See Specification Section 09 96 00.

J. Fabricate grating in accordance with NAAMM MBG 531.

1. Maximum tolerance for difference in depth between grating depth and seat or support angle depth: 1/8 IN.
2. Distance between edge of grating and face of embedded seat angle or face of wall or other structural member: 1/4 IN.
a. Tolerance: NAAMM MBG 531.
3. Removable sections: Not wider than 3 FT and not heavier than 100 LBS.
4. Ends and perimeter edges: Banded, with alternate bearing bars welded to band.
a. Provide full depth banding unless noted otherwise.
b. Banding at trenches and sumps to be 1/4 IN less than grating depth to allow for drainage.
5. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
6. Provide joints at openings between individual grating sections.
7. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned.

K. Fabricate checkered plate and miscellaneous metals in accordance with NAAMM AMP 555.

1. Workmanship: Class 2 [Class 1] [Class 3] unless noted otherwise.

L. See Specification Section 09 96 00 for preparation and painting of ferrous metals and other surfaces.

2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:

1. Refer to Specification Section 09 96 00 for surface preparation requirements.
2. All miscellaneous metal fabrication item surfaces shall be inspected and approved by NACE certified coatings inspector prior to application of shop-applied coatings.
a. Inspection shall be performed to determine depth of blast profile and cleanliness of surface.
b. Fabricator shall reblast and or re-clean surfaces as required until acceptable.

B. Shop Applied Coating Application:

1. Refer to Specification Section 09 96 00 for coating requirements.
2. After surface has been accepted in writing by NACE certified coatings inspector, fabricator may proceed with application of coatings.
3. Application of coatings shall be observed and certified by NACE certified coatings inspector.

C. Shop Inspection and Testing:

1. Owner will employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
2. Contractor responsible for testing to qualify shop and field welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.
3. Independent testing agency shall have a minimum of five years performing similar work and shall be subject to Owner's approval.

D. Responsibilities of Testing Agency:

1. Inspect shop and field welding in accordance with AWS Code including the following non-destructive testing:
a. Visually inspect all welds.

b. In addition to visual inspection, test 50% of full penetration welds and 20% of fillet welds with liquid dye penetrant or mag particle.

c. Test 20% of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.

2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.

a. Verify direct tension indicator gaps, if applicable.

3. Inspect structural steel which has been erected.

4. Inspect stud welding in accordance with AWS Code.

5. Prepare and submit inspection and test reports to Engineer.

a. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.

1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.

1. Shim and grout as necessary.

B. Contractor is solely responsible for safety.

1. Construction means and methods and sequencing of work is the prerogative of the Contractor.

2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing or rigid connections are installed.

3. Partially complete structural members shall not be loaded without an investigation by the Contractor.

4. Until all elements of the permanent structure and lateral bracing system are complete, temporary bracing for the partially complete structure will be required.

C. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.

1. Plumb, align, and set structural steel members to specified tolerances.

2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.

3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.

4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.

a. If not obvious from experience or from the Drawings, confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.

5. Remove and dispose of all temporary work and facilities off-site.

D. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.

1. Report defects in work-in-place which may influence satisfactory completion of the work.
2. Absence of such notification will be construed as acceptance of work-in-place.

E. Field Measurement:

1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
2. Contractor responsible for the accurate fit of the work.

F. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.

1. Use surveyor's level.
2. Notify Engineer of any errors or deviations found by such checking.

G. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

H. Erect plumb and level; introduce temporary bracing required to support erection loads.

I. Use light drifting necessary to draw holes together.

1. Drifting to match unfair holes is not allowed.

J. Welding:

1. Comply with AWS D1.1, AWS D1.2, and AWS D1.6 (as applicable for the material welded) and requirements of this Section’s “Fabrications” Article in “Part 2 - Products”.
2. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

K. Shore existing members when unbolting of common connections is required.

1. Use new bolts for rebolting connections.

L. Clean stored material of all foreign matter accumulated prior to the completion of erection.

M. Bolt Field Connections: Where practicable, conceal fastenings.

N. Field Welding:

1. Follow AWS procedures.
2. Grind welds smooth where field welding is required.

O. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.

1. Replace entire section.

P. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

Q. Unless noted or specified otherwise:

1. Connect steel members to steel members with 3/4 IN DIA ASTM F3125, Grade A325 high strength bolts.
2. Connect aluminum to aluminum with 3/4 IN DIA stainless bolts.
3. Connect aluminum to structural steel using 3/4 IN DIA stainless steel bolts.
   a. Provide dissimilar metals protection.

4. Connect aluminum and steel members to concrete and masonry using stainless steel mechanical anchor bolts or adhesive anchor bolts unless shown otherwise.
    a. Provide dissimilar materials protection.
5. Provide washers for all bolted connections.
6. Where exposed, bolts shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top of installed nut.
    a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

R. Install and tighten ASTM F3125, Grade A325 high-strength bolts in accordance with the AISC 325, Allowable Stress Design (ASD).
    1. Provide hardened washers for all Grade A325 bolts.
        a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

S. After bolts are tightened, upset threads of ASTM A307 bolts or anchor bolts to prevent nuts from backing off.

T. Secure metal to wood with lag screws of adequate size with appropriate washers.

U. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
    1. Provide full penetration welded splices where continuity is required.

V. Provide each fabricated item complete with attachment devices as indicated or required to install.

W. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

X. Set beam and column base plates accurately on nonshrink grout as indicated on Drawings.
    1. See Division 03 Specification Sections for non-shrink grout and anchorage.
    2. Set and anchor each base plate to proper line and elevation.
        a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
            1) Wedges, shims and setting nuts to be of same metal as base plate they support.
            2) Tighten nuts on anchor bolts.
        b. Fill space between bearing surface and bottom of base plate with nonshrink grout.
            1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
        c. Do not remove wedges or shims.
            1) Where they protrude, cut off flush with edge of base plate.
        d. Fill sleeves around anchor bolts solid with non-shrink grout.

Y. Tie anchor bolts in position to embedded reinforcing steel using wire.
    1. Tack welding prohibited.
        a. Coat projecting bolt threads and nuts with heavy coat of clean grease.
    2. Anchor bolt location tolerance:
        a. Per Section 03 15 19.

Z. Install bollards as detailed on Drawings.
    1. Fill pipe with concrete and round off at top.

AA. Provide abrasive stair nosings in each tread and landing of all concrete stairs and at each concrete stair landing having metal stair structure attaching to the concrete landing.
    1. Center stair nosings in stair width.

BB. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.

1. Keep screw holes clean and ready to receive screws.

CC. Attach grating to end and intermediate supports with grating saddle clips and bolts.

1. Maximum spacing: 2 FT OC with minimum of two per side.
2. Attach individual units of aluminum grating together with clips at 2 FT OC maximum with a minimum of two clips per side.

DD. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

EE. Repair damaged galvanized surfaces in accordance with ASTM A780.

1. Prepare damaged surfaces by abrasive blasting or power sanding.
2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

FF. Anchor ladder to concrete structure with minimum 3/4 IN stainless steel anchor bolts with minimum 6 IN embedment.

GG. Anchor ladder to masonry structure with minimum 3/4 IN stainless steel anchor bolts with minimum 6 IN embedment.

1. When anchoring into masonry, fill masonry cores with grout at anchor locations and each masonry core within 8 IN of anchor
2. When anchoring into cavity wall construction, provide minimum 6 IN embedment into concrete or masonry back-up wall.
    a. At each anchor location, provide sleeve between back face of veneer and cavity face of concrete or masonry back-up wall.
    b. Cut cavity insulation as required and seal around sleeve.
        1) Sleeve to be 1 IN DIA schedule 40 stainless steel tubing, TP-304L, ASTM A269.
            a) Minimum wall thickness to be .065 IN.
        2) Continuously weld 4 by 4 by 1/4 IN Type 304 stainless steel, ASTM A666 flange onto each end of pipe.
            a) Drill 1 IN hole in flange to match pipe.
            b) Attach sleeve to concrete or masonry back-up with 1/4 IN concrete screw anchors.
        3) Grout solid, area around bolt where bolt penetrates veneer.
        4) Accurately locate sleeves to align with bolt locations on ladder.

HH. Anchor ladder to metal stud walls using minimum 1/2 IN stainless steel bolts, nuts and washers.

1. Verify that stud wall has been provided with adequate backing to accept ladder anchors.

II. Install ladder safety extension post in accordance with manufacturer's instructions.

1. Mount device opposite the climbing side.
2. Provide ladder safety extension device for all ladders unless noted otherwise.

JJ. Mount ladder fall protection system with rail offset from ladder side rail approximately 3 IN.

KK. Install factory pre-fabricated stairs in location indicated in the Contract Documents and approved submittals.

3.3 FIELD QUALITY CONTROL

A. Tolerances shall meet structural requirements of Specification Section 05 12 00 for erecting items of structural nature.

B. Tolerances (unless otherwise noted on the Drawings):

1. Frame placement, after assembly and before welding or tightening.
    a. Deviation from plumb, level and alignment: 1 IN 500, maximum.
    b. Displacement of centerlines of columns: 1/2 IN maximum, each side of centerline location shown on Drawings.

C. Owner Pays for Field Inspection and Testing:

1. Owner will employ and pay for services of an independent testing agency to inspect and test structural steel shop and field work for compliance with this Specification Section.
2. Contractor provides sufficient notification and access so inspection and testing can be accomplished.
3. Contractor pays for retesting of failed tests and for additional testing required when defects are discovered.

3.4 CLEANING

A. After fabrication, erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. All stainless steel products in addition to Paragraph A. above:

1. Remove all heat tint, rusting, discoloration by passivation, ASTM A380, or other acceptable means as listed in NiDI 11 007 as approved by the Engineer.

C. Provide surface acceptable to receive field applied paint coatings specified in Specification Section 09 96 00.

END OF SECTION

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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 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Division 03 - Concrete.
4. Section 03 15 19 - Anchorage to Concrete.
5. Section 10 14 00 - Identification Devices.
6. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
7. Section 26 05 33 - Raceways and Boxes.

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.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of submittal process.
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.

B. 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) Aluminum: AA Type 6063-T6.
   b. Mounting hardware:
      1) Galvanized steel.
      2) Stainless steel.
   c. Concrete and reinforcing steel: See Division 03 specifications.

B. Equipment pads (interior and exterior):

1. Concrete and reinforcing steel: See Division 03 specifications.

C. Field touch-up of galvanized surfaces.

1. Zinc-rich primer.
   a. One coat, 3.0 MILS, ZRC by ZRC Products.

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.
4. See Specification Section 26 05 19 for combining multiple branch circuits in a common conduit.

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. Device Mounting Schedule:

1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
   a. Light switch (to center): 46 IN.
   b. Receptacle in architecturally finished areas (to center): 18 IN.
   c. Receptacle on exterior wall of building (to center): 18 IN.
   d. Receptacle in non-architecturally finished areas (to center): 46 IN.
   e. Telephone outlet in architecturally finished areas (to center): 18 IN.
   f. Telephone outlet for wall-mounted phone (to center): 46 IN.
   g. Safety switch (to center of operating handle): 54 IN.
   h. Separately mounted motor starter (to center of operating handle): 54 IN.
   i. Pushbutton or selector switch control station (to center): 46 IN.
   j. Panelboard (to top): 72 IN.

J. 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 Engineer's approval.

K. 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. Stainless steel system consisting of stainless steel channels and fittings, nuts and hardware.

L. 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.

M. Provide 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.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

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 Division 01.

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.

END OF SECTION

SECTION 26 05 19
WIRE AND CABLE - 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
    a. Building wire.
    b. Power cable.
    c. Control cable.
    d. Instrumentation cable.
    e. Wire connectors.
    f. Insulating tape.
    g. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Insulated Cable Engineers Association (ICEA):
    a. S-58-679, Standard for Control Cable Conductor Identification.
2. National Electrical Manufacturers Association (NEMA):
    a. ICS 4, Industrial Control and Systems: Terminal Blocks.
3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
    a. WC 57/S-73-532, Standard for Control Cables.
    b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
4. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC).
    b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
5. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
    a. 568, Commercial Building Telecommunications Cabling Standard.
6. Underwriters Laboratories, Inc. (UL):
    a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
    b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
    c. 467, Standard for Safety Grounding and Bonding Equipment.
    d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
    e. 486C, Standard for Safety Splicing Wire Connections.
    f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
i. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:

1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2. The following are specific types of instrumentation cables:
   a. Analog signal cable:
      1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 VDC) signals, using No. 16 AWG and smaller conductors.
      2) Commonly used types are defined in the following:
         a) TSP: Twisted shielded pair.
         b) TST: Twisted shielded triad.
   b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.
3. Thermocouple extension wire: Used to extend thermocouple wire.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

E. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
      1) Wire connectors.
      2) Insulating tape.
      3) Cable lubricant.
   b. See Specification Section 26 05 00 for additional requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Building wire, power and control cable :
   a. Aetna Insulated Wire.

b. Alphawire.
c. Cerrowire.
d. Encore Wire Corporation.
e. General Cable.
f. Okonite Company.
g. Southwire Company.

2. Instrumentation cable:
   a. Analog cable:
      1) Alphawire.
      2) Belden Inc.
      3) General Cable.
3. Wire connectors:
   a. Burndy Corporation.
   b. Buchanan.
   c. Ideal.
   d. Ilsco.
   e. 3M Co.
   f. Teledyne Penn Union.
   g. Thomas and Betts.
   h. Phoenix Contact.
4. Insulating and color coding tape:
   a. 3M Co.
   b. Plymouth Bishop Tapes.
   c. Red Seal Electric Co.

2.2 MANUFACTURED UNITS

A. Building Wire:

1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:

1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
5. Number of conductors as required, including a bare ground conductor.
6. Individual conductor color coding:
   a. ICEA S-58-679, Method 4.
   b. See PART 3 of this Specification Section for additional requirements.

7. Conform to NFPA 70 Type TC.

C. Control Cable:

1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Conform to NEMA/ICEA WC 57/S-73-532 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
5. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
    a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
6. Individual conductor color coding:
    a. ICEA S-58-679, Method 1, Table E-2.
    b. See PART 3 of this Specification Section for additional requirements.
7. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:

1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to UL 44 for Type SIS insulation.
5. Conform to UL 83 for Type MTW insulation.

E. Instrumentation Cable:

1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
2. Analog cable:
    a. Tinned copper conductors.
    b. 300 V or 600 V PVC insulation with PVC jacket.
    c. Twisted with 100 PCT foil shield coverage with drain wire.
    d. Six (6) twists per foot minimum.
    e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
    f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
3. Digital cable:
    a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
    b. Horizontal voice and data cable:
        1) Category 6 per TIA/EIA/ANSI 568.
        2) Cable shall be label-verified.
        3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
        4) Conductors: No. 24 AWG solid untinned copper.
        5) Rated CMP per NFPA 70.
    c. Conform to NFPA 262 and NFPA 70 Type ITC.

F. Wire Connectors:

1. Twist/screw on type:
    a. Insulated pressure or spring type solderless connector.
    b. 600 V rated.
    c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
    d. Phase and neutral conductors: Conform to UL 486C.
2. Compression and mechanical screw type:
    a. 600 V rated.
    b. Ground conductors: Conform to UL 467.
    c. Phase and neutral conductors: Conform to UL 486A.
3. Terminal block type:
    a. High density, screw-post barrier-type with white center marker strip.
    b. 600 V and ampere rating as required, for power circuits.
    c. 600 V, 20 ampere rated for control circuits.
    d. 300 V, 15 ampere rated for instrumentation circuits.
    e. Conform to NEMA ICS 4 and UL 486A.

G. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 MIL.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
    a. Insulating tape: Black.
    b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.

H. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Permitted Usage of Insulation Types:
1. Type XHHW-2:
    a. Building wire and power and control cable in architectural and non-architectural finished areas.
    b. Building wire and power and control cable in conduit in outdoor areas and below grade.
    c. Building wire and power and control cable in cable tray in outdoor areas.
2. Type THHN/THWN and THHN/THWN-2:
    a. Building wire and power and control cable No. 8 AWG and smaller in architectural and non-architectural finished areas.
3. Type SIS and MTW:
    a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Conductor Size Limitations:
1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.

2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

C. Color Code All Wiring as Follows:

1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
b. Conductors larger than No. 6 AWG:
   1) Insulated phase and neutral conductors shall be identified by one of the following methods:
      a) Continuous colored outer finish along its entire length.
      b) 3 IN of colored tape applied at the termination.
   2) Insulated grounding conductor shall be identified by one of the following methods:
      a) Continuous green outer finish along its entire length.
      b) Stripping the insulation from the entire exposed length.
      c) Using green tape to cover the entire exposed length.
   3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA S-58-679, Method 4 with:
   a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
   b. Ground conductor: Bare.
3. Control cables ICEA S-58-679, Method 1, Table E-2:
   a. When a bare ground is not provided, one of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
   b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

D. Install all wiring in raceway unless otherwise indicated on the Drawings.

E. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:

1. Where specifically indicated on the Drawings.
2. Where field conditions dictate and written permission is obtained from the Engineer.
3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
   a. The combinations shall comply with the following:

1) 12 VDC, 24 VDC and 48 VDC may be combined.
2) 125 VDC shall be isolated from all other AC and DC circuits.
3) AC control circuits shall be isolated from all DC circuits.

4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
   a. The combinations shall comply with the following:
      1) Analog signal circuits may be combined.
      2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for similar loads may be combined in a common raceway, such as multiple lighting circuits or multiple receptacle circuits or other 120Vac circuits. Do not combine lighting and receptacle circuits.
   a. Do not combine control device circuits with lighting or receptacle circuits.
   b. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
      1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
      2) The neutral conductors may not be shared.
      3) Up sizing raceway size for the size and quantity of conductors.

F. Ground the drain wire of shielded instrumentation cables at one end only.
   1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

G. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
         1) Twist/screw on type connectors.
      b. Junction and pull boxes and wireways:
         1) Twist/screw on type connectors for use on No. 8 and smaller wire.
         2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
      c. Motor terminal boxes:
         1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
         2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
      d. Manholes or handholes:
         1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
         2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
   2. Control circuits:
      a. Junction and pull boxes: Terminal block type connector.
      b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
      c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
   3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
      a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
      b. Junction and pull boxes: Terminal block type connector.

c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

H. Insulating Tape Usage:

1. For insulating connections of No. 8 AWG wire and smaller: 7 MIL vinyl tape.
2. For insulating splices and taps of No. 6 AWG wire or larger: 10 MIL vinyl tape.
3. For insulating connections made in cold weather or in outdoor locations: 8.5 MIL, all weather vinyl tape.

I. Color Coding Tape Usage: For color coding of conductors.

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. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical - Basic Requirements.
4. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
5. Section 26 05 33 - Raceways and Boxes.

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. 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. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. 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.

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.
2. Insulated conductors: Color coded green, per Specification Section 26 05 19.

B. Conduit: As specified in Specification Section 26 05 33.

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.
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.

G. Prefabricated Composite Material Test Stations:

1. Body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
2. Minimum load ratings: SCTE 77 Tier 15.
3. Open bottom.
4. Stackable design as required for 3 FT depth.
5. Cover:
   a. Engraved legend of "GROUND".
   b. Lay-in non-bolt down.
6. Size: 12 IN round or 12 IN square.

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.
   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.
g. At all above grade terminations, the conductors shall be labeled.

3. Ground ring grounding system:
a. Ground ring consists of ground rods and a conductor looped around the structure.
b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
c. Provide a minimum of four ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
d. Building/Structure grounding:
1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
e. Grounding conductor: Bare conductor, size as indicated on the Drawings.
f. Ground rod test stations:
1) Provided where indicated on the Drawings.
2) Grounding conductors connected to ground rod with removable ground clamps.

4. Triad grounding system:
a. Triad consists of three ground rods arranged in a triangle separated by 10 FT and a conductor interconnecting each ground rod.
b. Place first ground rod a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
c. Grounding conductor: Bare conductor, size as indicated on the Drawings.

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.
2. Metal light poles:
a. Connect metal pole and pole base reinforcing steel to a ground rod.
b. Grounding conductor: Bare #6 AWG minimum.
3. Equipment support rack and pedestals mounted outdoors:
a. Connect metallic structure to a ground rod.
b. Grounding conductor: #6 AWG minimum.

D. Transformer Separately Derived Grounding System:

1. Install the System Bonding Jumper at the transformer. At the first disconnect, ensure the neutral is isolated from ground.
2. Structures with a single electrical room/area:
a. Connect grounding electrode conductor to the Grounding Electrode System main ground bar.
3. See Grounding Electrode System paragraph for conductor termination requirements.

E. Raceway Bonding/Grounding:

1. Install all metallic raceway so that it is electrically continuous.

2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

F. Equipment Grounding:

1. Ground all utilization equipment with an equipment grounding conductor.

G. 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.

3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

B. Provide a continuity test on the components of the grounding electrode system.

C. Complete grounding system: Resistance of 5 ohms or less.

D. Test resistance of installed ground system after backfilling and before connection to any other grounded system including underground piping, utility services or other building ground systems.

1. Test ground grid resistance by fall-of-potential method.
2. Perform test at the ground rod test station.

END OF SECTION

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SECTION 26 05 33
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
    a. Conduits.
    b. Conduit fittings.
    c. Conduit supports.
    d. Wireways.
    e. Outlet boxes.
    f. Pull and junction boxes.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical - Basic Requirements.
4. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
5. Section 26 05 43 - Electrical - Exterior Underground.
6. Section 26 27 26 - Wiring Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Aluminum Association (AA).
2. American Iron and Steel Institute (AISI).
3. ASTM International (ASTM):
    a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    c. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
4. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
    c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
    d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
    e. TC 14.BG, Belowground Reinforced Thermosetting Resin Conduit and Fittings.
5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
    a. C80.1, Electric Rigid Steel Conduit (ERSC).
    b. C80.3, Steel Electrical Metallic Tubing (EMT).
    c. C80.5, Electrical Aluminum Rigid Conduit (ERAC).
    d. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
6. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

7. Underwriters Laboratories, Inc. (UL):
   a. 1, Standard for Flexible Metal Conduit.
   b. 6, Electrical Rigid Metal Conduit - Steel.
   c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
   d. 360, Standard for Liquid-Tight Flexible Metal Conduit.
   e. 467, Grounding and Bonding Equipment.
   f. 514A, Metallic Outlet Boxes.
   g. 514B, Conduit, Tubing, and Cable Fittings.
   h. 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
   i. 797, Electrical Metallic Tubing - Steel.
   j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
      1) Conduit fittings.
      2) Support systems.
   b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
   a. Identify dimensional size of pull and junction boxes to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Rigid metal conduits and electrical metallic tubing:
   a. Allied Tube and Conduit.
   b. Western Tube and Conduit Corporation.
   c. Wheatland Tube.
   d. Patriot Aluminum Products, LLC.
2. PVC coated rigid metal conduits:
   a. Ocal by Thomas & Betts.
   b. Robroy Industries.
3. Rigid nonmetallic conduit:
   a. Prime Conduit.
   b. Cantex, Inc.
   c. Osburn Associates, Inc.
   d. Champion Fiberglass, Inc.

e. United Fiberglass of America, Inc.

4. Flexible conduit:
   a. AFC Cable Systems.
   b. Anamet, Inc.
   c. Electri-Flex Company.
   d. International Metal Hose Company.
   e. Southwire Company, LLC.
5. Wireway:
   a. Hoffman Engineering.
   b. Wiegmann by Hubbell.
   c. Square D by Schneider Electric.
6. Conduit fittings and accessories:
   a. Appleton by Emerson Electric Co.
   b. Carlon by Thomas & Betts.
   c. Cantex, Inc.
   d. Crouse-Hinds by Eaton.
   e. Killark by Hubbell.
   f. Osburn Associates, Inc.
   g. O-Z/Gedney by Emerson Electric Co.
   h. Raco by Hubbell.
   i. Steel City by Thomas & Betts.
   j. Thomas & Betts.
7. Support systems:
   a. Unistrut by Atkore International, Inc.
   b. B-Line by Eaton.
   c. Kindorf by Thomas & Betts.
   d. Minerallac Company.
   e. CADDY by Pentair.
   f. Superstrut by Thomas & Betts.
8. Outlet, pull and junction boxes:
   a. Appleton by Emerson Electric Co.
   b. Crouse-Hinds by Eaton
   c. Killark by Hubbell.
   d. O-Z/Gedney by Emerson Electric Co.
   e. Steel City by Thomas & Betts.
   f. Raco by Hubbell
   g. Bell by Hubbell.
   h. Hoffman Engineering.
   i. Wiegmann by Hubbell.
   j. B-Line by Eaton.
   k. Adalet.
   l. RITTAL North America LLC.
   m. Stahlin by Robroy Enclosures.

2.2 RIGID METAL CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):

1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Threads galvanized after cutting.
4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
5. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Mild steel with continuous welded seam.

B. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.

C. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.

D. Standards: NFPA 70 Type EMT, NEMA/ANSI C80.3, UL 797.

2.4 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):

1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DEGC wire and shall be marked "maximum 90 DEGC".
5. Standards: NFPA 70 Type PVC, NEMA TC 2, UL 651.

2.5 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):

1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Standard: NFPA 70 Type FMC, UL 1.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):

1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.
4. Standard: NFPA 70 Type LFMC, UL 360.

2.6 WIREWAY

A. General:

1. Suitable for lay-in conductors.
2. Designed for continuous grounding.
3. Covers:
   a. Hinged or removable in accessible areas.
   b. Non-removable when passing through partitions.
4. Finish: Rust inhibiting primer and manufacturer's standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.

B. General Purpose (NEMA 1 rated) Wireway:

1. 14 or 16 gage steel without knockouts.
2. Cover: Solid, non-gasketed and held in place by captive screws.

C. Raintight (NEMA 3R) Wiring Trough:

1. 14 or 16 GA galvanized steel without knockouts.
2. Cover: Non-gasketed and held in place by captive screws.

2.7 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS:

1. General:
   a. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
   a. Threaded steel or malleable iron.
   b. Gasketed or non-gasketed.
   c. Grounding or non-grounding type.
3. Bushings:
   a. Threaded, insulated metallic.
   b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
5. Couplings:
   a. Threaded straight type: Same material and finish as the conduit with which they are used on.
   b. Threadless type: Gland compression or self-threading type, concrete tight.
6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. Cover:
      1) Clip-on type with stainless steel screws.
      2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. With or without drain and breather.
   d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
    a. Liquid tight and arc resistant.
    b. Electrically conductive so no bonding jumper is required.
    c. Dry and wet areas:
       1) Bronze braided covering over flexible brass core.
       2) Bronze end fittings.
       3) Zinc-plated steel or malleable iron unions and nipples.
    d. Corrosive areas:
       1) Stainless steel braided covering over flexible stainless steel core.
       2) Stainless steel end fittings.
       3) Aluminum unions and nipples.

11. Service entrance head:
    a. Malleable iron, galvanized steel or copper free aluminum.
    b. Insulated knockout cover for use with a variety of sizes and number of conductors.
12. Expansion couplings:
    a. 2 IN nominal straight-line conduit movement in either direction.
    b. Galvanized steel with insulated bushing.
    c. Gasketed for wet locations.
    d. Internally or externally grounded.
13. Expansion/deflection couplings:
    a. 3/4 IN nominal straight-line conduit movement in either direction.
    b. 30 DEG nominal deflection from the normal in all directions.
    c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
    d. Internally or externally grounded.
    e. Watertight, raintight and concrete tight.
14. Standards: UL 467, UL 514B, UL 1203.

B. Fittings for Use with EMT:
1. Connectors:
    a. Straight, angle and offset types furnished with locknuts.
    b. Zinc plated steel.
    c. Insulated gland compression type.
    d. Concrete and raintight.
2. Couplings:
    a. Zinc plated steel.
    b. Gland compression type.
    c. Concrete and raintight.
3. Conduit bodies (ells and tees):
    a. Body: Copper free aluminum with threaded hubs.
    b. Standard and mogul size.
    c. Cover:
        1) Screw down type with steel screws.
        2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
4. Standard: UL 514B.

C. Fittings for Use with FLEX:
1. Connector:
    a. Zinc plated malleable iron.
    b. Squeeze or clamp-type.
2. Standard: UL 514B.

D. Fittings for Use with FLEX-LT:
1. Connector:
    a. Straight or angle type.
    b. Metal construction, insulated and gasketed.
    c. Composed of locknut, grounding ferrule and gland compression nut.
    d. Liquid tight.
2. Standards: UL 467, UL 514B.

E. Fittings for Use with Rigid Nonmetallic PVC Conduit:

1. Coupling, adapters and conduit bodies:
    a. Same material, thickness, and construction as the conduits with which they are used.
    b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
    c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

F. Weather and Corrosion Protection Tape:

1. PVC based tape, 10 mils thick.
2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.8 ALL RACEWAY AND FITTINGS

A. Mark Products:

1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.9 OUTLET BOXES

A. Metallic Outlet Boxes:

1. Hot-dip galvanized steel.
2. Conduit knockouts and grounding pigtail.
3. Styles:
    a. 2 IN x 3 IN rectangle.
    b. 4 IN square.
    c. 4 IN octagon.
    d. Masonry/tile.
4. Accessories:
    a. Flat blank cover plates.
    b. Barriers.
    c. Extension, plaster or tile rings.
    d. Box supporting brackets in stud walls.
    e. Adjustable bar hangers.
5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:

1. Zinc plated cast iron or die-cast copper free aluminum with manufacturer's standard finish.
2. Threaded hubs and grounding screw.
3. Styles:
    a. "FS" or "FD".
    b. "Bell".
    c. Single or multiple gang and tandem.
    d. "EDS" or "EFS" for hazardous locations.
4. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.
5. Standards: UL 514A, UL 1203.

2.10 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:

1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. With or without concentric knockouts on four sides.
3. Flat cover fastened with screws.

B. NEMA 3R Rated:

1. Body and cover: 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. Drip shield top and seam-free sides, front and back.
3. With or without concentric knockouts on bottom.
4. Slip-on removable cover fastened on bottom edge with screws or continuous hinged cover fastened with screws.

C. NEMA 4X Rated (metallic):

1. Body and cover: 14 GA Type 304 or 316 stainless steel.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged door and stainless steel screws and clamps.
6. Door with oil-resistant gasket.

D. NEMA 4X Rated (Nonmetallic):

1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
2. No knockouts.
3. External mounting flanges.
4. Hinged door with quick release latches and padlocking hasp.
5. Door with oil resistant gasket.

E. Miscellaneous Accessories:

1. Rigid handles for covers larger than 9 SQFT or heavier than 25 LBS.
2. Split covers when heavier than 25 LBS.
3. Weldnuts for mounting optional panels and terminal kits.
4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

F. Standards: NEMA 250, UL 50.

2.11 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:

1. Material requirements.
   a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
   b. Stainless steel: AISI Type 316.

B. Single Conduit and Outlet Box Support Fasteners:

1. Material requirements:
   a. Zinc plated steel.
   b. Stainless steel.
   c. Malleable iron.

2.12 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

A. Sleeves through walls and floors:

1. Uncoated or galvanized iron or steel:

2. Wall thickness: Not less than standard Schedule 40 pipe.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:

1. NFPA 70.
2. Manufacturer instructions.

B. Size of Raceways:

1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
2. Unless specifically indicated otherwise, the minimum raceway size shall be:
   a. Conduit: 3/4 IN.
   b. Wireway: 2-1/2 IN x 2-1/2 IN.

C. Field Bending and Cutting of Conduits:

1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
2. Do not reduce the internal diameter of the conduit when making conduit bends.
3. Prepare tools and equipment to prevent damage to the PVC coating.
4. Degrease threads after threading and apply a zinc rich paint.
5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories 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 conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
   a. Total nominal thickness: 40 MIL.
4. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.

1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.

3.2 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.

1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
2. Run in straight lines parallel to or at right angles to building lines.
3. Do not route conduits:
    a. Through areas of high ambient temperature or radiant heat.
    b. In suspended concrete slabs.
4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 DEG of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All conduits within a structure shall be installed exposed except as follows:

1. As indicated on the Drawings.
2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
3. Conduits in architecturally finished areas shall be concealed.
4. Embedded in floor slabs or buried under floor slabs where shown on the Contract Drawings or with the Engineer's permission.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:

1. Between instrumentation and telecommunication: 1 IN.
2. Between instrumentation and 125 V, 48 V and 24 VDC, 2 IN.
3. Between instrumentation and 600 V and less AC power or control: 6 IN.
4. Between telecommunication and 125 V, 48 V and 24 VDC, 2 IN.
5. Between telecommunication and 600 V and less AC power or control: 6 IN.
6. Between 125 V, 48 V and 24 VDC and 600 V and less AC power or control: 2 IN.
7. Between 125 V, 48 V and 24 VDC and greater than 600 VAC power: 2 IN.
8. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.

1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:

1. Power wire or cables: All raceway types.
2. Control wire or cables: All raceway types.
3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
4. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:

1. Dry areas:

a. RGS.

2. Wet areas:
   a. RGS.
   b. PVC-RGS.

C. Permitted Raceway Types Per Routing Locations:

1. In stud framed walls:
   a. EMT.
2. In concrete block or brick walls:
   a. PVC-40.
3. Above acoustical tile ceilings:
   a. EMT.
   b. NEMA 1 rated wireway.
4. Embedded in poured concrete walls and floors:
   a. PVC-40.
   b. RGS wrapped with factory applied weather and corrosion protection tape when emerging from concrete into areas designated as dry, wet, corrosive or highly corrosive.
5. Beneath floor slab-on-grade:
   a. PVC-40.
6. Through floor penetrations:
   a. RGS wrapped with factory applied weather and corrosion protection tape when emerging from concrete into areas designated as dry, wet, corrosive or highly corrosive.
7. Direct buried conduits and ductbanks:
   a. PVC-40.
   b. 90 DEG elbows for transitions to above grade:
      1) RGS wrapped with factory applied weather and corrosion protection tape.
      2) PVC-RGS.
      3) Fiberglass (above grade rated).
   c. Long sweeping bends greater than 15 DEG:
      1) RGS wrapped with factory applied weather and corrosion protection tape.
8. Concrete encased ductbanks:
   a. PVC-40.
   b. Coilable HDPE Conduit.
   c. Long sweeping bends greater than 15 DEG:
      1) RGS for sizes 2 IN and larger.

D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.

1. The maximum length shall not exceed:
   a. 6 FT to light fixtures.
   b. 3 FT to all other equipment.

E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.

1. The maximum length shall not exceed:
   a. 6 FT to light fixtures.
   b. 3 FT to motors.
   c. 2 FT to all other equipment.

F. NEMA 1 Rated Wireway:

1. Surface mounted in electrical rooms.
2. Surface mounted above removable ceilings tiles of an architecturally finished area.

G. NEMA 3R Wiring Trough:

1. Surface mounted in exterior locations.

H. NEMA 4X Rated Wireway:

1. Surface mounted in areas designated as wet and or corrosive.

I. Underground Conduit: See Specification Section 26 05 43.

3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.

1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

B. Install Expansion Fittings:

1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
2. Elsewhere as identified on the Drawings.

C. Install Expansion/Deflection Fittings:

1. Where conduits enter a structure.
    a. Except electrical manholes and handholes.
    b. Except where the ductbank is tied to the structure with rebar.
2. Where conduits span structural expansions joints.
3. Elsewhere as identified on the Drawings.

D. Threaded connections shall be made wrench-tight.

E. Conduit joints shall be watertight:

1. Where subjected to possible submersion.
2. In areas classified as wet.
3. Underground.

F. Terminate Conduits:

1. In metallic outlet boxes:
    a. RGS:
        1) Conduit hub and locknut.
        2) Insulated bushing and two locknuts.
        3) Use grounding type locknut or bushing when required by NFPA 70.
    b. EMT: Compression type connector and locknut.
2. In NEMA 1 rated enclosures:
    a. RGS:
        1) Conduit hub and locknut.
        2) Insulated bushing and two locknuts.
        3) Use grounding type locknut or bushing when required by NFPA 70.
    b. EMT: Compression type connector and locknut.
3. In NEMA 4 rated enclosures:
    a. Watertight, insulated and gasketed hub and locknut.
4. When stubbed up through the floor into floor mount equipment:
    a. With an insulated grounding bushing on metallic conduits.

b. With end bells on nonmetallic conduits.

3.5 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:

1. Dry or wet and/or hazardous areas:
   a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.

B. Permitted single conduit support fasteners per area designations and conduit types:

1. Architecturally finished areas:
   a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
   b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
2. Dry or wet and/or hazardous areas:
   a. Material: Zinc plated steel, stainless steel and malleable iron.
   b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
3. Conduit type shall be compatible with the support fastener material.
   a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS and EMT.
   b. Nonmetallic fasteners may be used with PVC-40, PVC-80 and fiberglass.

C. Conduit Support General Requirements:

1. Maximum spacing between conduit supports per NFPA 70.
2. Support conduit from the building structure.
3. Do not support conduit from process, gas, air or water piping; or from other conduits.
4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
   a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
   b. Conduit hangers:
      1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
   c. Do not use suspended ceiling support systems to support raceways.
   d. Hangers in metal roof decks:
      1) Utilize fender washers.
      2) Not extend above top of ribs.
      3) Not interfere with vapor barrier, insulation, or roofing.
5. Conduit support system fasteners:
   a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
   b. Do not use concrete nails and powder-driven fasteners.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 26 05 00 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.

4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:

1. Permitted uses of metallic outlet boxes:
   a. Housing of wiring devices:
      1) Recessed in all stud framed walls and ceilings.
      2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
   b. Pull or junction box:
      1) Above gypsum wall board or acoustical tile ceilings.
      2) Above 10 FT in an architecturally finished area where there is no ceiling.
      3) Above 10 FT in dry non-architecturally finished areas.
2. Permitted uses of cast outlet boxes:
   a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
   b. Pull and junction box surface mounted in non-architecturally finished dry, wet areas.
3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
   a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
   b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.

C. Pull and Junction Boxes:

1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
   a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
3. Permitted uses of NEMA 3R enclosure:
   a. Pull or junction box surface mounted in exterior locations.
4. Permitted uses of NEMA 4 enclosure:
   a. Pull or junction box surface mounted in areas designated as wet.

END OF SECTION

SECTION 26 05 43
ELECTRICAL - EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
   a. Handhole.
   b. Underground conduits and ductbanks.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Division 03 - Concrete.
4. Section 26 05 26 - Grounding.
5. Section 26 05 33 - Raceways and Boxes.
6. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. HB-17, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A536, Standard Specification for Ductile Iron Castings.
3. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
4. Society of Cable Telecommunications Engineers (SCTE):
   a. 77, Specifications for Underground Enclosure Integrity.

1.3 DEFINITIONS

A. Direct-Buried Conduit(s):

1. Individual (single) underground conduit.
2. Multiple underground conduits, arranged in one or more planes, in a common trench.

B. Concrete Encased Ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
3. Fabrication and/or layout drawings:
   a. Provide dimensional drawings of each manhole indicating all specified accessories and conduit entry locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Prefabricated composite handholes:
    a. Armorcast Products Company.
    b. Quazite by Hubbell.
    c. Synertech by Oldcastle Enclosure Solutions.
2. Precast handholes:
    a. Lister Industries Ltd.
    b. Oldcastle Enclosure Solutions.
    c. Jensen Precast and Utility Concrete Products.
3. Handhole and ductbank accessories:
    a. Cantex, Inc.
    b. Condux International, Inc.
    c. Neenah Enterprises, Inc.
    d. Prime Conduit.
    e. Thomas and Betts.
    f. Underground Devices, Inc.
    g. Unistrut by Atkore International, Inc.

2.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:

1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
2. Minimum load ratings: SCTE 77 Tier 22.
3. Open bottom.
4. Stackable design as required for specified depth.
5. Cover:
    a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
    b. Non-gasketed bolt down with stainless steel penta head bolts.
    c. Lay-in non-bolt down, when cover is over 100 LBS.
    d. One or multiple sections so the maximum weight of a section is 125 LBS.
6. Cover lifting hook: 24 IN minimum in length.

B. Precast Handholes:

1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
3. Mating edges: Tongue and groove type.
4. Solid bottom with a 12 IN x 12 IN or 12 IN DIA french drain in the bottom of each manhole.

2.3 CONCRETE HANDHOLE ACCESSORIES

A. Cover and Frame:

1. Cast ductile iron: ASTM A536.
2. AASHTO live load rating: H-20.
3. Diameter: 30 IN.

4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.

B. Ground Rods and Grounding Equipment: See Specification Section 26 05 26.

2.4 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete and reinforcing steel: See Division 03 Specifications.

B. Conduit: See Specification Section 26 05 33.

C. Duct Spacers/Supports:

1. High density polyethylene or high impact polystyrene.
2. Interlocking web or mesh design.
3. Provide 3 IN minimum spacing between conduits.
4. Accessories, as required:
   a. Hold down bars.
   b. Ductbank strapping.

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks and direct buried conduit.

1. Field conditions may affect actual routing.

B. Manhole and Handhole Locations:

1. Approximately where shown on the Drawings.
2. As required for pulling distances.
3. As required to keep pulling tensions under allowable cable tensions.
4. As required for number of bends in ductbank routing.
5. Shall not be installed in a swale or ditch.
6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 31 23 33 for trenching, backfilling and compacting.

3.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:

1. For use in areas subjected to occasional non-deliberate vehicular traffic.
2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
5. Size: As indicated on the Drawings or as required for the number and size of conduits.
6. Provide cable rails and pulling eyes as needed.

B. Precast Manholes and Handholes:

1. For use in vehicular and non-vehicular traffic areas.
2. Construction:
    a. Grout or seal all joints, per manufacturer's instructions.
    b. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
        1) Drill opening in floor for ground rod.
        2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.
4. Install so that the top of cover is 1 IN above finished grade.
    a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.
5. After installation is complete, backfill and compact soil around manholes and handholes.
6. Handhole size:
    a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
    b. Minimum floor dimension of 4 FT x 4 FT and minimum depth of 4 FT.

3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:

1. Ductbank types per location:
    a. Concrete encased ductbank:
        1) Under roads.
        2) Pad mounted transformer secondaries.
        3) __As indicated on the drawings.
        4) As indicated in the Ductbank Schedule.
2. Do not place concrete or soil until conduits have been observed by the Engineer.
3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
    a. Low points shall be at manholes or handholes.
4. During construction and after conduit installation is complete, plug the ends of all conduits.
5. Provide conduit supports and spacers.
    a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
        1) 1 IN and less: 3 FT.
        2) 1-1/4 to 3 IN: 5 FT.
        3) 3-1/2 to 6 IN: 7 FT.
    b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
        1) 1 IN and less: 10 FT.
        2) 1-1/4 to 2-1/2 IN: 14 FT.
        3) 3 IN and larger: 20 FT.
    c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
6. Stagger conduit joints at intervals of 6 IN vertically.
7. Make conduit joints watertight and in accordance with manufacturer's recommendations.

8. Accomplish underground changes in direction of runs exceeding a total of 15 DEG by long sweep bends having a minimum radius of 25 FT.
    a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
9. Furnish manufactured elbows at end of runs.
    a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.
10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
11. After the conduit run has been completed:
    a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
        1) Test mandrel:
            a) Length: Not less than 12 IN.
            b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
    b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
12. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.
13. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 26 05 33, prior to entering a structure or going above ground.
14. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable.
15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:

1. Ductbank system consists of conduits completely encased in minimum 3 IN of concrete on each side of conduit and with separations between different cabling types as required in Specification Section 26 05 33 or as detailed on the Drawings.
2. Install so that top of concrete encased duct, at any point:
    a. Is not less than 24 IN below grade.
    b. Is below pavement sub-grading.
3. Where identified and for a distance 10 FT either side of the area, the concrete shall be reinforced.
    a. The reinforcement shall consist of #4 bars and #4 ties placed 12 IN on center, in accordance with Division 03 Specification Sections or as detailed on the Drawings.
    b. Conduit supports to be staggered to minimize weak vertical shear point.
4. Conduit supports shall provide a uniform minimum clearance of 3 IN between the bottom of the trench and the bottom row of conduit.
5. Conduit separators shall provide a uniform minimum clearance of 3 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.

C. Direct-Buried Conduit(s):

1. Install so that the top of the uppermost conduit, at any point:
    a. Is not less than 30 IN below grade.
    b. Is below pavement sub-grading.
2. Provide a uniform minimum clearance of 3 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
    a. Maintain the separation of multiple planes of conduits by one of the following methods:

1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill with flowable fill (100 PSI) per Specification Section 31 23 33 or concrete per Division 03 specifications.
2) Install the multilevel conduits one level at a time.
    a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 31 23 33, to maintain the required separations.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Branch circuit panelboards.
2. Distribution panelboards.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical - Basic Requirements.
4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
5. Section 26 43 13 - Low Voltage Surge Protective Devices (SPD).

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. PB 1, Panelboards.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
3. Underwriters Laboratories, Inc. (UL):
   a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
   b. 67, Standard for Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data.
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
   a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Contract Closeout Information:

1. Operation and Maintenance Data.
2. Panelboard schedules with as-built conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Eaton.

2. ABB/GE.
3. Square D by Schneider Electric.
4. Siemens Corporation.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:

1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
2. Short Circuit Current Rating (SCCR) and/or Ampere Interrupting Current (AIC) ratings equal to or greater than the interrupting rating indicated on the Drawings or in the schedule.
    a. Series rating is not acceptable.
    b. When fault current or minimum interrupting rating is not indicated, use rating of upstream equipment or infinite bus calculation of transformer secondary.
3. Service Entrance Equipment rated when indicated on the Drawings or when shown to be fed from a utility source.

C. Construction:

1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
2. Multi-section panelboards: Feed-through or sub-feed lugs.
3. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:

1. Main bus bars:
    a. Tin plated aluminum or tin plated copper sized to limit temperature rise to a maximum of 65 DEGC above an ambient of 40 DEGC.
    b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
3. Neutral bus bars: Insulated 100 PCT rated or 200 PCT rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Overcurrent and Short Circuit Protective Devices:

1. Main overcurrent protective device:
    a. Molded case circuit breaker.
2. Branch overcurrent protective devices:
    a. Bolt-on molded case circuit breaker.
3. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
4. Factory installed.

F. Enclosure:

1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Branch circuit panelboard:
    a. Trims supplied with hinged door-in-door construction.
        1) Outer door:
            a) Allows access to the interior of the enclosure.
            b) Hinged to the enclosure.

c) Opened by removal of screws or by operating a mechanical latch located behind the inner door.

2) Inner door:

a) Allows access to breakers (non-live parts).

b) Hinged to outer door.

c) Opened by operation of a keyed corrosion resistant chrome-plated combination lock and catch. Locks for all branch circuit panelboards keyed alike.

b. Trims for surface mounted panelboards, same size as box.

c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.

d. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.

e. Clear plastic cover for directory card mounted on the inside of each door.

f. Where NEMA 3R or NEMA 12 rating is indicated: Door gasketed.

g. Where NEMA 4X is indicated: Stainless Steel.

4. Distribution panelboard:

a. Trims cover all live parts with switching device handles accessible.

b. Minimum 8 IN deep and less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.

c. Clear plastic cover for directory card mounted front of enclosure.

d. Where NEMA 3R or NEMA 12 rating is indicated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike, or provisions for padlocks.

e. Where NEMA 4X is indicated: Stainless Steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 26 05 00.

C. Provide NEMA rated enclosure as indicated on the Drawings. Where enclosure type is not indicated, provide enclosure rating suitable for the atmosphere where equipment is installed.

D. Field identification:

1. Provide all required tagging and markings per the NFPA 70.

E. Provide each panelboard with a typed directory:

1. Identify all circuit locations in each panelboard with the load type and location served.
2. Use Owner-furnished mechanical equipment designation if different than designation indicated on the Drawings.
3. Use final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings.
4. Identify spare overcurrent devices.

END OF SECTION

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SECTION 26 26 13
PACKAGE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Package power supply consisting of a transformer and panelboard.

B. Related Sections include but are not necessarily limited to:

1. Division 00 – Procurement and Contracting Requirements
2. Division 01 – General Requirements
3. Section 26 05 00 - Electrical - Basic Requirements.
4. Section 26 05 26 - Grounding.
5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. PB 1, Panelboards.
   c. ST 20, Dry Type Transformers for General Applications.
3. Underwriters Laboratories, Inc. (UL):
   a. 67, Standard for Panelboards.
   b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

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.
   b. See Specification Section 26 05 00 for additional requirements.
2. Fabrication and/or layout drawings:
   a. Nameplate drawing.
   b. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Contract Closeout Information:

1. Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. GE by ABB.
2. Hammond Power Solutions.
3. Square D by Schneider Electric.

4. Eaton.
5. Siemens Corporation.

2.2 PACKAGED POWER SUPPLY

A. General:

1. Standards: IEEE C57.96, NEMA PB 1, NEMA ST 20, UL 67 and UL 1561.
2. Package power supply includes a main primary circuit breaker, an encapsulated dry-type transformer and a secondary panelboard with main circuit breaker.

B. Ratings:

1. Single or three-phase as indicated on the Drawings.
2. KVA and voltage ratings as indicated on the Drawings.
3. Suitable for use as service entrance equipment.

C. Transformer:

1. Non-ventilated, air cooled, two winding type.
2. Core and coil assembly encapsulated in a proportioned mixture of resin and aggregate to provide a moistureproof, shock resistant seal.
3. Cores:
   a. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
   b. Magnetic flux densities are to be kept well below the saturation point.
4. Coils: Continuous wound with electrical grade aluminum and grounded to the enclosure.
5. Insulation system: 185 DEGC with a 115 DEGC rise.
6. Taps: Two, 5% FCBN.
7. Sound levels:
   a. Manufacturer shall guarantee not to exceed the following:
      1) 9 kVA and less: 40 dB.
      2) 10 to 30 kVA: 45 dB.

D. Panelboard and Protective Devices:

1. Bus: Aluminum.
2. Factory installed wiring between primary breaker and transformer, secondary breaker and transformer and distribution section.
3. 480 VAC primary circuit breaker: 14,000 AMP minimum interrupting rating.
4. 240 VAC or less secondary circuit breaker: 10,000 AMP minimum interrupting rating.
5. Feeder breakers:
   a. Plug-in type with 10,000 AMP minimum interrupting rating.
   b. See Section 26 28 00 for additional requirements.

E. Enclosure:

1. Main, secondary and feeder circuit breakers enclosed with a padlockable hinged door.
2. Wiring compartment suitable for conduit entry and large enough to allow convenient wiring.
3. Totally enclosed, non-ventilated, NEMA 3R, steel finished with a rust inhibitor primer and manufacturer’s standard paint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Ground in accordance with Section 26 05 26 or as indicated on the Drawings.

END OF SECTION

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SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
    a. Wall switches.
    b. Receptacles.
    c. Device wallplates and coverplates.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 – Procurement and Contracting Requirements
2. Division 01 – General Requirements
3. Section 26 05 00 - Electrical - Basic Requirements.
4. Section 26 05 33 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    b. WD 1, General Color Requirements for Wiring Devices.
    c. WD 6, Wiring Devices - Dimensional Requirements.
2. Underwriters Laboratories, Inc. (UL):
    a. 20, General-Use Snap Switches.
    b. 498, Standard for Attachment Plugs and Receptacles.
    c. 514A, Metallic Outlet Boxes.
    d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
    e. 943, Ground-Fault Circuit-Interrupters.
    f. 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
    g. 1310, Standard for Class 2 Power Units.

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.
    b. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Wall switches and receptacles:
    a. Bryant Electric.
    b. Cooper Wiring Devices by Eaton.

c. Hubbell Incorporated Wiring Device-Kellems.
d. Leviton Manufacturing Company.
e. Legrand/Pass & Seymour.
f. Eaton Crouse-Hinds.
g. Appleton Electric Co.
h. Hubbell Killark.

2.2 WALL SWITCHES

A. Basic requirements unless modified in specific requirements paragraph of switches per designated areas or types:

1. Industrial Specification Grade.
2. Quiet action, snap switch.
3. Self-grounding with grounding terminal.
4. Back and side wired.
5. Solid silver cadmium oxide contacts.
6. Rugged thermoplastic and/or nylon housing and one-piece switch arm.
7. Ratings: 20 A, 120/277 VAC.
8. Switch handle type: Toggle.
9. Switch handle color: White .
10. Types as indicated on the Drawings:
    a. Single-pole.
    b. Double-pole.
    c. 3-way.
    d. 4-way.
11. Standards: UL 20, UL 514A, NEMA WD 1, NEMA WD 6.

B. Architecturally Finished Area Specific Requirements:

1. Commercial Specification Grade.
2. Wallplate:
    a. 302 or 304 brushed finish stainless steel.
    b. Single or multiple gang as required.

C. Wet or Damp Non-Architecturally Finished or Exterior Area Specific Requirements:

1. Coverplate:
    a. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
    b. Operator type:
        1) Side mounted rocker type handle to operate snap switch.
        2) Front mounted lever type handle to operate snap switch.
        3) Push/pull operator to operate snap switch.
        4) Spring type door to cover snap switch.
    c. Wet location rated.
    d. Single or multiple gang as required.

2.3 RECEPTACLES

A. Basic requirements unless modified in specific requirements paragraph of receptacles and per designated areas:

1. Industrial Specification Grade.
2. Straight blade.

3. Brass triple wipe line contacts.
4. One-piece grounding system with double wipe brass grounding contacts and self-grounding strap with grounding terminal.
5. Back and side wired.
6. Rating: 20 A, 125 VAC.
7. High impact nylon body.
8. Receptacle body color:
    a. Normal power Ivory.
    b. Generator or UPS power: Red.
9. Duplex or simplex as indicated on the Drawings.
10. Configuration: NEMA 5-20R.
11. Standards: UL 498, UL 514A, NEMA WD 1, NEMA WD 6.

B. Receptacle Type Specific Requirements:

1. Basic receptacles:
    a. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
        1) Identification: Letters “WR” on face of receptacle.
2. Ground Fault Circuit Interrupter (GFCI):
    a. Specification Grade.
    b. Class A protection.
    c. Feed through type.
    d. Test and reset buttons.
    e. Self-testing.
    f. Visual indicator light.
    g. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
        1) Identification: Letters “WR” on face of receptacle.
    h. Additional standards: UL 943.

C. Architecturally Finished Areas Specific Requirements:

1.
2. Wallplate:
    a. 302 or 304 brushed finish stainless steel.
    b. Single or multiple gang as required.

D. Dry Non-Architecturally Finished Areas Specific Requirements:

1. Coverplate for use on surface mounted outlet boxes:
    a. Raised steel, galvanized.
    b. Single or multiple gang as required.
2. Wallplate for use on recessed outlet boxes:
    a. Steel, galvanized.
    b. Single or multiple gang as required.

E. Wet Non-architecturally Finished Areas Specific Requirements:

1. Coverplate:
    a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cords.

F. Exterior Locations Specific Requirements:

1. Coverplate:
    a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cord.

G. Special Purpose Receptacles:

1. NEMA configuration as indicated on the Drawings.
2. Coverplate: See requirements per area designations herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 26 05 00.

C. See Specification Section 26 05 33 for device outlet box requirements.

D. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

F. Momentary contact switches shall be installed and connected such that the up position is 'on only' and the down position is 'off only.'

END OF SECTION

SECTION 26 28 00
OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Low voltage circuit breakers.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   b. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
   c. C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
3. Underwriters Laboratories, Inc. (UL):
   a. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   b. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
   c. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 26 05 00 for additional requirements.

B. Contract Closeout Information:

1. Operation and Maintenance Data.

C. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Reports:
   a. Short circuit study report.
   b. Protective coordination study report.
   c. As-left condition of all circuit breakers that have adjustable settings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Circuit breakers:
    a. Eaton.
    b. General Electric Company.
    c. Square D Company.
    d. Siemens.

2.2 CIRCUIT BREAKERS

A. Molded Case Type:

1. General:
    a. Standards: UL 489.
    b. Unit construction.
    c. Over-center, toggle handle operated.
    d. Quick-make, quick-break, independent of toggle handle operation.
    e. Manual and automatic operation.
    f. All poles open and close simultaneously.
    g. Three position handle: On, off and tripped.
    h. Molded-in ON and OFF markings on breaker cover.
    i. One-, two- or three-pole as indicated on the Drawings.
    j. Current and interrupting ratings as indicated on the Drawings.
    k. Bolt on type.
2. Thermal magnetic type:
    a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
    b. Frame size 150 amp and below:
        1) Non-interchangeable, non-adjustable thermal magnetic trip units.
    c. Frame sizes 225 to 400 amp (trip settings less than 400A):
        1) Interchangeable and adjustable instantaneous thermal magnetic trip units.
    d. Ground Fault Circuit Interrupter (GFCI) Listed:
        1) Standard: UL 943.
        2) One- or two-pole as indicated on the Drawings.
        3) Class A ground fault circuit.
        4) Trip on 5 mA ground fault (4-6 mA range).
3. Solid state trip type:
    a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.
    b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
        1) Standard rating.
        2) Interchangeable current sensor or rating plug.
        3) Adjustable long time pick-up setting.
            a) Adjustable from 50 to 100 PCT of the current sensor or rating plug.
        4) Adjustable short time pick-up setting.
        5) Adjustable instantaneous pick-up.

6) Fixed ground fault pick-up, when indicated on the Drawings.

4. Motor circuit protector:
   a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
   b. Sized for the connected motor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:

1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
   a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
   b. Motor circuit protectors sized for the connected motor.

3.2 FIELD QUALITY CONTROL

A. Coordinated Power System Protection:

1. Prepare a study to demonstrate that the equipment and system constructed meet the specified requirements for equipment ratings, coordination and protection.
2. Perform the studies in accordance with IEEE 242 and IEEE 399.
3. Include the name of the software developer, software package and software version number in the computer generated studies.
4. System short circuit study report:
   a. Begin the study at the main service electrical gear and extend down the system through all buses.
      1) Perform a balanced three-phase fault, bolted line-to-line fault and line-to-ground fault study.
   b. Prepare a one-line diagram to show the electrical system buses, transformers and all sources of fault current including generators and motors.
   c. Utilize manufacturer's data for the actual proposed equipment (e.g., transformer impedance).
   d. Coordinate the available utility fault current with the power utility company.
   e. Show input data in tabular form in the report and/or on the one-line diagram.
      1) Input data shall include but is not limited to:
         a) Utility fault current or MVA and X/R ratio.
         b) Bus voltages.
         c) Conductor sizes and type of conduit.
         d) Generator and motor sizes and contributions.
         e) Transformer sizes and impedances.
   f. Show available fault current at each bus in tabular form in the report and/or on the one-line diagram.
   g. Perform studies for both normal power and emergency/standby power scenarios.
5. System protective coordination study report:
   a. Begin the study at the main service electrical gear and extend down the system through all buses as required to ensure a coordinated power system.

b. Demonstrate that the maximum possible degree of selectivity has been obtained between devices specified for the protection of equipment and conductors from damage from overloads and fault conditions.
    1) Where necessary, an appropriate compromise shall be made between system protection and service continuity.
    2) Consider system protection and service continuity to be of equal importance.
c. Prepare a one-line diagram to show the electrical system buses, transformers and protective devices.
d. Utilize manufacturer's data for the actual proposed protective devices.
e. Summarize the coordination study, conclusions and recommendations.
    1) As a minimum, include the following:
        a) The manufacturer's information used to prepare the study.
        b) Assumptions made during the study.
        c) Recommended taps and settings of all adjustable devices in tabulated form.
        d) Composite coordination time-current curves on log-log paper showing:
            (1) That the settings for each protective device will provide protection and selectivity.
            (2) Identify each curve.
            (3) Cable and equipment damage points.
            (4) Circuit interrupting device operating and interrupting times.
            (5) One-line sketch of the part of the system being investigated.
            (6) Include as many curves as possible on a graph while maintaining readability.
        e) Position time-current curves for each device to provide for maximum selectivity to minimize system disturbances during fault clearing.
        f) Advise the Engineer of potential coordination problems discovered during the study and include recommendations to resolve the problem.
            (1) Provide time-current curves for the "as found" and "proposed" conditions for upgrade/retrofit projects.
        g) Submit the report for approval 90 days prior to equipment energization.

B. Adjustable Circuit Breakers:
    1. Set all circuit breaker adjustable taps as defined on the Drawings, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

END OF SECTION

SECTION 26 28 16
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Safety switches.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 26 05 00 - Electrical - Basic Requirements.
2. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
2. Underwriters Laboratories, Inc. (UL):
   a. 98, Enclosed and Dead-Front Switches.

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.
   b. Provide a Summary Table or use Exhibit A that associates the safety switch features with connected equipment tag number. Exhibit A indicates minimum data required.
   c. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:

1. Eaton.
2. GE by ABB.
3. Square D by Schneider Electric.
4. Siemens Corporation.
5. Appleton by Emerson Electric Co.
6. Crouse-Hinds by Eaton.
7. Killark by Hubbell.

2.2 SAFETY SWITCHES

A. General:

1. Non-fusible or fusible as indicated on the Drawings.
2. Suitable for service entrance when required.
3. NEMA Type HD heavy-duty construction.
4. Switch blades will be fully visible in the OFF position with the enclosure door open.
5. Quick-make/quick-break operating mechanism.

6. Deionizating arc chutes.
7. Manufacture double-break rotary action shaft and switchblade as one common component.
8. Clear line shields to prevent accidental contact with line terminals.
9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
    a. Red and easily recognizable.
    b. Padlockable in the OFF position.
    c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
1. Horsepower rated of connected motor.
2. Voltage and amperage: As indicated on the Drawings.
3. Short circuit withstand:
    a. Non-fused: 10,000A.
    b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
1. Neutral kits.
2. Ground lug kits.
3. Auxiliary contact kits:
    a. Opens before main switch.
    b. Rated 10A at 125/250 VAC.
    c. One N.O. and one N.C. contact.

D. Enclosures:
1. NEMA 1 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. With or without knockouts, hinged and lockable door.
2. NEMA 3R rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. With or without knockouts, hinged and lockable door.
3. NEMA 4 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
4. NEMA 4X rated (metallic):
    a. Body and cover: Type 304 or 316 stainless steel.
    b. No knockouts, external mounting flanges, hinged and gasketed door.
5. NEMA 4X rated (nonmetallic):
    a. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
    b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
6. NEMA 7 and NEMA 9 rated:
    a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
    b. Drilled and tapped openings or tapered threaded hub.
    c. Gasketed cover bolted-down with stainless steel bolts.
    d. External mounting flanges.
    e. Operating handle padlockable in the OFF position.

7. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:
    1. Fuses.
    2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.

F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
    1. The VFD is to be disabled when the switch is in the open position.

D. Permitted uses of NEMA 1 enclosure:
    1. Surface or flush mounted in areas designated dry in architecturally finished areas.

E. Permitted uses of NEMA 3R enclosure:
    1. Surface mounted in exterior location for HVAC equipment only.

F. Permitted uses of NEMA 4 enclosure:
    1. Surface mounted in areas designated as wet.

G. Permitted uses of NEMA 4X metallic enclosure:
    1. Surface mounted in areas designated as wet and/or corrosive.

H. Permitted uses of NEMA 4X nonmetallic enclosure:
    1. Surface mounted in areas designated as corrosive.
    2. Surface mounted in areas designated as highly corrosive.

I. Permitted uses of NEMA 7 enclosure:
    1. Surface mounted in areas designated as Class I hazardous.
    2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

J. Permitted uses of NEMA 9 enclosure:
    1. Surface mounted in areas designated as Class II hazardous.
    2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

K. Permitted uses of NEMA 12 enclosure:
    1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

EXHIBIT A

Safety Switch Summary Table					
Equipment Tag	Switch Model Number	Rated Amps	Fused / Non-fused	Enclosure Type	Accessories
Example	Per MFR	60A	NF	NEMA 4X non-metallic	Ground lug, Aux Contact

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SECTION 26 43 13
LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type 1 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), integrally mounted.
2. Type 2 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), externally mounted.

B. Related Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
   c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL):
   a. 1283, Standard for Electromagnetic Interference Filters.
   b. 1449, Standard for Surge Protective Devices.

B. Qualifications:

1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
   a. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage:

1. The applied surge shall be induced at the 90 DEG phase angle of the applied system frequency voltage.
2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:

1. The applied surge shall be induced at the 90 DEG phase angle of the applied system frequency voltage.
2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:

1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 PCT deviation of clamping voltage at a specified surge current.
2. Listed by mode, since number and type of components in any SPD may very by mode.

E. MCC: Motor Control Center.

F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

G. Surge Current per Phase:

1. The per phase rating is the total surge current capacity connected to a given phase conductor.
   a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
   b. The N-G mode is not included in the per phase calculation.

H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Manufacturer's qualifications.
   b. Standard catalog cut sheet.
   c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
   d. Testing procedures and testing equipment data.
   e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
      1) Data in the Product Data Sheet heading:
         a) SPD Type Number per PART 2 of the Specification.
         b) Manufacturer’s Name.
         c) Product model number.
      2) Data in the Product Data Sheet body:
         a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
         b) Column two: Manufacturer’s certified value confirming the product meets the specified value/feature.
         c) Name of the nationally recognized testing laboratory that preformed the tests.
         d) Warranty information.

3) Data in the Product Data Sheet closing:
    a) Signature of the manufacturer's official (printed and signed).
    b) Title of the official.
4) Date of signature.

B. Operation and Maintenance Manuals.

1. Warranty.

1.5 WARRANTY

A. Minimum of a five year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, MIL-STD 220B, UL 1283, UL 1449.

2.2 TYPE 1 SPD

A. Product:

1. SPD tag number or electrical equipment tag number SPD is connected to MDP.
2. Integrally mounted in panelboard MDP.
3. Hybrid solid-state high performance suppression system.
    a. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
4. Do not connect multiple SPD modules in series to achieve the specified performance.
5. Designed for parallel connection.
6. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
7. Device monitor:
    a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.
    b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.

C. Modes of Protection: All modes.

1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2-pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 PCT of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10 PCT deviation of the clamping voltage.

I. SPD Protection:

1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		C High V & I Wave	B Combination Wave	
L-L < 250 V **L-N < 150 V**	L-L	1470 V	1000 V	800 V
	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V **L-N > 150 V**	L-L	2700 V	2000 V	1800 V
	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.3 TYPE 2 SPD

A. Product:

1. Internally mounted in switchboards, panelboardsor MCCs and mounted adjacent to panelboards, as indicated on one-line drawings
2. Hybrid solid-state high performance suppression system.
   a. Do not use suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
3. Do not connect multiple SPD modules in series to achieve the specified performance.
4. Designed for parallel connection.
5. Enclosure:
   a. Metallic NEMA 1 for interior locations.
   b. Metallic NEMA 4 for exterior locations.
6. Field connection:
   a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors. OR
   b. Preinstalled lead conductors: Size per manufacturer, length as required with a maximum of 5 FT.
7. Device monitor:
   a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phase.
   b. A fuse status only monitor system is not acceptable.
8. Accessories (when specifically specified): Unit mounted disconnect switch.

B. Operating Voltage: Nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.

1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2 pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 PCT of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation of more than 10 PCT deviation of the clamping voltage.

I. SPD Protection:

1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 DEG phase angle including 6 IN lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		C High V & I Wave	B Combination Wave	
L-L < 250 V **L-N < 150 V**	L-L	1470 V	1000 V	800 V
	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V **L-N > 150 V**	L-L	2700 V	2000 V	1800 V
	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.4 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:

1. Integral unit level and/or component level fusing.
2. Neutral and ground shall not be bonded during testing.
3. 6 IN lead lengths.
4. Integral disconnect switch when provided.

C. The “as installed” SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:

1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
2. Single pulse surge current capacity test.
3. Repetitive surge current capacity testing.
4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Type 2, 4 and 5 SPD:

1. Mounting options:
   a. On wall or support structure adjacent to the equipment to be protected with leads routed through conduit.
2. Install leads as short and straight as possible.
3. Maximum lead length: 18 IN.
4. Minimum lead size:
5. As indicated on plans or as recommended by manufacturer.When conduit connection is used, provide a minimum of four twists per foot in the lead conductors and install in NFPA 70 sized conduit.
6. Connect leads to the equipment to be protected by one of the following means:
   a. Through a circuit breaker or molded case switch mounted in the equipment.
      1) Use manufacturer recommended circuit breaker size.

END OF SECTION

SECTION 26 50 00
INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
    a. Interior building and exterior building mounted luminaires.
    b. Exterior and site luminaires.
    c. Lamps and LEDs.
    d. Ballasts and drivers.
    e. Light poles.
    f. Lighting control.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Division 03 - Concrete.
4. Section 26 05 00 - Electrical - Basic Requirements.
5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI):
    a. C78.377, Specification for the Chromaticity of Solid State Lighting Products.
2. Federal Communications Commission (FCC):
    a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. Illuminating Engineering Society of North America (IESNA):
    a. LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
    b. LM-80, Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
5. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    b. 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
    c. LE 4, Recessed Luminaires, Ceiling Compatibility.
6. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
    a. SSL 1, Electronic Drivers for LED Devices, Arrays or Systems.
7. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC).
    b. 101, Life Safety Code.
8. Underwriters Laboratories, Inc. (UL):
    a. 924, Standard for Emergency Lighting and Power Equipment.

b. 1598, Luminaires.
c. 8750, Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.

9. United States Department of Energy (USDOE):
   a. EPAct, the National Energy Policy Act.

1.3 DEFINITIONS

A. Useful Life for LED luminaire light sources:

1. The operating hours before reaching 70 PCT of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.
2. This is also known as 70 PCT "Rated Lumen Maintenance Life" as defined in IESNA LM-80.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. Identify luminaire by Luminaire Schedule designation.
   c. Luminaire data sheet:
      1) Name of manufacturer.
      2) Complete order information (catalog number).
      3) Description of construction and optics.
      4) Total input wattage.
      5) Luminous efficacy (lumens/Watt).
      6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
      7) Dimensional size.
      8) Weight.
      9) UL nameplate data for luminaires used in Class 1, Division 1 and 2 areas.
      10) Effective Projected Areas (EPA) for pole mounted luminaires.
   d. Solid state Luminaire additional data:
      1) Voltage.
      2) Initial and IES L70 lumens.
      3) Luminous efficacy (lumens/Watt).
      4) Correlated Color Temperature (CCT).
      5) Color Rendering Index (CRI).
      6) Total Harmonic Distortion (THD).
      7) Lamp life.
      8) Driver manufacturer and model number.
      9) Driver life.
      10) Driver type (0-10V, constant voltage, constant current).
      11) Dimming range and control device compatibility.
      12) Remote driver: Maximum wire length to luminaire.
      13) Emergency battery driver:
         a) Compatibility with lighting module.
         b) Lumen output of lighting module in emergency operation.
         c) Battery life.

d) Description of testing.
e) Ambient operating temperature.
14) Warranty information.

e. Pole data sheet:
1) Name of manufacturer.
2) Complete order information (catalog number).
3) Description of construction.
4) Length, shaft size and thickness.
5) Wind loading (available luminaire EPA per wind speed).
6) Anchor bolt template.
7) Bolt size and material.

f. See Specification Section 26 05 00 for additional requirements.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
a. Submittal data for each component covered by warranty.
b. Warranty.

1.5 WARRANTY

A. Minimum of a five year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15 PCT of the individual light emitting diodes fail to illuminate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Luminaires: Per Luminaire Schedule .
2. Solid State Light Sources:
a. Luminaire manufacturer’s proprietary system.
3. LED Driver: Luminaire manufacturer's standard.
4. Poles: Luminaire manufacturer's standard.

2.2 GENERAL REQUIREMENTS

A. Luminaires complete with lamps and ballasts or LED modules and drivers.

B. Rated for area classification as indicated on the Drawings.

1. In Class I, Division 1 and 2 areas, the temperature rating of the luminaires and lamp or LED combination shall not exceed the auto-ignition temperature of the atmosphere in which the Luminaire is used.

C. Provide all recessed luminaires with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.

1. Provide recessed luminaires with trim gaskets cemented in proper position.

D. Coordinate luminaire mounting where installed onto building canopies prior to Submitting Shop Drawings. Confirm clearances and luminaire flange compatibility with construction.

E. Electrical components of recessed luminaires shall be accessible and removable through luminaire without having to remove luminaire from ceiling.

F. No live parts normally exposed to contact.

G. When intended for use in wet areas: Mark luminaire "Suitable for wet locations."

H. When intended for use in damp areas: Mark luminaire "Suitable for damp locations" or "Suitable for wet locations."

2.3 LUMINAIRES

A. Standards and Listings:

1. UL 1598.

B. Housings:

1. As indicated in the Luminaire Schedule and the following:
   a. Troffer luminaires:
      1) Minimum 22 gage sheet steel.
      2) Integral end plates and trim flanges to suit ceiling construction.
      3) Wire way covers with captive retainers to allow access to electrical components without use of tools.
   b. Down Light luminaires:
      1) Minimum 22 gage sheet steel, or minimum 16 gage sheet aluminum, unless noted otherwise.
      2) Auxiliary junction box secured to mounting frame.
   c. Extruded aluminum housings, where scheduled, shall be at least 1/8 IN thick.
   d. Punch and form housings prior to finishing (post-paint).

C. Castings:

1. As indicated in the Luminaire Schedule and the following:
   a. Uniform quality, free from imperfections affecting strength and appearance.
   b. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.

D. Finishes:

1. As indicated in the Luminaire Schedule and the following:
   a. Painted surfaces:
      1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish; acrylic, alkyd, epoxy, polyester or polyurethane.
      2) White finishes shall have minimum 85 PCT reflectance.
   b. Unpainted surfaces:
      1) Interior: Clear anodic coating, satin finish.
      2) Exterior: Clear anodic coating.

E. Lenses:

1. As Indicated in the Luminaire Schedule and the Following:
   a. 100 PCT virgin, UV stabilized acrylic.
   b. Held securely in place but must also be removable for cleaning.
   c. Luminaires with directional lenses shall include a lens orientation device to ensure that lens installation provides light distribution as designed.
   d. No light leaks between the lens and the luminaire.

F. Gaskets:

1. As Indicated in the Luminaire Schedule and the Following:
   a. Gaskets at face plates or frames of recessed luminaires which serve as ceiling trim and which allow interior access.

b. Moisture seal gaskets at exterior locations and in other designated wet areas.

c. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks.

G. Wiring:

1. Factory-wired to be compatible with the project electrical and controls systems.

H. Mounting Accessories:

1. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered.
2. Recessed Luminaires:
   a. Plaster Frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
   b. Baffles and Gaskets: As required to prevent light leakage.
   c. Flanged luminaires are required in all ceiling systems except exposed grid lay-in panel type.
3. Luminaire Suspension Material:
   a. Finished Spaces: Unless otherwise noted.
      1) Manufactured cable or stem and outlet box canopy.
         a) Contemporary design with swivel self-aligning features.
         b) Size canopy to cover outlet box, minimize size of canopy not associated with outlet box.
         c) Finish to match luminaire.
      2) Coordinate pendant location with ceiling tiles/ceiling grid.
         a) Submit coordinated mounting accessories as part of Shop Drawing submission.
      3) Luminaires mounted on suspended ceiling grids should be provided with outlet box designed for grid mounting with direct cord entry and supported by outlet box.
      4) For high intensity discharge lamps:
         a) Use stems suspended from swivel shock-absorbing fittings.

2.4 SOLID-STATE LUMINAIRES - ADDITIONAL REQUIREMENTS

A. Standards:

1. IESNA LM-79, IESNA LM-80.
2. NEMA SSL 1.
3. UL 1012, 1310, and 8750.
4. UL 844 for hazardous locations.

B. Solid state modules and driver to be provided and warrantied by luminaire manufacturer.

C. Solid-State Modules:

1. Uniform color temperature of 4000K unless otherwise noted on the Luminaire schedule.
   a. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for frosted lensed luminaires, and 2 SDCM for other luminaire types (ANSI C78.377).
2. Minimum color rendering index (CRI) of 80.
3. LED module light output and efficacy: Measured in accordance with IESNA LM-79 standards.
4. LED useful life and lumen maintenance: Measured in accordance with IESNA LM-80 standards.
5. Driver and LED module: Minimum useful life of 50,000 HRS (L70).

6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.

D. Driver:

1. Compatible with solid-state modules and control devices specified.
2. Operate from 60 Hz input source of 120V through 277V with sustained variations of ±10 PCT (voltage and frequency).
3. Input current Total Harmonic Distortion (THD): Less than 20 PCT when operated at nominal line voltage.
4. Power Factor: Greater than 0.90.
5. Avoid interference with infrared devices and eliminate visible flicker.
6. Comply with ANSI C62.41 Category A for Transient protection.
7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
8. Control device must be compatible with type of driver, and coordinated prior to submission of Shop Drawings
9. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.

E. Emergency Battery Driver:

1. UL 924.
2. Confirm compatibility with LED modules utilized.
3. Consist of a high temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry.
4. A solid state charging indicator light to monitor the charger and battery.
5. Single-pole test switch.
6. The following product family shall be selected based on coordination with LED lamp type:
   a. Philips Bodine “BSL23C” or approved equivalent: can operate up to 4.5W at 410mA.
   b. Philips Bodine “BSL26C” or approved equivalent: can operate up to 5.1W at 265mA.
   c. Philips Bodine “BSL722 IN or approved equivalent: can operate up to 23W at 770mA.
   d. Philips Bodine “BSL23C” or approved equivalent: can operate up to 23W at 770mA in operating conditions ranging from -20 DEGC (-4 DEGF) to 60 DEGC (140 DEGF).
   e. Alternate manufacturer: Iota.

F. Luminaire properly heat sinked to assure LED junction temperature ratings are not exceeded.

1. Provide ambient operating temperature range for which product is warrantied.

2.5 EXIT SIGNS AND EMERGENCY LIGHTING UNITS

A. Standards:

1. UL 924.
2. NFPA 101.
3. Local State or City requirements.

B. Exit Signs:

1. Housing and finish: As indicated in the Luminaire Schedule.
2. LED illuminated with integral driver.
3. AC powered or AC and battery powered: As indicated in the Luminaire Schedule.
4. Battery powered units:
   a. Battery type: As indicated in the Luminaire Schedule.
   b. Self-testing/self-diagnostic.

1) Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.

c. Consist of batter, charger and electronic circuitry.

d. Solid state charging indicator light to monitor the charger and battery.

e. Single-pole test switch.

f. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.

C. Emergency Circuit Transfer Device:

1. Transfer device permits emergency lights to be switched under normal conditions and automatically transfers to unswitched emergency circuit upon power interruption.
2. Multiple luminaire switching:
   a. Up to 20A.
   b. Mounting as indicated on the Drawings.
   c. Acceptable product family:
      1) Philips Bodine GTD20A or equal.
3. Individual luminaire switching:
   a. Mount on top of luminaire or in ballast channel.
   b. Acceptable product family:
      1) Philips Bodine GTD or equal.

2.6 POLES

A. As Indicated in the Luminaire Schedule and the Following:

B. Metal Poles:

1. Material: Steel.
2. Shaft shape: Straight.
3. Pole cross section: Round.
4. Pole height: 30 FT.
5. Additional features:
   a. Luminaire mounting provisions.
   b. Handhole near base of pole.
   c. Grounding lug accessible at handhole.
   d. Galvanized anchor bolts.
   e. Anchor bolt covers.
   f. Vibration dampener(s).
6. Steel pole finish: Dark bronze polyester powder.

2.7 MAINTENANCE MATERIALS

A. Furnish a minimum of 2 or 10 PCT of total of each type and wattage of lamps, whichever is greater.

B. Furnish a minimum of 10 PCT of total of each type and amperage of fuses for fixtures indicated to be fused.

C. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate Luminaire Types with Ceiling Construction:

1. Provide mounting hardware for the ceiling system in which the luminaire is to be installed.

B. Fasten luminaires supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted luminaires.

1. Do not support luminaire from conduit system.
2. When luminaire is supported from outlet boxes, install per NFPA 70.
3. Supports for luminaire mounted on exterior walls shall not be attached to exterior face of the wall.

D. Support surface mounted luminaires from the building structure and not from the ceiling suspension system.

1. Luminaires up to 4 FT wide and 4 FT long: A minimum of four supporting points, one at each corner.
2. Luminaires 8 FT long: A minimum of five support points, one at center of luminaire and one at each corner.
3. Luminaires smaller than 2 FT in length: A minimum of two supporting points.

E. Provide pendant luminaires with swivel hangers which will allow luminaire to swing in any direction but will not permit stem to rotate.

1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
2. Swivel hangers for luminaires in mechanical equipment areas: Shock absorbing type.
3. Secure low and high bay luminaires with safety chain or safety aircraft cable to the building structure.
    a. Chain or cable to prevent luminaire from falling more than 3 IN before the luminaire is caught by the chain or cable.

F. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.

1. Locate luminaires in accordance with reflected ceiling plans.

G. Locate luminaire in exact center of ceiling tile unless otherwise indicated.

1. Relocate misinstalled luminaire and replace damaged ceiling materials.

H. Mount luminaire at heights indicated in Specification Section 26 05 00 or per Luminaire Schedule or as indicted on the Drawings.

I. Install exterior luminaires so that water can not enter or accumulate in the wiring compartment.

J. Ground luminaire and ballasts.

3.2 POLE INSTALLATION

A. Drawings Indicate the Intended Location of Light Pole:

1. Field conditions may affect actual location.
2. Coordinate location with all existing or new utilities and pavement.

B. Anchor Base Plated Poles:

1. Mounted on cast-in-place foundations, as detailed on the Drawings.
    a. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.
2. Protect pole finish during installation.
    a. Repair damage to pole finish with manufacturer approved repair kit.

C. Ground poles as indicated on the Drawings.

D. Conductors:

1. See Specification Section 26 05 19 for required underground conductors.

2. Use interior building wire, as specified in Specification Section 26 05 19, from pole base to luminaire, #12 AWG minimum.

E. Overcurrent and Short Circuit Protection:

1. Protect each phase with a UL Class CC fuse:
   a. Size: Three times load current.
   b. Standard: UL 248-4.
2. Fuseholder:
   a. Watertight, in-line and break-a-way style.
   b. Accept up to a 30 A, 600 V fuse.
   c. Neutral conductor shall utilize a fuseholder with a solid copper rod.
   d. Conductor terminal: Adequate size for the installed conductors.

3.3 LIGHTING CONTROL

A. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

END OF SECTION

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SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Site clearing, tree protection, stripping topsoil and demolition.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 23 00 - Earthwork.
4. Section 31 25 00 - Soil Erosion and Sediment Control.
5. Section 32 92 00 – Seeding, Sodding and Landscaping.

1.2 QUALITY ASSURANCE

A. North Carolina Erosion and Sediment Control Planning and Design Manual, Current Edition.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing trees and other vegetation to remain against damage.

1. Do not smother trees by stockpiling construction materials or excavated materials within drip line.
2. Avoid foot or vehicular traffic or parking of vehicles within drip line.
3. Provide temporary protection as required.

B. Repair or replace trees and vegetation damaged by construction operations.

1. Repair to be performed by a qualified tree surgeon/licensed arborist.
2. Remove trees which cannot be repaired and restored to full-growth status.
3. Replace with new trees of minimum 4 IN caliper or as required by local tree ordinance.

C. Owner will obtain authority for removal and alteration work on adjoining property, as applicable.

3.2 SITE CLEARING

A. Topsoil Removal:

1. Strip topsoil to depths encountered or as specified within the soils report, 4 IN minimum.
   a. Remove heavy growths of grass before stripping.
   b. Stop topsoil stripping sufficient distance from such trees to prevent damage to main root system.
   c. Separate from underlying subsoil or objectionable material.
2. Stockpile topsoil where directed by Engineer.
   a. Construct storage piles to freely drain surface water.
   b. Seed or cover storage piles to prevent erosion.
3. Do not strip topsoil in wooded areas where no change in grade occurs.
4. Borrow topsoil: Reasonably free of subsoil, objects over 2 IN DIA, weeds and roots.

B. Clearing and Grubbing:

1. Clear from within limits of construction all trees not marked to remain.
    a. Include shrubs, brush, downed timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, structures and debris.
2. Grub (remove) from within limits of construction all stumps, roots, root mats, logs and debris encountered.

C. Disposal of Waste Materials:

1. Do not burn combustible materials on site.
2. Remove all waste materials from site.
3. Do not bury organic matter on site.

3.3 ACCEPTANCE

A. Upon completion of the site clearing, obtain Engineer's acceptance of the extent of clearing, depth of stripping, and rough grade.

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. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.
4. Section 31 25 00 - Soil Erosion and Sediment Control.
5. Section 32 92 00 – Seeding, Sodding and Landscaping.

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/FT^3).
   c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT^3(2,700 kN-M/M^3)).
   d. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   e. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   f. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   g. 29 CFR Part 1926.650, Safety and Health Regulations for Construction - Excavations, referred to herein as OSHA Standards.

B. CQA Engineer: The Owner may retain a CQA Engineer to observe earthwork and perform additional geotechnical testing to confirm Contractors work is in accordance with the Contract Documents.

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 retained by Contractor providing field quality control for the project.

D. CQA Engineer: Independent geotechnical specialist retained by Owner providing field quality assurance for the project.

E. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.

F. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

G. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.

H. 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.

I. 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. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
3. Certifications: Signed certification letter, with all necessary permits, that the material source is in full compliance with state, county, and local laws and regulations.

B. Samples:

1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer and CQA Engineer, as applicable.

C. Test Reports (provide to CQA Engineer, and Engineer as applicable):

    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.

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.

C. Site Information:

1. Data in subsurface investigation reports was used for the basis of the design.

a. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings.
b. The Owner or Engineer will not be responsible for interpretations or conclusions drawn from this data by Contractor.

2. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
3. Site data provided is not contractual and shall be considered "for information only."

1.6 SOILS/GEOTECHNICAL

A. The Contractor shall engage a Geotechnical Engineer to test and monitor compliance with the requirements of these Specifications.

B. The Contractor will afford these representatives access to the job site for the performance of their duties as described in the Contract Documents.

C. General Duties and Responsibilities of Geotechnical Engineer:

1. Approve materials proposed for incorporation into the work as proposed by the Contractor.
2. Review subgrades and excavations and approve suitability of materials encountered as proposed by the Contractor. Approve extent of any overexcavation required to remove unsuitable materials under roadways, structures, or other areas of construction, as proposed by Contractor.
3. Observe placement of fill materials and testing by Contractor for compliance with these specifications.
4. Review/approve the suitability of existing on-site materials for use in construction of embankments and fills.
5. Review construction operations and monitor for compliance with Contract Documents.

D. Prior to the general placement of the fill and during such placement, the CQA Engineer may select areas within the limits of the fill for testing. The Contractor shall cooperate fully in obtaining the information desired.

E. Soil borings or other exploratory operations may be made by the Contractor at no additional cost to the Owner. The Contractor shall provide the Owner with a copy of any data obtained/developed during such work. Such additional work shall be performed in a timely manner in accordance with and not impacting or changing the project schedule set forth in the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fill and Backfill:

1. Selected material approved by Geotechnical Engineer from site excavation or from offsite borrow.
2. Structural Fill:
   a. May be low volume change cohesive or granular soil at Contractor's option.
   b. Free of organic matter, frozen material and debris.
   c. Highly micaceous and elastic silts shall not be used.
   d. Low volume change cohesive soil:
      1) ASTM D2487 classification: CL-ML or CL.
      2) Liquid limit: Less than 45.
      3) Maximum plasticity index: 20.
   e. Granular soil:
      1) ASTM D2487 classification: GW, GP, GM, GC, SW, SP, SM, SP-SM or SC.

3. 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 PCT fines passing the No. 200 sieve.
    3. ASTM C33/C33M gradation size No. 57 or No. 67 or other material acceptable to Geotechnical Engineer.

C. Conformance testing shall be performed by the CQC Consultant on samples from the soil source or the backfill materials. Materials identified for use as backfill shall be tested at the specified frequency for the following:

TEST	METHOD	FREQUENCY
Grain Size	ASTM D422	Every 10,000 cy and change in material
Atterberg Limits	ASTM D4318	Every 10,000 cy and change in material
Moisture/Density	ASTM D698	Every 20,000 cy and change in material
Natural Moisture	ASTM D2216	Every 10,000 cy and change in material

1. The Engineer reserves the right to reject material based on the results of the conformance tests.

PART 3 - EXECUTION

3.1 PROTECTION

A. Erosion Control:
    1. See Specification Section 31 25 00.
    2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
    3. 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.

C. Protection of trees to remain:
   1. Perform excavation by hand within dripline of large trees designated on Drawings to remain. Protect root systems from damage or dryout to the greatest extent possible.
      a. Maintain moist condition for root system and cover exposed roots with moistened burlap.

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 sheepsfoot, 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.

E. Grading Tolerances: Grading shall be to a tolerance of + 0.1 FT unless otherwise noted in the Contract Documents and then the stricter criteria shall be used.

3.3 ROCK EXCAVATION

A. All rock excavation shall be under one classification.

1. This classification shall include solid ledge rock in its natural location that requires systematic quarrying, drilling and/or blasting for its removal and also boulders that exceed 1/2 CUYD in volume.
2. Rock excavation includes any material which cannot be dislodge by a D-8 Caterpillar tractor, or equivalent, equipped with a hydraulically operated power ripper, or by a Caterpillar 330 hydraulic excavator, or equivalent, without the use of drilling or blasting.

B. When rock is encountered, strip free of earth.

1. Employ an independent surveyor to determine rock quantities before removal operation begins.
2. In computing the volumetric content of rock excavation for payment, the pay lines shall be taken as follows:
   a. For structures: 3 FT outside the exterior limits of foundations and from rock surface to 6 IN below bottom of foundations.
   b. For piping and utilities: A width 18 IN wider than the outside diameter of the pipe or conduit and from rock surface to 6 IN below bottom exterior surface of the pipe or conduit.
   c. For paving: 2 FT outside the exterior limits of paving and from rock surface to 6 IN below bottom of pavement subbase.
   d. For stormwater basin: 1 FT outside the limits of excavation shown on the Contract Drawings.

C. Test Blasting Program:

1. Establish maximum explosive charge weight per delay necessary to meet the specified vibration limits.
2. Confirm proposed blasting plan is within specified limits.
3. Start test blasts with smaller charges and progressively increase the charge to production levels.
4. Monitor blast parameters and evaluate after each blast before proceeding with the next larger blast.
5. Vibration levels from test blast shall not exceed the specified limits.

D. The use of explosives shall be limited to the magnitude and location of the charge that will not cause damage to adjacent existing construction and utilities through shock vibrations or other stress loadings.

1. Blast vibration limits:
    a. Per U.S. Bureau of Mines' Report of Investigations 8507/1980, titled "Structure Response and Damage Produced by Ground Vibrations from Surface Mine Blasting", except the maximum peak particle velocity as measured by an engineering seismograph shall not exceed 4 IN per second.
    b. Blast vibration level may change, depending on the presence of nearby structures and the results of the preconstruction survey.
2. Provide adequate blanket protection to ensure that there will not be fragments of rock or other debris flying through the air when discharging explosives.
3. Contractor to employ personnel certified by Harnett County to execute blasting operations if the county requires such certification.
    a. Any damage to existing construction or other features caused by blasting operations to be repaired and paid for by Contractor.
4. Explosive permits shall be obtained from all applicable authorities.
5. Coordinate blasting with other work to avoid damage to new construction and possible decrease in concrete strength place less than 28-days prior to the blast.
    a. Avoid late blasting for utility trenches that may affect the strength of previously placed structures.
6. Hold blasting charges above the design grades and minimize fractured rock from overblast.
7. Actual grades for setting charges selected by the Contractor.
8. Excavate and remove rock damaged by blasting and replace loose rock with concrete fill
9. Do not drill more than 2 FT below the proposed subgrades to minimize the presence of fracture rock below final grade.
10. The Contract unit price for rock excavation shall include all equipment and materials and other work necessary for excavation and hauling the rock from the site, and for furnishing and placing suitable replacement material as specified in its place.

E. Where explosives and blasting are used, comply with all laws and ordinances of municipal, state and Federal agencies relating to the use of explosives.

1. Use qualified personnel for blasting and take proper precautions to protect persons, property or the work from damage or injury from blast or explosion.
2. Conduct preblast survey in the company of the Engineer to aid in determining any damage caused by blasting.
    a. Document the condition of all existing structures, streets and sidewalks within 200 FT of the proposed construction.
    b. Include interior walls, ceiling, floors, exterior walls, roofs and any other element that could be damaged from the blasting.
    c. Document condition using video tapes, written notes, measurements, sketches and photographs.

d. Re-examine all structures documented in the preblast survey after construction is complete.

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 PCT per ASTM D698	-2 to +3 PCT of optimum
Cohesionless soils	75 PCT relative density per ASTM D4253 and ASTM D4254	
Unpaved Areas:		
Cohesive soils	90 PCT of ASTM D698	-2 to +3 PCT of optimum
Cohesionless soils	65 PCT 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 PCT per ASTM D698	-2 to +3 PCT of optimum
Outside structures next to walls, piers, columns and any other structure exterior member	92 PCT per ASTM D698	-2 to +3 PCT of optimum

3. Specific areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside structures under equipment support foundations	98 PCT per ASTM D698	-2 to +3 PCT of optimum
Under void	85 PCT per ASTM D1557	-2 to +3 PCT of optimum
Granular fill under base slabs with pressure relief valves	75 PCT relative density per ASTM D4253 and ASTM D4254 or 98 PCT of ASTM D698	
Granular fill under building floor slabs-on-grade	60 PCT 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.
4. Proof-roll all subgrades to receive fill or concrete placement after subgrade has been scarified and compacted.

a. Proof-roll in the presence of Geotechnical Engineer with a fully-loaded tandem axle dump truck or other equipment with a minimum gross weight of 25 tons.

5. 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.
6. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
7. 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.
8. Dewatering:
   a. Where groundwater is or is expected to be encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade below foundations and fill material, to allow foundations and fill material to be placed in the dry, and to maintain a stable excavation side slope.
   b. Groundwater shall be maintained at least 3 FT below the bottom of any excavation.
   c. Review Geotechnical investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
   d. Employ dewatering specialist for selecting and operating dewatering system.

e. Keep dewatering system in operation until dead load of structure exceeds possible buoyant uplift force on structure.

f. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.

1) Install groundwater monitoring wells as necessary.

g. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.

9. 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.

10. Do not place floor slabs-on-grade including equipment support pads until subgrade below has been approved, piping has been tested and approved, reinforcement placement has been approved, and Contractor receives approval to commence slab construction.

a. Do not place building floor slabs-on-grade including equipment support pads when temperature of air surrounding the slab and pads is or is expected to be below 40 DEGF before structure is completed and heated to a temperature of at least 50 DEGF.

11. 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.

12. 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.

13. 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.

14. 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 PCT.
    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 as required by Specifications or shown on Contract Drawings.
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 8 IN loose 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.
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 3.5, 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. Install composite drainage panel as shown on Contract Drawings.
    e. 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. Contractor provides sufficient notification and access so inspection and testing can be accomplished.

C. Contractor pays for retesting of failed tests and for additional testing required when defects are discovered.

D. 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 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. Make at least one field density test on subgrade and each compacted fill layer for every 2000 SQFT.
7. Prepare and submit inspection and test reports to Engineer.
    a. Coordinate such work with other Special Inspectors.
8. 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.

E. 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 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. Division 26 - Electrical.
2. 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/FT^3 (600 kN-M/M^3)).
   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 Engineer.
    a. Free of rock cobbles, roots, sod or other organic matter, and frozen material.
    b. Moisture content at time of placement: ±3% of optimum moisture content as specified in accordance with ASTM D698.
2. Gravel trench backfill materials:
    a. ASTM C33/C33M, gradation 57 or 67.

B. Subgrade Stabilization Materials: Provide subgrade stabilization material consisting of ASTM C33/C33M, gradation 57 or 67.

C. Bedding Materials:

1. As approved by the Geotechnical Engineer.
2. Granular bedding materials:
    a. ASTM C33/C33M, gradation 57 or 67.
3. Flowable fill:
    a. Description: Flowable fill shall be a mixture of cement, fly ash, fine sand, water, and air having a consistency which will flow under a very low head.
    b. Material characteristics:
        1) The approximate quantities of each component per cubic yard of mixed material shall be as follows:
            a) Cement (Type I or II): 50 LBS.
            b) Fly ash: 200 LBS.
            c) Fine sand: 2,700 LBS.
            d) Water: 420 LBS.
            e) Air content: 10%.
        2) Actual quantities shall be adjusted to provide a yield of 1 cubic yard with the materials used.
        3) Approximate compressive strength should be 85 to 175 PSI.
        4) Fine sand shall be an evenly graded material having not less than 95% passing the No. 4 sieve and not more than 5% passing the No. 200 sieve.

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.
2. See Specification Section 31 23 00 for applicable requirements.

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.

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 where proposed work crosses at a lower elevation.
        1) Stabilize excavation to prevent undermining of existing utility.
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) Maximum trench width at top of pipe or conduit may not exceed outside diameter of utility service by more than the following dimensions:

OVERALL DIAMETER OF UTILITY SERVICE	EXCESS DIMENSION
33 IN and less	18 IN
more than 33 IN	24 IN

3) Cut trench walls vertically from bottom of trench to 1 FT above top of pipe, conduit, or utility service.
4) 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. Conform to appropriate requirements of Specification Section 31 23 00.
5. Flowable fill batching, mixing, and placing may be started if weather conditions are favorable, and the air temperature is 34 DEGF and rising.
6. At the time of placement, flowable fill must have a temperature of at least 40 DEGF.
7. Mixing and placing shall stop when the air temperature is 38 DEGF or less and falling.
8. Each filling stage shall be as continuous an operation as is practicable.
9. 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.
10. 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

SECTION 31 25 00
SOIL EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil erosion and sediment control.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Erosion control standards: Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas by the United Sates Department of Agriculture (USDA), Soil Conservation Service, College Park, Maryland.
2. North Carolina Erosion and Sediment Control Planning and Design Manual, current edition.
3. North Carolina State Department of Transportation Standard Specifications for Roads and Structures Construction, current edition.
4. EPA Water Management for Industrial Activities.

1.3 SITE CONDITIONS

A. The Contractor may use existing features with the Owner's prior approval, provided the Contractor maintains said features.

B. The Contractor shall protect stream and buffers from sediment laden runoff.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rip Rap: Refer to Drawings.

B. Grass Seed: Refer to Section 32 92 00, Seeding, Sodding, and Landscaping.

C. Geotextiles: Refer to Drawings.

D. Silt Fence: Refer to Drawings.

E. Erosion Control Blankets and Turf Reinforcement Matting (TRM): Refer to Drawings.

F. Sediment Tubes: Refer to Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to General Stripping Topsoil and Excavating:

1. Install construction entrance/exit.
2. Install silt fence, silt fence outlets, and tree protection fencing where indicated on Drawings.
3. Excavate and shape sediment basin.
4. Construct riser structure and discharge pipe, outlet protection, skimmer, and emergency spillway for sediment basin.
5. Machine compact all berms, dikes and embankments for basins.
6. Construct stormwater channels, check dams, and sediment tubes.

7. Refer to the construction sequence on the plans for further details.

B. Temporarily seed basin slopes and topsoil stockpiles:

1. Refer to Section 32 92 00, Seeding, Sodding and Landscaping, as well as Drawings.
2. Reseed as required until good stand of grass is achieved.

3.2 DURING CONSTRUCTION PERIOD

A. Maintain Basin, Silt Fence, Silt Fence Outlets, Stormwater Channels, Sediment Tubes, Check Dams, etc.:

1. Inspect regularly especially after rainstorms.
2. Repair or replace damaged or missing items.

B. After rough grading, sow temporary grass cover over all exposed earth areas not draining into sediment basin or trap.

C. Provide necessary swales and dikes to direct all water towards and into sediment basin to extent possible.

D. Do not disturb existing vegetation (grass and trees) outside limits of construction.

E. Excavate sediment out of basin when capacity has been reduced by 50 PCT.

1. Remove sediment from behind silt fence, and other controls to prevent overtopping.

F. Topsoil and Fine Grade Slopes and Swales, etc.: Seed and mulch as soon as areas become ready.

G. Should any temporary erosion and sediment control measure employed by the Contractor fail to produce results which comply with the state and local enforcement requirements, Contractor shall immediately take whatever steps are necessary to correct the deficiency at his own expense.

1. Inspect temporary erosion and sediment control measures at least weekly and after each rain event or more frequently if required by erosion and sediment control permit. Record inspection results.

3.3 NEAR COMPLETION OF CONSTRUCTION AFTER SITE STABILIZATION

A. Convert sediment basin to permanent stormwater pond.

B. Eliminate silt fence, check dams, sediment tubes, and other temporary erosion and sediment controls.

C. Fine grade any areas disturbed during removal of controls, then seed and mulch.

END OF SECTION

SECTION 31 32 19
GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Geotextile fabric for all uses as shown in Drawings including but not limited to:
   a. Fabric for temporary silt fence.
   b. Separator geotextile between rip rap and soil.
   c. Roadbed geotextile for placement above compacted subgrade for both gravel and paved roadways.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 23 00 - Earthwork.
4. Section 31 37 00 – Stone Revetment (Riprap).
5. Section 32 05 16 – Aggregate Course.
6. Section 32 12 16 – Asphaltic Concrete Vehicular Paving.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway Transportation Officials (AASHTO):
   a. M288, Standard Specification for Geotextile Specification for Highway Applications.
2. ASTM International (ASTM):
   a. D3786, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
   b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   e. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   f. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   g. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
   h. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
   i. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
   j. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

B. Qualifications:

1. Each manufacturing, fabricating firm shall demonstrate five years continuous experience, including a minimum of 10,000,000 SQFT of geotextile installation in the past three years.

1.3 DEFINITIONS

A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.

B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data.
3. Manufacturer's delivery, storage, handling, and installation instructions.
4. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
5. Manufacturer and Installer quality control manuals.
6. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals.
    a. Results shall include or bracket the rolls delivered for use in the Work.
7. Proposed details of anchoring and overlapping if different than included in Contract Documents.

B. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. For needle punched geotextiles, the manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
3. Qualification documentation specified in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. See Specification Section 01 65 50.

B. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.

C. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.

1. Do not remove the plastic wrapping until deployment.

D. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).

E. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.

F. Do not expose geotextile to temperatures in excess of 71 DEGC (160 DEGF) or less than 0 DEGC (32 DEGF) unless recommended by the manufacturer.

G. Do not use hooks, tongs or other sharp instruments for handling geotextile.

1. Do not lift rolls lifted by use of cables or chains in contact with the geotextile.
2. Do not drag geotextile along the ground.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Amoco Fabrics and Fibers Co.
2. Advanced Drainage Systems Inc.
3. Propex Geosynthetics.
4. SKAPS Industries.

5. TenCate Mirafi.
6. Synthetic Industries, Inc.
7. or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.2 MATERIALS AND MANUFACTURE

A. Geotextile:

1. Temporary Silt Fence: Woven fabric meeting the requirements of NCDOT Type 3, Class A or B (see NCDOT Standard Specification Section 1056).
2. Rip Rap Separator Fabric: Non-woven fabric meeting the requirements of NCDOT Type 2 (see NCDOT Standard Specification Section 1056).
3. Roadbed Separator Fabric: Woven fabric meeting the requirements of NCDOT Type 4 (see NCDOT Standard Specification Section 1056).

B. Thread:

1. High-strength polyester, nylon, or other approved thread type.
2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
3. Contrasting color with the geotextile.

PART 3 - EXECUTION

3.1 PREPARATION

A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

3.2 INSTALLATION

A. General Handling and Layout:

1. General storage and handling of geotextiles must meet requirements of ASTM D4873.
2. Exercise care when installing to prevent damage to geotextile.
3. Lay out geotextile smooth and free of wrinkles, but loose enough that placement of overlying materials will not stretch or tear the fabric.
4. Repair or replace geotextile that is torn or punctured. Repair by placing a geotextile patch over the damaged area, overlapping the existing geotextile by 12 IN (minimum) from any part of the damaged area. Repair or replace at no extra cost to Owner.
5. No equipment may operate directly on geotextiles. A minimum vertical separation of 9 IN must be maintained between all geotextiles and equipment tracks or wheels.

B. Seaming and Joining:

1. Separator: Join sheets as specified below:
   a. With Sewing: Overlap adjacent panels a minimum of 4 IN. Use Type SSa (prayer) seam and a Type 401 stitch having a minimum distance from the edge of the geotextile to the stitch line of 2.0 IN or follow recommendations of geotextile manufacturer.
   b. With Heat Bonding: Overlap adjacent panels a minimum of 4 IN. Heat bond seam must develop a minimum of 60% of the tensile strength of the parent geotextile as measured in ASTM D4632.

C. Rip Rap Separator Geotextile: Non-woven:

1. Place fabric directly on a relatively smooth subgrade, free of obstructions, abrupt depressions or humps, debris, or deposits of loose or soft soil.
2. Care must be taken to avoid damaging the geotextile during placement of rock over the geotextile.
3. Limit vertical fall of rock onto geotextile to 2 feet or less.

D. Roadbed Separator Geotextile Fabric: Woven:

1. Place woven geotextile directly on a relatively smooth subgrade, free of obstructions, abrupt depressions or humps, debris, or deposits of loose or soft soil.
2. If required, the geotextile may be held in place with staples.
3. Geotextile shall be overlapped in the direction of the crushed stone placement.
4. Limit vertical fall of crushed stone onto geotextile to 2 feet or less.
5. Carefully spread and compact crushed stone on top of geotextile to avoid displacing or damaging geotextile.

E. Use adequate ballast (e.g., sand bags) to prevent uplift by wind.

F. Do not leave geotextile uncovered for more than 14 days.

END OF SECTION

SECTION 31 37 00
STONE REVETMENT (RIP RAP)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stone revetment (riprap) for protection of drainage ways against erosion.
    a. Channel protection.
    b. Culvert outlets.
    c. Hydraulic structures.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 23 00 - Earthwork.
4. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
5. Section 31 25 00 - Soil Erosion and Sediment Control.
6. Section 33 40 00 - Storm Drainage.
7. Section 31 32 19 - Geotextiles.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
    a. C127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
    b. D3744/D3744M, Standard Test Method for Aggregate Durability Index.
    c. D5312/D5312M, Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions.
    d. D5313/D5313M, Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions.
    e. D5519, Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
3. Certifications.
4. Test reports.
5. Submit all tests and certification in a single coordinated submittal.
    a. Partial submittals will not be accepted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Riprap shall be made up of durable angular quarry stone.

B. Individual stones making up the riprap shall be resistant to weathering and shall not contain cracks, non-mineralized defects, shale, unsound sandstone, or organic material.

C. Neither the width nor thickness of any stone shall be less than one-third of the stone's length.

D. Gradation of the material: As indicated in the Contract Drawings.

2.2 MATERIAL QUALITY CONTROL

A. Geotextile:

1. See Section 31 32 19 for geotextile requirements.

B. Riprap:

1. Riprap material quality shall be evaluated using one of the following two methods:
   a. Specific rock properties:
      1) Quarry rock tests completed on rock that is representative of the material to be used on the project may be submitted for review if the testing was completed by a reputable testing company for State or Federal agency certification purposes within the last five years. The material testing requirements are as follows:
         a) Minimum Specific Gravity 2.5 per (ASTM C127).
         b) Durability Absorption Ratio less than 10 fails, greater than 23 passes, between 10 and 23 passes only if the Durability Index is greater than 52.
            (1) Durability Absorption Ratio = Durability Index / (PCT Absorption+1), Durability Index test ASTM D3744, Absorption test ASTM C127
         c) Maximum of 1 PCT loss due to Wetting and Drying test ASTM D5313/D5313M.
         d) Maximum of 5 PCT loss due to Freeze Thaw test ASTM D5312/D5312M.
   b. Ability of rock to perform.
      1) The Contractor may propose to use material from a source that has a documented track record of acceptable performance for comparable applications and exposure conditions. If requesting approval of materials using this method, provide the following information for the Geotechnical Engineer to review to determine if the riprap is of acceptable quality:
         a) As-built plans for a project where riprap has been in place a minimum of 20 years.
         b) Documentation of the riprap material source.
         c) Installation performance data.
         d) Available material testing data.
         e) Maintenance records for the riprap installation.
         f) Recent photos of riprap installation.
         g) Contact information for the Owner of the project.
      2) The Geotechnical Engineer shall review the provided information to determine whether the in place material was subjected to conditions expected for the project and if the rock performed satisfactorily as determined by the Owner and Geotechnical Engineer.
      3) A minimum oftwo months shall be allowed after the information has been submitted by the Contractor for review of data with the Owner, a site visit, and material determination.

PART 3 - EXECUTION

3.1 MATERIAL ACCEPTANCE

A. Final acceptance is determined at the in-place riprap installation which shall consist of a homogenous mass with a distribution of rock sizes that meets the specified gradation. Riprap

transport, handling, and placement methods shall not cause breakage of individual rocks or segregation of riprap gradation.

B. Rock quality shall be determined at the quarry. Stone with a coloration or appearance dissimilar to the accepted material shall be rejected.

C. A representative gradation sample shall be located adjacent to the stockpile locations at both the quarry and project stockpile area for the duration of the project.

D. Arriving loads of material not bearing reasonable similarity to the representative gradation sample shall be rejected.

E. The riprap gradation shall be produced at the quarry and shall not be accomplished by mixing at the project site.

3.2 PLACEMENT

A. Provide at least 24 HR notice for the Geotechnical Engineer to review the work in the field including the subgrade and geotextile fabric. Do not place any geotextile fabric or stone material on prepared base prior to the Geotechnical Engineer's review. Placement of bedding, fabric, or riprap on ice or snow is not permitted.

B. Subgrade:

1. Compact fill areas to density specified for backfill in accordance with Specification Section 31 23 00 - Earthwork.
2. Grade subgrade to elevations indicated in the plans within plus or minus 0.1 FT in dry areas and ±0.3 FT in areas that are underwater and do not require dewatering for construction.
3. The subgrade shall be smooth and free of topsoil, organic material, roots, sticks, debris, yielding material or other materials that would prevent meeting the specified subgrade elevation tolerance.
4. The Contractor, at no additional cost to the Owner, may decide to not grade the subgrade to the specified tolerance and increase the riprap layer thickness. The lack of subgrade preparation shall not result in a decreased riprap layer thickness or change in the top of riprap elevation unless the change is requested in writing and approved in writing by the Engineer.

C. Geotextile Fabric:

1. Place geotextile fabric only after inspection of subgrade by Geotechnical Engineer.
2. Place geotextile fabric in accordance with manufacturer specifications.
3. The ends of the geotextile fabric shall be buried and the placement sequence shall result in overlaps, with the upstream fabric overlapping the downstream fabric.
4. Fabric must be secured using pins or weights to prevent displacement by water, wind, or riprap placement.
5. See Specification Section 31 32 19 – Geotextiles.

D. Riprap:

1. Place riprap on prepared bedding only after the Geotechnical Engineer has reviewed the work.
2. Place riprap on prepared foundation per line and grade shown on the plans. The riprap thickness tolerance is +0.5 FT and -0 FT as measured over an area of 200 SQFT when placed in the dry, and 400 SQFT when placed underwater.
3. Riprap material shall be placed to result in a homogenous mass with a minimum of voids. Rearranging of individual rock may be required to obtain a suitable distribution of rock sizes.
4. Riprap placement methods shall not result in the following: cause breakage of individual rocks, result in segregation of riprap gradation, result in introduction of fines, or impact the filter material.

5. Individual stones making up the riprap shall not be dropped from a height greater than 1 FT above the geotextile, unless it can be demonstrated to the satisfaction of the Geotechnical Engineer that the geotextile fabric will not be damaged.
6. When placing riprap on a slope, start placement from the bottom of slope and proceed to top of slope.
7. Place rock to full thickness in a single operation to avoid displacing the underlying material.
8. The top of riprap shall match adjoining grades and allow for positive drainage.
9. Maintain the riprap until acceptance at project completion.

END OF SECTION

SECTION 32 05 16
AGGREGATE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Crushed stone paving course, compacted.

B. Related Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 01 33 00 – Submittals.
4. Section 31 23 00 – Earthwork.

1.2 QUALITY ASSURANCE

A. Reference Standards:

1. ASTM:
   a. D422, Standard Test method for Particle-Size Analysis.
   b. D1557, Standard Test Methods for Laboratory Compaction of Soil Modified Effort.
   c. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
2. North Carolina Department of Transportation, Standard Specifications for Roads and Structures, current edition..

1.3 SUBMITTALS

A. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:

1. Certification that the proposed material conforms to the Specifications along with copies of the test results (from a qualified commercial testing laboratory).

C. Test Reports:

1. Narrative.
2. Sieve analysis of crushed stone per ASTM D422 (1 test/source or change in material).
3. Compaction test of crushed stone per ASTM D1557 (1 test/source or change in material)

PART 2 - PRODUCTS

2.1 MATERIAL

A. Material shall be ABC stone as provided in accordance with Section 1010 of the North Carolina Department of Transportation Standard Specifications for Roads and Structures.

PART 3 - EXECUTION

3.1 CONSTRUCTION

A. Construct aggregate course to grade, thickness, and typical section as indicated on drawings. Existing subgrade and select subgrade upon which aggregate course is to be placed shall be compacted in accordance with Section 31 23 00.

B. Install non-woven geotextile between compacted subgrade and select subgrade as indicated in Drawings.

C. Aggregate course shall be constructed in accordance with Section 520 of the North Carolina Department of Transportation Standard Specifications for Roads and Structures, unless indicated otherwise on plans or specifications.

3.2 COMPACTION

A. Compact by vibrating or other approved methods to 95 percent maximum dry density as determined by ASTM D1557.

B. Any irregularities in the surface shall be corrected by scarifying, remixing, reshaping and recompacting until a smooth surface is secure.

3.3 FIELD QUALITY CONTROL AND QUALITY ASSURANCE

A. The crushed stone will be tested for density at a minimum average frequency of 1 test/200 LF of roadway per ASTM D6938 or alternate method approved by CQA Engineer.

B. The crushed stone will be tested for gradation at a minimum average frequency of 1 test/500 CY of material delivered.

C. The crushed stone will be tested for depth at a minimum average frequency of 1 test/200 LF of roadway.

D. Perform laboratory compaction of crushed stone per ASTM D1557 at a minimum frequency of 1 test/change in material if pre-construction test submittals are not representative of materials delivered.

END OF SECTION

SECTION 32 12 16
ASPHALTIC CONCRETE VEHICULAR PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphaltic concrete vehicular paving.
2. Line painting.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 23 00 – Earthwork.
4. Section 32 05 16 – Aggregate Course.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Federal Specifications (FS):
   a. TT-P-1952F, Paint, Traffic and Airfield Marking, Waterborne.
2. Construction standards: North Carolina Department of Transportation Standard Specifications for Roads and Structures, as amended to date.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Asphalt design mix including technical data and tested physical and performance properties.
   d. Certifications, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
   e. Material Certificates: For each paving material, from Manufacturer.
   f. Material Test Reports: For each paving material.

B. Request and perform a pre-construction meeting with the Engineer and County. The Contractor shall have a pre-installation conference with the Contractor and Engineer prior to commencement of the Work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The materials specified below are referenced to various sections of the NCDOT Standard Specification for Roads and Structures. The Sections which are listed below shall be included as part of this specification as bound herein. Recycled shingles are encourages to be utilized as permitted by NCDOT:

1. Coarse Aggregate, Fine Aggregate, and Mineral Filler:
   a. In accordance with the requirements of Section 520 NCDOT Standard Specifications and the Drawings.

2. Asphalt Materials:
    a. All Materials utilized in the production of hot mix asphalt shall meet NCDOT applicable requirements of the provisions from Section 610 titled “Asphalt Concrete Plant Mix Pavement,” for the type of Superpave plant mix pavement on the Drawings.
3. Mixes:
    a. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by NCDOT designed according to procedures AI MS-2, “Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types”:
        1) See Drawings for required mixes and thicknesses.
4. Prime Coat:
    a. Asphalt Grade RC-300 in accordance with NCDOT Section 600 “Prime Coat”.
5. Line Paint:
    a. Nonreflective.
    b. White and Yellow.
    c. FS TT-P-1952F.
    d. Thermoplastic.

PART 3 - EXECUTION

3.1 ASPHALTIC CONCRETE APPLICATION

A. Construct to line, grade and section as shown on Drawings and in accordance with Section 520 NCDOT Standard Specifications.

B. Install an 8-inch compacted layer of aggregate base course in accordance with Section 520 NCDOT Standard Specifications where indicated on Drawings.

C. Spread a prime coat uniformly on compacted aggregate base course at rate of 0.20 to 0.50 GAL per square yard in accordance with Section 600 of NCDOT Standard Specifications.

D. Apply tack coat uniformly to surfaces of existing pavement at a rate of 0.04 to 0.08 GAL per square yard in accordance with Section 605 of NCDOT Standard Specifications.

E. Install Superpave mix types, in accordance with Section 610 of State Specifications. The asphalt shall be placed to the requirements of NCDOT Sections 610-8 to 610-12.

F. Tolerance of Finished Grade: +0.10 FT from required elevations.

3.2 LINE PAINTING

A. Thoroughly clean surfaces which are to receive paint.

B. Dry completely before paint is applied.

C. Do not paint until minimum of five days has elapsed from time surface is completed.

1. A longer period may be required if directed by Engineer.

D. Do not apply paint over wet surfaces, during wet or damp weather, or when temperature is below 40 DEGF.

E. Lay out markings and striping in accordance with Drawings.

1. Width of painted lines: 4 IN.
2. Stop bar per NCDOT standard.

3.3 FIELD QUALITY CONTROL

A. Contractor shall provide and conduct a quality control program as defined as all activities, including mix design, process control inspection, sampling and testing, and necessary adjustments in the process that are related to the production of the pavement in accordance with NCDOT’s “Hot Mix Asphalt Quality Management System” (HMA/QMS) manual which is in force on the date of contract advertisement, unless otherwise approved.

B. Thickness:

1. In-place compacted thickness of hot-mix asphalt cores will be determined according with NCDOT requirements.

C. Compaction:

1. Perform QC of the compaction process in accordance with Section 609-7 NCDOT Standard Specifications. CQC Consultant shall observe asphaltic concrete placement and perform tests to ensure conformance with requirements of this specification.

END OF SECTION

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SECTION 32 92 00
SEEDING, SODDING AND LANDSCAPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding, sodding and landscape planting:
    a. Soil preparation.
    b. Lawn-type seeding.

B. Seeding schedule in Drawings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Nursery and Landscape Association/American National Standards Institute (ANLA/ANSI):
    a. Z60.1, American Standard for Nursery Stock.
2. AOAC International (AOAC).
3. ASTM International (ASTM):
    a. D2028, Standard Specification for Cutback Asphalt (Rapid-Curing Type).

B. Quality Control:

1. Fertilizer:
    a. If Engineer determines fertilizer requires sampling and testing to verify quality, testing will be done at Contractor's expense, in accordance with current methods of the AOAC.
    b. Upon completion of Project, a final check of total quantities of fertilizer used will be made against total area seeded.
    c. If minimum rates of application have not been met, Contractor will be required to distribute additional quantities to make up minimum application specified.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
    c. Signed copies of vendor's statement for seed mixture required, stating botanical and common name, place of origin, strain, percentage of purity, percentage of germination, and amount of Pure Live Seed (PLS) per bag.
    d. Type of herbicide to be used during first growing season to contain annual weeds and application rate.
2. Certification that each container of seed delivered will be labeled in accordance with Federal and State Seed Laws and equals or exceeds Specification requirements.

B. Informational Submittals:

1. Copies of invoices for fertilizer used on Project showing grade furnished, along with certification of quality and warranty.

1.4 SEQUENCING AND SCHEDULING

A. Installation Schedule:

1. Show schedule of when lawn type and other grass areas are anticipated to be planted.

2. Indicate planting schedules in relation to schedule for finish grading and topsoiling.
3. Indicate anticipated dates Engineer will be required to review installation for initial acceptance and final acceptance.

B. Pre-installation Meeting:

1. Meet with Engineer and other parties as necessary to discuss schedule and methods, unless otherwise indicated by Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Seed Quality:

1. Fresh, clean, new-crop seed labeled in accordance with USDA Rules and Regulations under the Federal Seed Act in effect on date of bidding.
2. Provide seed of species, proportions, and minimum percentages of purity, germination and maximum percentage of weed seed as specified.
3. Approval of all seed for use shall be based on the accumulative total of PLS specified for each phase of work.

B. Lawn-Type Seed Mixture: See seeding schedule in Drawings.

C. Mulch:

1. For seeded areas:
   a. Clean, seed-free, threshed straw of oats, wheat, barley, rye, beans, peanuts, or other locally available mulch material which does not contain an excessive quantity of matured seeds of noxious weeds or other species that will grow or be detrimental to seeding, or provide a menace to surrounding land.
   b. Do not use material which is fresh or excessively brittle, or which is decomposed and will smother or retard growth of grass.

D. Fertilizer:

1. Commercial fertilizer meeting applicable requirements of State and Federal law.
2. Cyanic compound or hydrated lime not permitted in mixed fertilizers.
3. For lawn-type seeding and sod: 5-10-5 analysis.

E. Limestone: Agricultural grade ground limestone containing not less than 88% of combined calcium and magnesium carbonates, 100% passing a 10-mesh sieve, 90% passing a 20-mesh sieve, and 60% passing a 100-mesh sieve.

F. Asphalt Binder: Emulsified asphalt per State specifications.

G. Water:

1. Water free from substances harmful to grass or sod growth.
2. Provide water from source approved prior to use.

PART 3 - EXECUTION

3.1 SOIL PREPARATION

A. General:

1. Limit preparation to areas which will be planted soon after.
2. Provide facilities to protect and safeguard all persons on or about premises.
3. Protect existing trees designated to remain.
4. Verify location and existence of all underground utilities.
   a. Take necessary precaution to protect existing utilities from damage due to construction activity.

b. Repair all damages to utility items at sole expense.

5. Provide facilities such as protective fences and/or watchmen to protect work from vandalism.
   a. Contractor to be responsible for vandalism until acceptance of work in whole or in part.

B. Preparation for Lawn-Type Seeding:

1. Loosen surface to minimum depth of 4 IN.
2. Remove stones over 1 IN in any dimension and sticks, roots, rubbish, and other extraneous matter.
3. Spread limestone uniformly over designated areas at a rate of 50 LBS per 1000 SQFT.
   a. Thoroughly mix and till through topsoil layer.
4. Prior to applying fertilizer, loosen areas to be seeded with a double disc or other suitable device if the soil has become hard or compacted.
5. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
6. Distribute fertilizer uniformly over areas to be seeded:
   a. For lawn-type seeding: 30 LBS per 1000 SQFT.
7. Incorporate fertilizer into soil to a depth of at least 2 IN by disking, harrowing, or other approved methods.
8. Remove stones or other substances from surface which will interfere with turf development or subsequent mowing operations.
9. Grade lawn areas to a smooth, even surface with a loose, uniformly fine texture.
   a. Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
   b. Limit fine grading to areas which can be planted soon after preparation.
10. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and before planting.

3.2 INSTALLATION

A. Lawn-Type Seeding:

1. Do not use seed which is wet, moldy, or otherwise damaged.
2. Perform seeding work in accordance with seeding schedule in Drawings, unless otherwise approved by Engineer.
3. Employ satisfactory methods of sowing using mechanical power-driven drills or seeders, or mechanical hand seeders, or other approved equipment.
4. Distribute seed evenly over entire area at rate of application not less than 4 LBS (PLS) of seed per 1000 SQFT, 50% sown in one direction, remainder at right angles to first sowing.
5. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds excessive moisture, or other factors.
   a. Resume work only when favorable conditions develop.
6. Lightly rake seed into soil followed by light rolling or cultipacking.
7. Immediately protect seeded areas against erosion by mulching as indicated in seeding schedule in Drawings.
8. Protect seeded slopes against erosion with erosion netting or other methods approved by Engineer.
   a. Protect seeded areas against traffic or other use by erecting barricades and placing warning signs.
9. Immediately following spreading mulch, anchor mulch using a rolling coulter or a wheatland land packer having wheels with V-shaped edges to force mulch into soil surface, or apply evenly distributed emulsified asphalt at rate of 10-13 GAL/1000 SQFT.

a. SS-1 emulsion or RC-1 cutback asphalt in accordance with ASTM D2028 are acceptable.
b. If mulch and asphalt are applied in one treatment, use SS-1 emulsion with penetration test range between 150-200.
c. Use appropriate shields to protect adjacent site improvements.

10. If hydroseeding is used, machinery must be approved, modern, properly equipped and operated by an experienced operator.
    a. Seed and fertilize at the rate specified.
    b. Use appropriate shields to protect adjacent site improvements.

3.3 MAINTENANCE AND REPLACEMENT

A. General:

1. Begin maintenance of planted areas immediately after each portion is planted and continue until final acceptance or for a specific time period as stated below, whichever is the longer.
2. Provide and maintain temporary piping, hoses, and watering equipment as required to convey water from water sources and to keep planted areas uniformly moist as required for proper growth.
3. Protection of new materials:
    a. Provide barricades, coverings or other types of protection necessary to prevent damage to existing improvements indicated to remain.
    b. Repair and pay for all damaged items.
4. Replace unacceptable materials with materials and methods identical to the original specifications unless otherwise approved by the Engineer.

B. Seeded Lawns:

1. Maintain seeded lawns: 90 days, minimum, after installation and review of entire project area to be planted.
2. Maintenance period begins at completion of planting or installation of entire area to be seeded or sodded.
3. Engineer will review seeded or sodded lawn area after installation for initial acceptance.
4. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading, and replanting as required to establish a smooth, uniform lawn, free of weeds and eroded or bare areas.
5. Lay out temporary lawn watering system and arrange watering schedule to avoid walking over muddy and newly seeded areas.
    a. Use equipment and water to prevent puddling and water erosion and displacement of seed or mulch.
6. Mow lawns as soon as there is enough top growth to cut with mower set at recommended height for principal species planted.
    a. Repeat mowing as required to maintain height.
    b. Do not delay mowing until grass blades bend over and become matted.
    c. Do not mow when grass is wet.
    d. Time initial and subsequent mowings as required to maintain a height of 1-1/2 to 2 IN.
    e. Do not mow lower than 1-1/2 IN.
7. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose.
    a. Anchor as required to prevent displacement.
8. Unacceptable plantings are those areas that do not meet the quality of the specified material, produce the specified results, or were not installed to the specified methods.
9. Replant bare areas using same materials specified.
10. Engineer will review final acceptability of installed areas at end of maintenance period.

11. Maintain repaired areas until remainder of maintenance period or approved by Engineer, whichever is the longer period.

END OF SECTION

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SECTION 33 05 16
PRECAST CONCRETE MANHOLE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete structures and appurtenant items.
    a. Bioretention basin outlet risers..
    b. Sumps.
    c. Flow bypass structures at level spreaders.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 21 00 - Reinforcement.
4. Section 03 31 30 - Concrete Materials and Proportioning.
5. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
    a. A48/A48M, Standard Specification for Gray Iron Castings.
    b. C150/C150M, Standard Specification for Portland Cement.
    c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
    d. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
    e. D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
    f. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
3. Fabrication and/or layout drawings:
    a. Include detailed diagrams of structures showing typical components and dimensions, reinforcements and other details.
    b. Itemize, on separate schedule, sectional breakdown of each structure with all components and refer to drawing identification number or notation.
    c. Indicate knockout elevations for all piping entering each structure.
4. Buoyancy uplift and structural calculations where applicable.
5. Drawings shall be signed and sealed by a Professional Engineer registered in state corresponding to the project location.

B. Unless approved prior to submittal, submit all products from this Specification Section in one complete submittal package. Include all products and accessories together.

1.4 SITE CONDITIONS

A. For this project, the established high groundwater elevation is indicated in the Geotechnical Investigation Report at each test boring, where observed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Manhole rings, covers and frames:
    a. Neenah Foundry and Neenah Enterprises, Inc.
    b. Deeter Foundry.
2. Black mastic joint compound:
    a. Kalktite 340.
    b. Tufflex.
    c. Plastico.
3. Premolded joint compound:
    a. RAM-NEK.
    b. Kent Seal.
4. Emulsified fibrated asphalt compound:
    a. Sonneborn Hydrocide 700B.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.2 SANITARY SEWER, STORM AND DRAIN STRUCTURE COMPONENTS

A. Structure Components:

1. Reinforcement: ASTM C478.
2. Minimum wall thickness: 6 IN.
3. Minimum base thickness: 12 IN.
4. Provide the following components for each structure as applicable:
    a. Base (precast) with integral bottom section or (cast-in-place).
    b. Precast bottom section(s).
    c. Precast barrel section(s).
    d. Precast eccentric transition section.
    e. Precast adjuster ring(s).
    f. Precast concrete transition section.
    g. Precast flat top.
5. Unless dimensioned or specifically noted on Drawings, provide structure section with minimum 48 IN inside dimensions.

B. Nonpressure Type Frames and Cover:

1. Cast iron frame and covers: ASTM A48/A48M, Class 35 (minimum).
2. Use only cast iron of best quality, free from imperfections and blow holes.
3. Furnish frame and cover of heavy-duty construction a minimum total weight of 450 LBS.
4. Machine all horizontal surfaces.
5. Furnish unit with solid nonventilated lid with concealed pickholes.
6. nsure minimum clear opening of 24 IN DIA.

C. Nonpressure Type Frames and Cover:

1. Cast iron frame and covers: ASTM A48/A48M, Class 35 (minimum).

D. Trash racks for sediment basin outlet structure:

1. Fabricate as indicated on drawings.
2. Include provisions for mounting on precast outlet structure.
   a. Black mastic compound: ASTM D4586.
3. Vertical wall surfaces:
   a. Emulsified fibrated asphalt compound meeting ASTM D1227 Type II for all exterior vertical wall surfaces.

PART 3 - EXECUTION

3.1 STRUCTURE CONSTRUCTION

A. Base slabs (either cast-in-place or precast may be used):

1. Cast-in-place base slabs:
   a. Construct cast-in-place concrete base slabs.
   b. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
   c. On all straight runs, lay pipe through structure and cut out top half of pipe.
      1) If pipes deflect at structure, shape as specified in Paragraphs 2 and 4 IN this General Paragraph.
   d. Shape inverts accurately and steel trowel finish.
      1) For changes in direction of the sewer and entering branches into the structure, make a circular curve in the structure invert using as large a radius as structure inside diameter will permit.
      2) Pour base slab integral with bottom barrel section.

2. Precast base slabs:
   a. Utilize precast concrete base with integral bottom section.
   b. Ensure accurate vertical placement and leveling prior to placement of interior grout.
      1) Provide vertical alignment tolerance of maximum 1 IN horizontal to 10 FT vertical.
   c. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
      1) Shape inverts accurately and give them a steel trowel finish.
      2) For changes in direction of the sewer and entering branches into the structure, make a circular curve in the structure invert of as large a radius as structure size will permit.

B. Build each structure to dimensions shown on plans and at such elevation that pipe sections built into wall of structure will be true extensions of line of pipe.

C. For all horizontal mating surfaces between concrete and concrete or concrete and metal, above established high groundwater elevation shown trowel apply to clean surface black mastic joint compound to a minimum wet thickness of 1/4 IN immediately prior to mating the surfaces.

D. For horizontal joints that fall below established high groundwater elevation shown, install a resilient O-ring type gasket or pre-molded joint compound.

E. Seal all pipe penetrations in.

1. Form pipe openings smooth and well shaped.
2. After installation, seal cracks with, non shrink grout.

3. After grout cures, wire brush smooth and apply two coats emulsified fibrated asphalt compound to minimum wet thickness of 1/8 IN to ensure complete seal.

F. Set and adjust frame and cover final 6 IN (minimum) to 18 IN (maximum) to match finished pavement or finished grade elevation using precast adjuster rings.

END OF SECTION

SECTION 33 40 00
STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Storm drainage systems.
2. Storm drainage pipe.
3. Inlets, headwalls, flumes and flared end sections.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M36, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760/A760M).
   b. M190, Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches.
2. ASTM International (ASTM):
   a. A760/A760M, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
   b. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
3. Standard Specifications for Road and Structures, State of North Carolina Department of Transportation:
   a. Standard Details.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
3. Certifications.
4. Test reports.
5. Submit all tests and certification in a single coordinated submittal.
   a. Partial submittals will not be accepted.

B. Submit schedules and details for structures and joints.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Cold applied asphalt joint:
    a. Kalktite 340 Compound.
    b. TUFFLEX POLYMERS.
    c. Plastico.
2. Preformed flexible pipe joint sealing compound:
    a. RAM-NEK by Henry Company.
    b. BIDCO C-56 by Trelleborg.

2.2 MATERIALS

A. Reinforced Concrete Pipe (RCP):

1. Reinforced concrete culvert, storm drain and sewer pipe: ASTM C76, Classes III, IV, and V.

B. RCP Joint Sealer:

1. Rubber gasket: ASTM C361.

C. Flared End Sections:

1. Conform to State of North Carolina DOT Specifications.
2. Bituminous coated: AASHTO M190, Type A.
3. Jointing: Same as pipe.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with Specification Section 31 23 33.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Comply with Specification Section 31 23 33.

3.3 FIELD QUALITY CONTROL

A. Verify and coordinate installation.

B. In case of conflict, do not relocate piping without prior approval from the Engineer.

END OF SECTION

Northwest Convenience Center

APPENDIX A

Geotechnical Engineering Report

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Geotechnical Engineering Report for Northwest Convenience Center

Harnett County, NC
January 19, 2022

January 19, 2022

Mr. Chad Beane
Solid Waste Manager
Harnett County
P.O. Box 940
Lillington, NC 27564

Reference: Northwest Convenience Center
Harnett County, North Carolina
Geotechnical Engineering Report

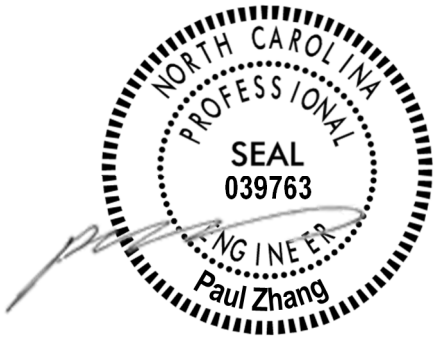
Dear Mr. Beane:

HDR Engineering Inc., of the Carolinas (HDR) has completed the subsurface exploration within the proposed solid waste convenience center in Harnett County, North Carolina. The purpose of this exploration was primarily to provide geotechnical recommendations for the proposed facility. This report provides a summary of relevant project information, exploration test methods, test boring logs, our interpretations and conclusions of the data, and the recommendations for the design and construction of earth supported elements.

HDR appreciates the opportunity to provide geotechnical engineering services for this project. If you have any questions or need any additional information, please contact us.

Sincerely,

HDR ENGINEERING, INC. OF THE CAROLINAS



Paul Zhang, Ph.D., P.E.
Senior Geotechnical Project Manager

Kenneth R. Bussey, Jr., PE
Geotechnical Section Manager

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APPENDIX A – Subsurface Exploration Data

- Boring Location Plan
- Legend
- Test Boring Logs

1.0 Project Description and Scope of Services

Harnett County, North Carolina operates four convenience centers and recycling facilities for household trash and recyclables. The County desires to relocate the Cokesbury Road facility onto County owned land off Oakridge River Road (Lot 0634-54-0565). The lot is located in Zoning District RA-30. In addition to the convenience center, the County plans to develop recreational fields at the site. The use of these lots for a manned Recycling Collection Center and Solid Waste Container Site required a Conditional Use Permit from the County Zoning Board of Adjustment. In 2018, HDR assisted County with development of sketch plans for the development of the site, which was the basis for the Conditional Use Permit received in 2018. In June 2019, HDR assisted with the development of Site Plan Application Drawings and supporting stormwater impact analysis. The County has received approval of the Site. Plan Application and wishes to proceed with final design and construction in early 2022. The purpose of our geotechnical investigation is to identify and evaluate subsurface conditions at the site. Geotechnical and groundwater data were collected by performing geotechnical borings and identifying the elevation of the water table after drilling.

The purpose of this report is to summarize findings from our subsurface exploration and provide site preparation, general construction, and foundation recommendations for the proposed structures and facilities. The following services were provided in order to achieve the preceding objectives:

- Executed a program of subsurface exploration consisting of subsurface sampling and field-testing. The program included nine (9) Standard Penetration Test (SPT) borings.

- Visually classified and tested representative samples using the Unified Soil Classification System (USCS). Visual field classifications were performed in general accordance with the American Society of Testing and Materials (ASTM) standards.

- Collected groundwater level measurements.

- Analyzed field data.

- Prepared this formal engineering report, summarizing the course of study pursued, the field and laboratory data generated, subsurface conditions, and geotechnical recommendations for the proposed structures and facilities.

2.0 Project Information

The project is located southwest of the intersection of Revels Road and Oakridge River Road in Harnett County, North Carolina. The majority of the site is undeveloped and covered by heavy vegetations.

2.1 Regional Geology

Based on the Geologic Map of North Carolina, the site is located within the Piedmont physiographic province. Topographically, the area is gently rolling. Geologically the project site is located within the Raleigh Belt. Bedrock generally consists of Felsic mica gneisses (CZfg). Typically, this gneiss is interlayered with mica schist, mica-garnet schist, and hornblende gneiss. Avents Creek and its tributaries drain the project towards south in general.

2.2 Geotechnical Data Collection

On November 29 and 30, 2021, HDR performed geotechnical SPT borings in accordance with ASTM D1586 at nine (9) locations throughout the site laid out by HDR personnel. Boring collar elevations were interpolated from the existing topography data and should only be considered approximate. The borings were advanced with a CME 45B ATV drill rig utilizing 3.25-inch inner diameter (I.D.) hollow stem augers for borehole stabilization. Within each boring, samples of subsurface soils were taken at 2.5-foot intervals above a depth of 10 feet and at 5-foot intervals below 10 feet using a split-spoon sampler. HDR personnel monitored the drilling operations, visually classified the samples, and prepared field logs of the explorations. All boreholes were backfilled with soil cuttings and sealed with bentonite immediately after. The samples were transported back to HDR's office for further examination and classification by a geotechnical engineer. Representative samples were subjected to classification testing. All soil samples were visually reviewed and classified by a North Carolina Professional Engineer (PE) or a North Carolina Licensed Geologist (LG).

Final boring logs were prepared and stratified in general accordance with the Unified Soil Classification System (USCS) as described by ASTM D2487. The strata contact lines represent approximate boundaries between the soil types; the actual transition between the soil types in the field may be gradual in both the horizontal and vertical directions. Boring logs are presented in **Appendix A** of this report.

3.0 Subsurface Data

3.1 Geotechnical Data

The information contained within this section of the report summarizes the subsurface conditions encountered in the HDR exploration.

Artificial fills consisting of layers of sandy silty and clay (ML, CL, CH) and silty gravel (GM) were encountered at most boring locations near the ground surface and extend to depths ranging from approximately 3 to 14 feet. SPT N-values within artificial fills range from 3 to 29 blows per foot. Artificial fills appear dry to moist.

Residual soils were encountered below artificial fills in all borings to depths ranging from approximately 10 to 20 feet. These soils consist primarily of silty sands (SM) and silts (ML). SPT N-values within residual soils ranged from 4 to 44 blows per foot. Residual soils appeared dry to saturated.

Weathered rock (WR) was encountered at borings B-3 and B-4 below residual soils and extended to boring termination depths ranging from approximately 14 to 19 feet.

The subsurface soil stratification is generalized to highlight major subsurface stratification features and material classifications. Specific details concerning subsurface conditions and materials encountered at each test location may be obtained from the soil test boring logs. The depths of strata indicated in the boring logs represent approximate boundaries between soil types; however, the actual transition may be gradual.

3.2 Groundwater Measurements

Groundwater was encountered at a depth of approximately 18 feet in Boring B-8 at the time of drilling completion. In addition, wet and saturated soil samples were encountered between depths of approximately 14 and 20 feet in Boring B-9. The other borings were dry at the bottom. It should be noted that fluctuation in groundwater elevations should be expected throughout the year due to varying rainfall and temperature conditions, and perched groundwater should be expected above less permeable fine-grained materials and lenses of weathered rock overlying residual soil.

4.0 Engineering Evaluations and Recommendations

4.1 Shallow Foundations

Our field exploration results indicate that variable man-placed fills were encountered at or near the ground surface underlain by residual soils. Undercutting of variable man-placed fills at footing levels should be anticipated. In general, the proposed structures may be supported by conventional spread footings bearing on residual soils or properly placed and compacted structural fill provided our recommendations below are followed.

The spread footings may be designed using an allowable bearing pressures of 2,500 pounds per square foot (psf) without experiencing excessive settlements. Some additional measures may be required to reduce the impact of the settlements on the structures. These provisions may include additional reinforcement, flexible utility connections and other measures. Conventional shallow spread and/or continuous footings should be designed for minimum dimensions of 36 inches and should bear at least 18 inches below exterior finished grade. Continuous footings should be provided with nominal, continuous, longitudinal steel reinforcement for greater bending strength so they can span across small areas of loose or soft soils that may go undetected during construction.

Footing excavations should be inspected prior to concrete placement to assess that the exposed bearing materials are suitable for the design soil bearing pressure. If soft or loose soil pockets are encountered during footing excavations, then these materials should be removed and backfilled with compacted structural fill. In general, footings shall be undercut one footing width below the

bottom of the footing and extend ½ of a footing width on either side of the footing and mat foundations shall be undercut 18 inches below the bottom of the mat and extend a minimum of three feet beyond the foundation, at the direction of the Geotechnical Engineer. The undercut should be backfilled with properly placed and compacted structural fill.

4.2 Concrete Pads

Three concrete pads (12 feet wide and 28 feet long) will be constructed to support the at-grade self-contained waste and recycling compactors. The loads on the pad could be up to 40,000 pounds. If properly prepared, the concrete pads may be designed for a modulus of subgrade reaction of 80 pound per cubic inches (pci). In order to provide uniform subgrade reaction beneath any proposed concrete pads, we recommend that pads be underlain by a minimum of 4 inches of free-draining aggregate base course (ABC) or equivalent.

4.3 Retaining Wall Considerations

A retaining wall with a height of 5 to 6 feet is proposed to support Phase 2 Convenience Center. The retaining wall should be designed to resist earth pressures calculated from the soil parameters provided in Table 4-1 below. The material type selected from the table, for the design of the wall, should be based upon the materials that will be present within the influence zone of the wall (horizontal distance equal to 1.5 times the height of the wall).

Table 4-1 Soil Parameters for Retaining Wall

Soil Type	Approximate Soil Unit Weight (pcf)		Soil Angle of Internal Friction (degrees)	Coefficient of Sliding Friction	Earth Pressure Coefficient		
	γ Total	γ' effective			Active (K_a)	At-Rest (K_o)	Passive (K_p)
Structural Backfill	120	57.6	30	0.36	0.33	0.50	3.00
Existing Fill (Sandy Clay)	120	57.6	28	0.34	0.36	0.53	2.77
Stiff Residual Sandy Silt	120	57.6	30	0.36	0.33	0.50	3.00

Note: Earth pressure coefficients provided are based upon the angle of internal friction only and do not consider wall friction angle, slope of ground, surface loadings or other parameters.

The retaining wall should be protected by a suitable drainage system to intercept groundwater. The outside surface of the below grade walls should be covered with a waterproof membrane or mastic to a height equal to finished grade against the wall. A 4-inch diameter perforated pipe should be placed against the below grade walls and retaining walls and encased in a 2-foot thick layer of granular, free-draining material, surrounded by a properly graded filter medium and a geotextile fabric to prevent clogging by the infiltration of fine-grained soils. The drainage system should slope to allow for gravity drainage or tie into a collection system or outfall to direct water away from the foundation.

4.4 Pavement Considerations

Based upon the traffic information provided by the County, we understand that a roll off truck would utilize the access road 4 to 5 time a week. Following NCDOT "Pavement Design Procedure (2019)" and AASHTO guidelines (1993), we recommend the following Superpave bituminous pavement sections and full depth bituminous sections for heavy duty sections.

Typical Bituminous Pavement Section

2.5" Asphalt Surface Course (Type S9.5B)
3.5" Asphalt Intermediate Course (Type I-19.0C)
8" Compacted Aggregate Base Course (ABC)

Typical Full-Depth Bituminous Pavement Section

2.5" Asphalt Surface Course (Type S9.5B)
3.5" Asphalt Intermediate Course (Type I19.0C)
4" Asphalt Base Course (Type B25.0C)

The above sections represent minimum thicknesses for typical construction practices and as such periodic maintenance should be anticipated. All pavement materials and construction procedures should conform to NCDOT or appropriate county requirements. Positive drainage should be incorporated into all pavement designs.

4.5 Structural Fill Material

Existing non-highly plastic on-site soils may be used as structural fill provided these soils are free of organic material and within the specified optimum moisture contents. It should be noted that based upon current moisture levels, some the existing site soils are anticipated to be wetter than optimum moisture conditions. Therefore, fill placement and compaction efforts should be conducted in the drier months of the year and scarifying to sufficiently dry the soils should be anticipated. Any highly plastic soils (i.e. plasticity indices greater than 25) should not be used as structural fill within 3 feet of subgrade levels due to their shrink/swell potential. These soils may be used in non-structural or landscaped areas.

Off-site structural fill materials should be free of organic material, have low to medium plasticity (i.e. plasticity indices less than 25) and a particle size of less than 3 inches. Samples of proposed structural fill materials shall be tested for compliance with the above criteria prior to use on-site. All structural fill should be placed and compacted as described in the section below.

4.6 Slope Construction

Based upon the plans provided, cut and fill slopes are planned with slopes of 3H:1V or 4H:1V. The maximum height is anticipated to be on the order of 10 feet. These slopes are anticipated to be suitable for the proposed project provided the recommendations presented below are followed.

Prior to constructing fill slopes at the site, the site should be prepared in accordance with Section 4.7 of this report. Materials utilized in embankment fill slopes should be as specified in Section 4.5 of this report.

The subsurface conditions in cut slope areas are anticipated to consist of firm to stiff silts and clays and are anticipated to be stable. The proposed construction sequencing for the cut slope should be from top to bottom of existing grades, to avoid undermining existing slopes. Based upon our previous experience and the following site and fill placement recommendations, slope heights of 10 feet or less are anticipated to provide a minimum factor of safety of 1.3 or greater under static loadings conditions. Finished slopes shall be properly seeded or vegetated and maintained in accordance with NCDOT Specifications to reduce the potential for erosion.

4.7 Site Preparation and Earthwork

Initial site preparation should include the following:

- Stripping and grubbing of all organic material within proposed construction limits. Topsoil and rootmat on the order of 3 to 6 inches is anticipated.
- Subgrades in the structure areas and any areas designated to receive fill should be proofrolled to identify zones of instability. Proofrolling should be accomplished using a fully loaded tandem axle dump truck. Areas exhibiting instability should be evaluated by a geotechnical engineer or their qualified representative to determine extent of repair. Following proofrolling, the subgrade areas shall be compacted to a minimum depth of 6 inches in accordance with the criteria provided below.
- All undercut material, if warranted by the geotechnical engineer, should be replaced with structural fill compacted to at least 95 percent of the soil's maximum dry density as determined by the Standard Proctor method, ASTM D-698.

Following above site preparation recommendations, all structural fill and backfilled material should be placed in loose eight-inch lifts and compacted to 95 percent of Standard Proctor dry density at (±) 3 percent of optimum moisture conditions as determined by ASTM D-698, except the top 8 inches of the proposed subgrade which should be compacted to 100 percent of maximum density. Field density tests should be performed on each lift of fill placed to verify compliance with compaction specifications. Existing on-site soils may be reused as structural fill provided these soils are free of organic material, debris, and are not highly plastic.

4.8 Temporary Excavation and Support

Temporary excavations are anticipated for the construction of the foundations and utilities at the site. All excavations deeper than four feet must conform to applicable sections of the Construction Industry Occupational Safety and Health Administration (OSHA) Standards (29CFR1926). In general, compliance will require either sloping back excavations or the use of temporary shoring. If sloping of the excavations is used, slopes should be no steeper than 2:1 (H:V) as discussed below. The referenced (OSHA) standard should be reviewed for requirements regarding use of sloping. It is the Contractor's responsibility to design and construct stable, temporary excavations as part of their safety procedure in accordance with local, state, and federal safety regulations.

HDR does not assume responsibility for construction safety or the contractor's or other party's compliance with applicable safety or other regulations.

Provided sufficient separation from existing slopes or traffic exists, sloping of the temporary excavations may be performed as described above. Higher groundwater levels or standing water in the excavation may result in unstable slopes.

In areas where sufficient separation from existing slopes or traffic does not exist, shoring and/or bracing will be necessary. Based upon the results of the test borings, it is anticipated that the site soils may be retained utilizing conventional shoring techniques such as sheet piles, timber pile and lagging walls or soil nail walls. The shoring should be designed to resist lateral earth pressures from the existing soils and include hydrostatic pressure to account for rises in groundwater levels and/or water infiltrating the retained soils. Once plans are available, HDR should be consulted to review the temporary excavations and shoring designs to ensure they are consistent with the recommendations presented in our report.

Excavated soils may be used as backfill provided these soils are free of organic material and within the specified optimum moisture contents. All backfill should be placed and compacted as described above.

In addition, it should also be noted that site grades should be designed to provide positive surface drainage away from the proposed excavation.

4.9 Groundwater Control and Dewatering

Groundwater was encountered at a depth of approximately 18 feet in some areas during the time of our exploration. However, fluctuation in groundwater elevations should be expected throughout the year due to varying rainfall and temperature conditions.

If encountered during construction, water levels should be maintained at a minimum of 1 foot below the bottom of any proposed excavation. A gravity drainage system, sump pump, or other conventional dewatering procedures may be used for groundwater control. We recommend that the contractor be required to design and submit a plan to collect and remove the groundwater prior to excavation.

5.0 Limitations

This report has been prepared for the exclusive use of Harnett County in accordance with generally accepted engineering practice for specific application to this project. Any construction recommendations, wetland, environmental, or contaminant assessment efforts are beyond the scope of this geotechnical exploration; and therefore, those issues are not addressed in this report. No other warranty, expressed or implied, is made. These interpretations and conclusions do not reflect variations in subsurface conditions that could exist intermediate of the test locations or in unexplored areas of the project site. Should such variations become apparent during construction, HDR reserves the right to re-evaluate these interpretations and conclusions based

upon observations of the conditions. In the event changes are made in the proposed construction plans, the information presented in this report shall not be considered valid unless reviewed by HDR and conclusions of this report modified or verified in writing.

APPENDIX A: Subsurface Exploration Data

MASON JAMMY SCOTT & MASON SHARON PEARCE
PARCEL ID 050634 0019 03
ZONING: RA-30
ZONING JURISDICTION: HARNETT COUNTY
28.07 ACRES

N

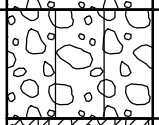
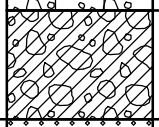
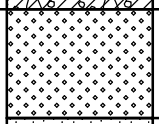
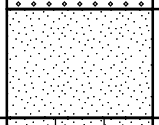
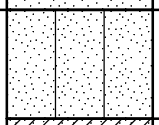
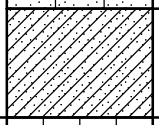
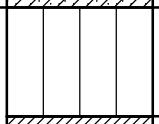
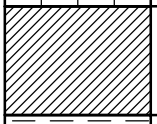
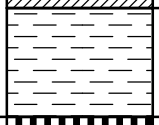
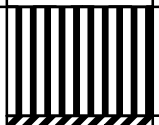
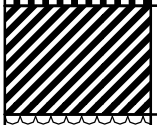
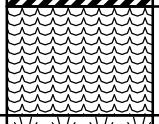
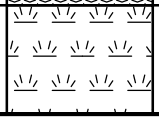
FUTURE CELL TOWER
140' FALL ZONE
PROPOSED (7) NUTTAL OAK, 2" CALIBER
LINE BASIN SLOPES WITH EROSION CONTROL BLANKET
PROPOSED LIMIT OF CLEARING
Phase 1 Swale
FUTURE STORAGE/PUBLIC RESTROOM (40' X 40')
Phase 3 Paved Parking and Storage Bldg
LINE CHANNEL WITH SEDIMENT TUBES SPACED EVERY 50 FT
STORMWATER MANAGEMENT AREA
24" CURB & 6" GUTTER
6' SIDEWALK W/ 5' TYPE C BUFFER STRIP
STORMWATER CONVEYANCE CHANNEL
FUTURE MULTI-USE FIELD
FUTURE PLAYGROUND (100' X 100')
Phase 2 Pond
Phase 1 Convenience Center on Gravel Pad
(2) 2X2 DROP INLET
RIM: 352.5
24" Ø RCP
INV IN: 350.0
PROPERTY LINE
GRAVEL MAINTENANCE/ACCESS ROAD
50-F00T VEGETATIVE BUFFER
PROPOSED HYDRANT
Phase 1 Access Driveway
Phase 1 Pond
24" CURB & 6" GUTTER
6X6 OUTLET STRUCTURE
RIM: 319
36" Ø RCP OUTLET
INV IN: 315.0
INV OUT: 312.0
(SEE SHEET 00C-06 FOR ORIFICE INVERTS)
DROP INLET
RIM: 349.5
24" Ø RCP
INV IN: 348.0
STORMWATER CONVEYANCE PIPE
PROPOSED 24" RCP CULVERT
STORMWATER CONVEYANCE CHANNEL
100 SF PREFABRICATED ATTENDANT BUILDING
PROPOSED 6-INCH WATER LINE
SOLID WASTE CONVENIENCE CENTER
PROPOSED LEVEL SPREADER
FUTURE WALKING TRAILS AND EXERCISE STATIONS
Phase 2 Convenience Center
SILT FENCE
CHECK DAM
TAPPING SLEEVE AND VALVE ASSEMBLY
PROPOSED HYDRANT
EXISTING 6-INCH WATER MAIN
PROPOSED 24" RCP CULVERT TO CONVEY EXISTING ROADSIDE SWALE TO THE SOUTH
PROPOSED UNDERGROUND ELECTRIC SERVICE
NCSR #1427 REVELS ROAD (60' PUBLIC ROW)
NCSR #1418 OAKRIDGE RIVER ROAD (60' PUBLIC ROW)
TYP. 50' BUFFER
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
50'
0 1" 2"

			PROJECT MANAGER	J. MURRAY, P.E.
			DRAWN BY	J. RAYMOND
A	06/05/2019	SUBMITTED TO HARNETT PLANNING DEPARTMENT	PROJECT NUMBER	10168206
ISSUE	DATE	DESCRIPTION		

HARNETT COUNTY NORTHWEST CONVENIENCE CENTER AND PARK SITE PLAN APPLICATION

Boring Location Plan

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

KEY TO SOIL CLASSIFICATION

Correlation of Penetration Resistance with Relative Density and Consistency

Sands and Gravels

No. of Blows, N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
Over 50	Very dense

Silts and Clays

No. of Blows, N	Relative Density
0 - 2	Very soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very stiff
31 - 50	Hard
Over 50	Very hard

Particle Size Identification (Unified Classification System)

Boulders:	Diameter exceeds 8 inches
Cobbles:	3 to 8 inches diameter
Gravel:	**Coarse** - 3/4 to 3 inches diameter **Fine** - 4.76 mm to 3/4 inch diameter
Sand:	**Coarse** - 2.0 mm to 4.76 mm diameter **Medium** - 0.42 mm to 2.0 mm diameter **Fine** - 0.074 mm to 0.42 mm diameter
Silt and Clay:	Less than 0.07 mm (particles cannot be seen with naked eye)

Modifiers

The modifiers provide our estimate of the amount of silt, clay or sand size particles in the soil sample.

Approximate Content	Modifiers
≤ 5%:	Trace
5% to 12%:	Slightly silty, slightly clayey, slightly sandy
12% to 30%:	Silty, clayey, sandy
30% to 50%:	Very silty, very clayey, very sandy

Field Moisture Description	
Saturated:	Usually liquid; very wet, usually from below the groundwater table
Wet:	Semisolid; requires drying to attain optimum moisture
Moist:	Solid; at or near optimum moisture
Dry:	Requires additional water to attain optimum moisture

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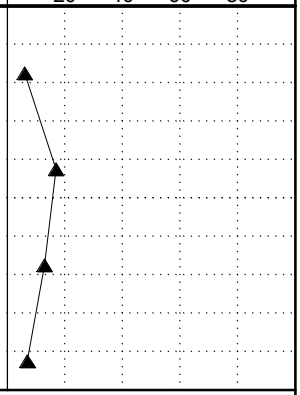
BORING NUMBER B-1

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/29/21 **COMPLETED** 11/29/21
GROUND ELEVATION 359 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Orange, tan, and white, firm to very stiff, sandy SILT (ML) with quartz, micaceous, dry to moist (RES)					
			SS 1		2-3-3 (6)		
			SS 2		4-7-10 (17)		
5			SS 3		2-6-7 (13)		
			SS 4		2-3-4 (7)		
10		Bottom of borehole at 10.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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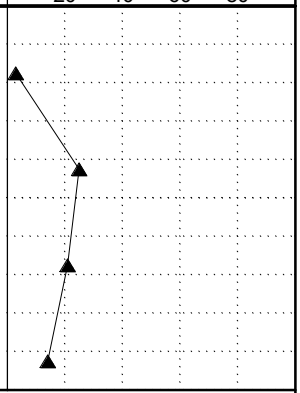
BORING NUMBER B-2

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/29/21 **COMPLETED** 11/29/21
GROUND ELEVATION 358 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Brown, soft, sandy CLAY (CH), moist (FILL)	SS 1		2-2-1 (3)		
5		Brown, red, and tan, very stiff, sandy CLAY (CL) with gravel, moist	SS 2		6-12-13 (25)		
			SS 3		9-9-12 (21)		
10		Brown, tan, and white, stiff, sandy SILT (ML), slightly micaceous, moist (RES)	SS 4		5-6-8 (14)		

Bottom of borehole at 10.0 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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BORING NUMBER B-3

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/30/21 **COMPLETED** 11/30/21
GROUND ELEVATION 344 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Brown, orange, and red, stiff to very stiff , sandy CLAY (CL), micaceous, dry to moist (FILL)	SS 1		7-10-5 (15)		
			SS 2		18-9-13 (22)		
5			SS 3		6-8-9 (17)		
		Tan, brown, and white, hard, sandy SILT (ML), slightly micaceous, moist (RES)	SS 4		11-13-31 (44)		
10							
		Tan, white, and gray, GNEISS (WR)	SS 5		33-24-50/3"		

Bottom of borehole at 14.1 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

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BORING NUMBER B-4

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/30/21 **COMPLETED** 11/30/21
GROUND ELEVATION 344 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Red and brown, very stiff, sandy CLAY (CL), moist (FILL)	SS 1		3-7-11 (18)		
			SS 2		7-7-13 (20)		
5		Tan, red, and gray, very stiff to hard, sandy SILT (ML), slightly micaceous, dry to moist (RES)	SS 3		5-8-10 (18)		
			SS 4		10-11-13 (24)		
10							
			SS 5		10-14-17 (31)		
15							
		Tan, red, and white, GNEISS (WR)	SS 6		14-50/2"		

Bottom of borehole at 19.2 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

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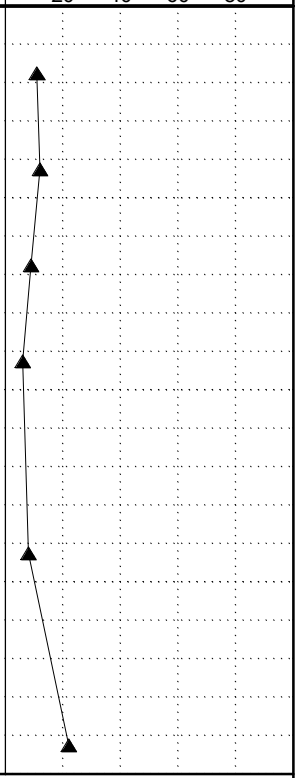
BORING NUMBER B-5

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/29/21 **COMPLETED** 11/29/21
GROUND ELEVATION 352 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Dark brown and orange, stiff, sandy CLAY (CL) with gravel, moist (FILL)	SS 1		2-5-6 (11)		
			SS 2		5-5-7 (12)		
5		Orange, tan, and purple, firm to very stiff, sandy SILT (ML), micaceous, dry to moist (RES)	SS 3		3-4-5 (9)		
			SS 4		3-2-4 (6)		
10							
			SS 5		2-2-6 (8)		
15							
			SS 6		5-9-13 (22)		
20		Bottom of borehole at 20.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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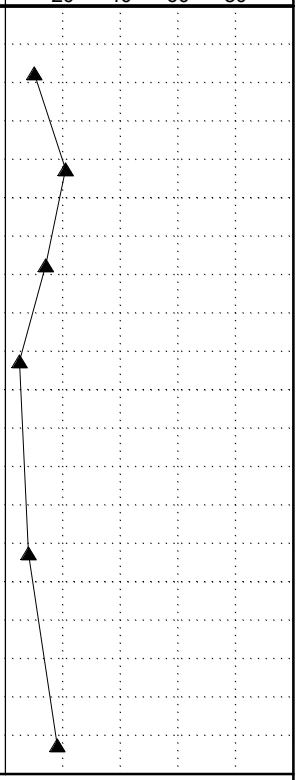
BORING NUMBER B-6

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/29/21 **COMPLETED** 11/29/21
GROUND ELEVATION 358 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Brown and tan, stiff, sandy CLAY (CL), moist (FILL)	SS 1		3-5-5 (10)		
		Tan, brown, and orange, medium dense, silty GRAVEL (GM), moist	SS 2		14-11-10 (21)		
5		Gray, tan, and purple, firm to very stiff, sandy SILT (ML), slightly micaceous, dry to moist (RES)	SS 3		6-7-7 (14)		
			SS 4		2-3-2 (5)		
10							
			SS 5		2-4-4 (8)		
15							
			SS 6		2-8-10 (18)		
20							

Bottom of borehole at 20.0 feet.



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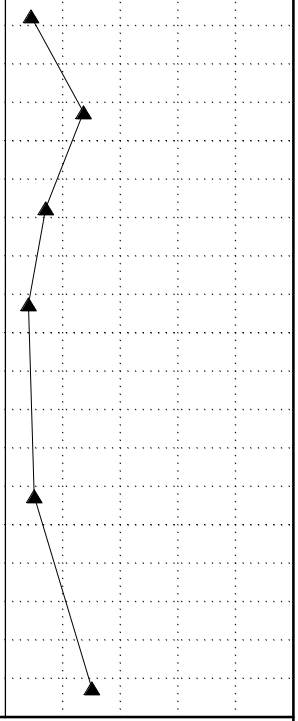
BORING NUMBER B-7

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/30/21 **COMPLETED** 11/30/21
GROUND ELEVATION 348 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Dark brown, stiff, sandy SILT (ML) with gravel, moist (FILL)	SS 1		1-4-5 (9)		
		Red and brown, very stiff, sandy CLAY (CL), moist	SS 2		6-11-16 (27)		
5							
		Tan, orange, and gray, firm to very stiff, sandy SILT (ML), micaceous, dry to moist (RES)	SS 3		4-7-7 (14)		
			SS 4		4-4-4 (8)		
10							
			SS 5		4-4-6 (10)		
15							
			SS 6		3-6-24 (30)		
20		Bottom of borehole at 20.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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BORING NUMBER B-8

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/30/21 **COMPLETED** 11/30/21
GROUND ELEVATION 316 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING 18.00 ft / Elev 298.00 ft
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Dark brown, soft, sandy SILT (ML), moist (FILL)	SS 1		1-1-2 (3)		
		Brown, red, and orange, stiff, sandy CLAY (CL), moist	SS 2		3-4-5 (9)		
5		Red, tan, and black, firm, sandy SILT (ML), micaceous, moist (RES)	SS 3		2-3-5 (8)		
			SS 4		3-3-3 (6)		
10		Light gray, dark gray, and tan, loose, silty SAND (SM), micaceous, wet to saturated					
			SS 5		2-3-4 (7)		
15							
			SS 6		2-2-4 (6)		
20		Bottom of borehole at 20.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

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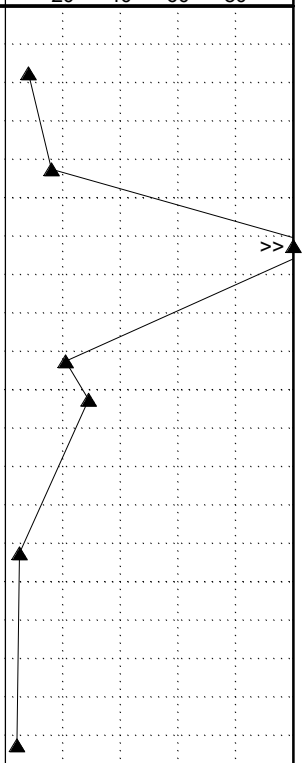
BORING NUMBER B-9

CLIENT City of Raleigh
PROJECT NAME Harnett County NW CC
PROJECT NUMBER 10329306
PROJECT LOCATION
DATE STARTED 11/30/21 **COMPLETED** 11/30/21
GROUND ELEVATION 316 ft **HOLE SIZE** 3 1/4" inches
Catlin CONTRACTOR Catlin
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING
LOGGED BY A. McGrew **CHECKED BY** P. Zhang
AT END OF DRILLING Dry
Coordinates
AFTER DRILLING Backfill

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Dark brown, tan, and orange, firm, sandy SILT (ML) with clay seams, moist (FILL)	SS 1		1-3-5 (8)		
		Red and brown, very still to hard, sandy CLAY (CL) with quartz and boulders, moist	SS 2		3-7-9 (16)		
5			SS 3		6-50/0"		
			SS 4		2-7-14 (21)		
10		Auger refusal at 9 ft due to boulders. Boring offset 5 feet.	SS 5		12-13-16 (29)		
		Gray and tan, firm to soft, sandy SILT (ML), micaceous, wet to saturated (RES)	SS 6		2-2-3 (5)		
15							
			SS 7		2-2-2 (4)		
20							

Bottom of borehole at 20.0 feet.

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



ROY COOPER
Governor
ELIZABETH S. BISER
Secretary
DOUGLAS R. ANSEL
Interim Director

NORTH CAROLINA
Environmental Quality

January 19, 2023

LETTER OF APPROVAL WITH MODIFICATIONS

Harnett County
Attn: Chad C. Beane, Solid Waste Director
P.O. Box 759
Lillington, NC 27546

RE: Project Name: Northwest Convenience Center
Acres Approved: 7
Project ID: HARNE-2023-070
County: Harnett City: Fuquay-Varina, Address: 1971 Oakridge river Road
River Basin: Cape Fear
Stream Classification: HQW
Submitted By: HDR, Inc.
Date Received by LQS: December 20, 2022
Plan Type: New

Dear Mr. Beane:

This office has reviewed the subject erosion and sedimentation control plan and hereby issues this Letter of Approval. This plan approval shall expire three (3) years following the date of approval, if no land-disturbing activity has been undertaken, as is required by Title 15A NCAC 4B .0129. Should the plan not perform adequately, a revised plan will be required (G.S. 113A-54.1)(b).

As of April 1, 2019, all new construction activities are required to complete and submit an electronic Notice of Intent (eNOI) form requesting a Certificate of Coverage (COC) under the NCG010000 Construction General Permit. After the form is reviewed and found to be complete, you will receive a link with payment instructions for the $100 annual permit fee. After the fee is processed, you will receive the COC via email. As the Financially Responsible Party shown on the FRO form submitted for this project, you MUST obtain the COC prior to commencement of any land disturbing activity. The eNOI form may be accessed at deq.nc.gov/NCG01. Please direct questions about the NOI form or Paul Clark at Paul.clark@ncdenr.gov. After you submit a complete and correct NOI Form, a COC will be emailed to you within **three business days**. A $100 fee will be charged annually until a Notice of Termination is issued. This fee is to be sent to the DEMLR Stormwater Central Office staff in Raleigh. If the owner/operator of this project changes in the future, the new responsible party must obtain a new COC.

Title 15A NCAC 4B .0118(a) and the NCG01 permit require that the following documentation be kept on file at the job site:

1. The approved E&SC plan as well as any approved deviation.

2. The NCG01 permit and the COC, once it is received.
3. Records of inspections made during the previous 12 months.

Also, this letter gives the notice required by G.S. 113A-61.1(a) of our right of periodic inspection to ensure compliance with the approved plan.

Title 15A NCAC 4B .0118(a) requires that a copy of the approved erosion control plan be on file at the job site. Also, this letter gives the notice required by G.S. 113A-61.1(a) of our right of periodic inspection to ensure compliance with the approved plan.

North Carolina's Sedimentation Pollution Control Act is performance-oriented, requiring protection of existing natural resources and adjoining properties. If, following the commencement of this project, it is determined that the erosion and sedimentation control plan is inadequate to meet the requirements of the Sedimentation Pollution Control Act of 1973 (North Carolina General Statute 113A-51 through 66), this office may require revisions to the plan and implementation of the revisions to ensure compliance with the Act.

Acceptance and approval of this plan is conditioned upon your compliance with Federal and State water quality laws, regulations, and rules. In addition, local city or county ordinances or rules may also apply to this land-disturbing activity. This approval does not supersede any other permit or approval.

Please note that this approval is based in part on the accuracy of the information provided in the Financial Responsibility Form, which you provided. You are requested to file an amended form if there is any change in the information included on the form. This permit allows for a land-disturbance, as called for on the application plan, not to exceed the approved acres. Exceeding the acreage will be a violation of this permit and would require a revised plan and additional application fee. In addition, it would be helpful if you notify this office of the proposed starting date for this project.

Your cooperation is appreciated.

Sincerely,

Jodi Pace

Jodi Pace, EI
Regional Engineering Associate
DEMLR

Enclosures: Certificate of Approval
Modifications Required for Approval
NPDES NCG01 Fact Sheet

cc: Jeffrey Murray, HDR, Inc. (electronic copy)
Jay Sikes, Building Inspector (electronic copy)
DEMLR - Fayetteville Regional Office File

MODIFICATIONS REQUIRED FOR APPROVAL

Project Name: NORTHWEST CONVENIENCE CENTER
Project Number: HARNE-2023-070
County: HARNETT

Provide two copies of the full-size sheets corresponding to the received in the NCDENR office and addressing the above comment, prior to the beginning of land disturbing activities. This is to include all the calculations.

Ref: G.S. 113A-54.1 through G.S. 113A-57
Sections 15A NCAC 04A.0101 through 15A NCAC 04E.0504
General Permit NCG 010000 NPDES for Construction Activities

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