SECTION 02221

TRENCHING, BACKFILLING FOR UTILITIES

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Work included: Trench, backfill, and compact as specified herein and as needed for installation of underground utilities associated with the Work.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions and Sections in Division 1 of these Specifications.
2. Section 02721 - Sewers: Storm Drainage.

### 1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.

### 1.3 JOB CONDITIONS

A. Existing utilities:

1. There now exists in the construction areas, waterworks, storm drainage, sanitary sewers, street paving, gas mains, power, telecommunications and other utilities.
2. Approximate location of certain underground lines and structures are shown on the plans for information only, other underground lines or structures are not shown.
3. Locate these and other possible unknown utility lines using electronic pipe finder, or other approved means.
4. Locate, excavate and expose all existing underground lines in advance of trenching operations.
5. The Contractor will be held responsible for the workmanlike repair of any damage done to any of these utilities in the execution of his work under this Section.
6. The Contractor shall familiarize himself with the existing conditions and be prepared to adequately care for and safeguard himself and the Owner from damage.

B. Notification of intent to excavate:

1. South Carolina Underground Utility Damage Prevention Act (S.C. Code Ann, 58-35-10, CT-SEQ, Supp. 1978) requires persons to ascertain the location of underground public utility property prior to excavation or demolition in certain situations. The Act also requires such persons to give timely notice of intent to excavate or demolish prior to commencing such operations. Failure to comply could subject the violator to a civil penalty of up to one thousand dollars ($1,000) for each violation of the Act.

2. Notification of intent to excavate may be given by calling this toll free number: 1-888-721-7877.
3. Notify Owner so that their privately owned utilities may also be located prior to construction.

C. Protecting trees, shrubbery and lawns:

1. Trees and shrubbery in developed areas and along the trench line shall not be disturbed unless absolutely necessary, and subject to the approval of the Engineer.
   a. Any such trees and shrubbery necessary to be removed shall be heeled in and replanted.
2. Where trenches cross private property through established lawns, sod shall be cut, removed, stacked and maintained in suitable condition until replacement is approved by the Engineer.
   a. Topsoil underlying lawn areas shall be removed and kept separate from general excavated materials.

D. Clearing:

1. Perform all clearing necessary for installation of the complete work.
2. Clearing shall consist of removing all trees, stumps, roots, brush and debris in the rights-of-way obtained for the Work.
3. All timber of merchantable size shall remain the property of the Owner and shall be trimmed and cut in such lengths as directed and stacked along the edge of the right-of-way.
4. All other material, including trimmings from above, shall be completely disposed of in a satisfactory manner.

E. Removing and resetting fences:

1. Where existing fences must be removed to permit construction of utilities:
   a. Remove such fences and, as the Work progresses, reset the fences in their original location and condition.
   b. Provide temporary fencing or other safeguards as required to prevent stock and cattle from wandering to other lands.

F. Restoration of disturbed areas:

1. Restore all areas disturbed by, during or as a result of construction activities to their existing or better condition.
   a. For existing areas with sod type grasses, replace with new sod. Existing sod may be reused where properly removed and stored.
2. Do not interpret this as requiring replacement of trees and undergrowth in undeveloped sections of the rights-of-way.

G. Minimizing silting and bank erosion during construction:

1. During construction, protective measures shall be taken and maintained to minimize silting and bank erosion of creeks and rivers adjacent to the work being performed during construction.

2. Sack breakers are to be used on steep slopes along creek banks and fill slopes to prevent washing of ditch. Sack breakers are to be placed at the direction of the Engineer.

H. Blasting (Only if previously approved in writing by Owner and all Federal, State and/or Local Agencies):

1. Store all explosives in a secure manner, complying with all laws, ordinances, and regulations.
2. Contractor shall be responsible for damage caused by blasting operations.

## PART 2 - PRODUCTS

### 2.1 EXCAVATED MATERIALS

A. Perform all excavation of every description and of whatever substances encountered to depths indicated or specified.

B. Pile material suitable for backfilling in an orderly manner at safe distance from banks or trenches to avoid overloading and to prevent slides or cave-ins.

C. Remove and deposit unsuitable or excess materials as directed by the Engineer.

### 2.2 BACKFILL MATERIALS

A. Provide from materials excavated for installation of utility.

1. Select soil material free from organic matter and deleterious substances, containing no rocks or lumps over 2" in greatest dimension for backfill up to 12" above top of utility being covered.
2. Do not permit rocks larger than 2" in greatest dimension in top 6" of backfill.

### 2.3 OTHER MATERIALS

A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

B. Should the quantity of suitable on-site material be insufficient to complete the work, provide suitable borrow material as approved by the Engineer at no additional expense to the Owner.

C. Provide select materials from on-site if acceptable material as approved by the Engineer is available on-site. Otherwise, provide approved select material from an off-site source at no additional expense to the Owner.

## PART 3 - EXECUTION

### 3.1 PROCEDURES

A. Existing utilities:

1. Unless shown to be removed, protect active utility lines shown on the drawings or otherwise made known to the Contractor prior to trenching. If damaged, repair or replace at no additional cost to the Owner.
2. If active utility lines are encountered and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.

4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Engineer and secure his instructions.
5. Do not proceed with permanent relocation of utilities until written instructions are received from the Engineer.

B. Locations within streets or highways:

1. Comply with South Carolina Department of Transportation's (SCDOT) "Encroachment Permit" issued for the Work, and the South Carolina Department of Transportation's (SCDOT) "*A Policy for Accommodating Utilities on Highway Rights-of-Way*".
2. Take all precautions and comply with all requirements as may be necessary to protect the improvements, including barricades for protection of traffic.
3. Keep minimum of one lane open to traffic at all times where utility crosses street or highway.

C. Protection of persons and property:

1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access.
2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout and other hazards created by operations under this Section.

D. Dewatering:

1. Remove all surface and subsurface waters from excavations and maintain the excavation in a dry condition during construction operations.
2. Maintain the ground water level a minimum of 3-feet below the trench bottom during excavation, installation and backfilling.
   a. Material disturbed below the invert elevation due to improper dewatering shall be removed and replaced with crushed stone or lean concrete at no expense to the Owner.
   b. Use sumps, pumps, drains, trenching, wells, vacuum or well point system as necessary to maintain the ground water level a minimum of 3-feet below the trench bottom and maintain a dry excavation.
   c. Dewatering by trench pumping will not be permitted if migration of fine grained natural material (running sand) from bottom, side walls or bedding material will occur.
   d. Provide monitoring wells sufficient in size, location, number and depth to monitor the ground water level in the construction area during excavation and backfill operations.
   e. Maintain dewatering operations until backfilling and compaction operations are complete.
3. Dispose of water pumped from excavations in storm drains having capacity, canals, trenches or other approved locations.
   a. Contractor is responsible for acquiring all permits required to discharge the water and shall protect waterways from turbidity during the operation.
   b. Prevent flooding of streets, roadways, or private property.
   c. Provide engines driving dewatering pumps with residential type mufflers.

E. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site.

F. Maintain access to adjacent areas at all times.

3.2 TRENCH EXCAVATION (Unclassified)

A. Remove all materials of whatever substance encountered.

B. Where trenching occurs in existing lawns, remove turf in sections and keep damp. Replace turf upon completion of the backfilling.

C. Open cut:

1. Excavate for utilities by open cut.
2. If conditions at the site prevent such open cut, and if approved by the Engineer, tunneling may be used.
3. Short sections of a trench may be tunneled if, in the opinion of the Engineer, the conductor can be installed safely and backfill can be compacted properly into such tunnel.
4. Remove boulders and other interfering objects, and backfill voids left by such removals, at no additional cost to the Owner.
5. Remove wet or otherwise unstable soil incapable of properly supporting the utility, as determined by the Engineer, to depth required and backfill to proper grade with stone bedding material, at no additional cost to the Owner.
6. Excavating for appurtenances:
   a. Excavate for manholes and similar structures to a distance sufficient to leave at least 12" clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.
   b. Overdepth excavation beyond such appurtenances that has not been directed will be considered unauthorized. Fill with sand, gravel, or lean concrete as directed by the Engineer, and at no additional cost to the Owner.

D. Trench to the minimum width necessary for proper installation of the utility, with sides as nearly vertical as possible. Accurately grade the bottom to provide uniform bearing for the utility.

E. Provide sheeting and shoring necessary for protection of the Work and for the safety of personnel.

1. Remove in units when level of backfilling has reached the elevation necessary to protect the utility work and adjacent property.
2. Sheeting at the bottom of trenches over 10' deep for sewers 15" and larger in size, shall remain in place and be cut off no less than 2" above top of pipe, at no additional cost to the Owner.

F. Depressions:

1. Dig bell holes and depressions for joints after the trench has been graded. Provide uniform bearing for the pipe on prepared bottom of the trench.
2. Except where rock is encountered, do not excavate below the depth indicated or specified.
3. Where rock is encountered, excavate rock to a minimum overdepth of 4" below the trench depth indicated or specified, and to provide 6" clearance in any horizontal direction from all parts of the utility and appurtenances.

G. Special requirements relating to excavation for specific types of utilities shall comply with the following:

1. Water distribution lines:
   a. Provide depth of cover shown or minimum cover of 36", whichever is greater.

b. Where minimum cover only is required, carry excavations to depths necessary to properly grade the pipe on tangents and vertical curves as directed by the Engineer.
c. Provide minimum clearance of 6" between pipe walls and trench walls or sheeting and bracing lines.
d. If minimum cover of 36" cannot be provided, then thermoplastic piping may not be used. Use ductile iron piping or other Engineer-approved material.

2. Sanitary or storm sewer lines:
a. Comply with requirements of Section 02722 and Section 02721.
b. Do not excavate trench more than 200' ahead of pipe laying, unless permitted by Engineer.
c. Maintain trench sides vertical to point not less than 2' above top of pipe.
d. Upper portion of trench may be sloped to any width which will not cause damage to adjoining structures, utilities, pavements or private property.

3. Sewers, Sanitary Pressure: (Force Main):
a. Comply with requirements of Section 02723.
b. Grade trenches to avoid high points, unless otherwise indicated.
c. Provide minimum cover of 36".
d. Provide minimum clearance of 6" between pipe walls and trench wall or sheeting and bracing lines.
e. If minimum cover of 36" cannot be provided, then thermoplastic piping may not be used. Use ductile iron piping or other Engineer-approved material.

4. Electrical conduit:
a. Provide depth of cover shown or minimum cover of 36", whichever is greater.
b. Where minimum cover only is required, carry excavations to depths necessary to properly grade the conduit on tangents and vertical curves as directed by the Engineer.
c. Provide minimum clearance of 12" between conduit and trench wall or sheeting and bracing lines.
d. If minimum cover of 36" cannot be provided, then thermoplastic piping may not be used. Use ductile iron piping or other Engineer-approved material.

5. Gas distribution lines:
a. Provide depth of cover shown or minimum cover of 48", whichever is greater.
b. Where lines are constructed in the rights-of-way of the South Carolina Department of Transportation, provide minimum cover of 48" below the elevation of the pavement.
c. Where minimum cover only is required, carry excavations to depths necessary to properly grade the pipe on tangents and vertical curves as directed by the Engineer.
d. Grade trenches to avoid high points.
e. Provide minimum clearance of 6" between pipe walls and trench walls or sheeting and bracing lines.

H. Comply with pertinent OSHA regulations in regards to the excavation of utilities.

3.3 BACKFILLING

A. General:

1. Backfill trenches and excavations immediately after the pipes are laid, unless other protection is directed or indicated.

2. Select and deposit backfill materials with special reference to the future safety of the pipes.
3. Reopen trenches which have been improperly backfilled, to a depth as required for proper compaction. Refill and compact as specified, or otherwise correct to the approval of the Engineer.
4. Surplus material shall be disposed of as directed by the Engineer.
5. Original surface shall be restored to the approval of the Engineer.
6. Maintain proper dewatering during backfill and compaction operations.

B. Lower portion of trench:

1. Deposit approved backfill and bedding material in layers of 6" maximum thickness, and compact with suitable tampers to the density of the adjacent soil until there is a cover of not less than 24" over sewers and 12" over other utility lines.
2. Take special care in backfilling and bedding operations not to damage pipe and pipe coatings.

C. Remainder of trench:

1. Except for special materials for pavements, backfill the remainder of the trench with material free from stones larger than 6" or 1/2 the layered thickness, whichever is smaller, in any dimension.
2. Deposit backfill material in layers not exceeding the thickness specified, and compact each layer to the minimum density directed by the soil engineer.

D. Adjacent to buildings: Mechanically compact backfill in 6" layers within ten (10') feet of buildings.

E. Under roads, streets and other paved areas:

1. Mechanically tamp in 6" layers using heavy duty pneumatic tampers or equal.
2. Tamp each layer to a density equivalent of not less than 100% of an ASTM D 698 Proctor Curve.
3. Provide additional compaction by leaving the backfilled trench open to traffic while maintaining the surface with crushed stone.
4. Refill any settlement with crushed stone and continue such maintenance until replacement of pavement is authorized by the Engineer.

F. Undeveloped areas:

1. Backfill in wooded, swampy or undeveloped areas shall be as specified hereinbefore, except that tamping of the backfill above a level 2' over the top of the pipe will not be required.
2. Mound excavated material neatly over the ditch to provide for future settlements.

3.4 MEASUREMENT AND PAYMENT

A. Unclassified excavation for trenching:

1. No measurement or direct payment will be made for the Work under this Section and all costs for same shall be included in the price bid for the utility line to which it pertains.

END OF SECTION

SECTION 02260

EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Provide protection of the environment during the construction of this project to reduce soil erosion and siltation to the lowest reasonably achievable level.

1.2 GENERAL

A. Exercise every reasonable precaution, throughout the life of the project, to prevent the eroding of soil and the silting of rivers, streams, lakes, reservoirs, other water impoundments, ground or roadway surfaces, or other property. Erosion control practices to be used for this project are shown on the drawings and are to conform to South Carolina Department of Health and Environmental Control regulations.

PART 2 - PRODUCTS

2.1 CRUSHED STONE

A. Provide #57 crushed stone for project entrance and exit.

B. Provide #57 crushed stone for temporary sediment barriers around inlets and for temporary stone check dams.

2.2 GRASSING

A. Comply with Section 02930 - Grassing.

2.3 SILT FENCE

A. All posts to be self-fastener angle steel, 5' in length.

1. Wooden posts are not acceptable.

B. Woven wire shall conform to the requirements of ASTM A 116, Class I zinc coating for wire. Each woven square shall measure 5.33" X 12". The top and bottom wires shall be 10 gauge. All other wires shall be 12-1/2 gauge.

1. Securely attach woven wire to posts with wire ties.

C. Filter fabric shall be Mirafi 600X synthetic fabric as manufactured by Celanese Fibers Co., Bidim C34 as manufactured by DuPont or approved equal.

1. Limit splices in filter fabric using continuous rolls whenever possible.
2. Whenever splices are necessary a minimum overlap of 6" is required and all splices must occur at a post so that the integrity of the fence is not compromised.
3. Securely attach filter fabric to top of woven wire and at posts with wire ties.

D. Silt fences should be continuous and transverse to the flow. The silt fence should follow the contours of the site as closely as possible. Place the fence such that the water cannot runoff around the end of the fence.

2.4 EROSION CONTROL BLANKET

A. Use erosion control blanket S150, from North American Green or approved equal.

1. Use Biostakes where staples are required or indicated on the drawings for stabilization.
   a. Staple in pattern recommended by blanket manufacturer.
2. Staple locations must be clearly marked on the blanket when stakes are used.

PART 3 - EXECUTION

3.1 GENERAL

A. Construct and maintain all erosion control measures until the substantial completion of the project.

3.2 TEMPORARY CONSTRUCTION ENTRANCE/EXIT

A. Construct a gravel area or pad at points where vehicles enter and leave a construction site.

B. Clear the entrance and exit area of all vegetation, roots, and other objectionable material and properly grade and place gravel to the grade and dimensions shown on the plans.

C. Construct drainage channels to carry water to a sediment trap or other suitable outlet.

D. Use geotextile fabrics to improve stability of the foundation in locations subject to seepage or high water table.

E. Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site by periodic top dressing with two inches of stone.

F. After each rainfall, inspect any structure used to trap sediment and clean it out as necessary.

G. Immediately remove objectionable materials spilled, washed, or tracked onto public roadways.

3.3 TEMPORARY GRASSING

A. Provide a temporary cover for erosion control on disturbed areas that will remain unstabilized for a period of more than 30 days in accordance with Section 02930.

B. This practice applies to cleared areas, diversions, dams, temporary sediment basins, temporary road banks, and topsoil stockpiles where vegetation is needed for less than 1 year.

C. Provide grassing on slope 5% or greater within 14 days of disturbance. Comply with Section 02930.

3.4 SILT FENCE

A. Provide silt fence barrier where shown on the plans and on utility construction parallel to the disturbed trench where perpendicular sheet flow runoff occurs on disturbed areas with slopes greater than 4%.

B. Place at the extreme limits of the area to be disturbed as shown.

C. Construct temporary sediment barriers of filter fabric, buried at the bottom, stretched and supported by posts and install below small disturbed areas as indicated on the drawings to retain sediment by reducing the flow velocity to allow sediment deposition.

D. Space posts 10'-0" on center, maximum or as indicated on the drawings.

E. Remove sediment deposits prior to reaching one-third height of the fence.

F. Monitor site frequently and place additional silt fencing should evidence indicate that erosion is about to occur at locations other than those shown on plan.

3.5 INLET PROTECTION

A. Construct temporary sediment barriers around storm drain curb inlets using block and gravel as indicated on the drawings.

B. Construct metal frame barriers around grate and frame of drop inlets as indicated on the drawings.

C. Sediment tubes may be used as an inlet protection method. This shall comply with current SCDHEC requirements.

D. Inspect structure after each rainfall and repair as required.

E. Remove sediment when trap reaches one-half capacity.

F. Repair any torn fabric or bent posts.

G. Remove structure when protected areas have been stabilized.

3.6 EROSION CONTROL BLANKET

A. Provide on areas as shown on the plans or on all embankments with slopes equal to or steeper than 2-1/2:1.

3.9 MAINTENANCE

A. Place all erosion control devices or measures prior to any land disturbing activity within the drainage area they are located.

B. Inspect erosion control devices and clean or otherwise remove silt buildup as necessary once a week or 24-hours following a rain event of $\geq$ 0.1".

3.10 REMOVAL

A. Remove temporary structures after protected areas have been stabilized.

## 3.11 MEASUREMENT AND PAYMENT

A. No separate measurement or direct payment will be made for the items under this Section and all costs for same shall be included in the price bid for the project.

END OF SECTION

SECTION 02510

STONE BASE COURSE

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Work included: Provide crushed stone base (with prime) constructed on the compacted subgrade where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
2. Section 02210 - Site Grading.
3. Section 02513 - Asphaltic Concrete Paving.

### 1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

### 1.3 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

B. Certificates, signed by materials producer, stating that materials meet the specified requirements.

### 1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

## PART 2 - PRODUCTS

### 2.1 COARSE AGGREGATE

A. Furnish a coarse aggregate (retained on No. 4 sieve) consisting of hard, durable particles of stone, reasonably free from soft, thin, elongated or laminated pieces and deleterious substances.

B. Furnish aggregate with an abrasion loss of less than 65% as measured by the Los Angeles Abrasion Test.

### 2.2 FINE AGGREGATE

A. Furnish a fine aggregate consisting of material produced by stone crushing operations.

B. Liquid limit shall not exceed 25 and the plasticity index shall not exceed 6 when tested in accordance with AASHTO T-89 and T-90, respectively.

2.3 COMPOSITE MIXTURE

A. Produce in one crushing operation or by blending the fine and coarse aggregate in proper proportions.

B. After the materials have been mixed, laid down, and initial compaction operations begun, the composite mixture shall conform to the following:

| Sieve Designation | Percent by Weight Passing |
|---|---|
| 2" | 100 |
| 1-1/2" | 95-100 |
| 1" | 70-100 |
| 1/2" | 48-75 |
| No. 4 | 30-50 |
| No. 30 | 11-30 |
| No. 200 | 0-12 |
| Liquid Limit | 25 max. |
| Plasticity Index | 6 max. |

2.4 PRIME ASPHALT

A. Use either MC-30, RC-30, RC-70, or EA-P complying with requirements of Sections 406, 407 and 408 of the South Carolina Department of Transportation specifications.

PART 3 - EXECUTION

3.1 PREPARATION OF SUBGRADE

A. Proofroll all areas to receive crushed stone paving.

1. Make not less than three passes over the full area, using a 35 to 50 ton rubber tired roller.

B. Remove all soft, unstable or unsuitable material that will not compact readily.

1. Remove to full depth of unsuitable material, or to a depth of 30", whichever is less.
2. Replace with satisfactory materials.

C. Fill all holes, ruts or depressions which develop in the subgrade with approved on-site material, bringing subgrade to indicated line and grades.

D. Compact subgrade using suitable construction procedures to provide not less than 95% Standard Proctor Maximum Dry Density.

E. Seal roll the subgrade surface with a steel wheel roller, sealing the surface against excessive water infiltration.

3.2 PLACING AND MIXING OF PAVING MATERIAL

A. Place aggregates using spreader boxes or other approved spreaders uniformly on one operation.

B. Take care to avoid segregation of the fine from the coarse aggregate during handling, spreading or shaping operations.

C. Mix, while at proper moisture, with motor grader or other equipment and maintain to required section and grade until thoroughly compacted.

3.3 ROLLING AND COMPACTING

A. Perform using 3-wheel steel wheel roller weighing not less than 10 tons, tandem roller weighing at least 8 tons, or other rollers approved by the Engineer.

B. Start rolling at edges and proceed toward the center, continue rolling until aggregates are firmly keyed or set.

C. When initial compaction is completed, should voids remain, place fine aggregates on the surface in an amount only sufficient to fill the voids.

D. Broom, wet and roll until coarse aggregate is set, bonded and thoroughly compacted for full width and depth.

3.4 ALLOWABLE TOLERANCES

A. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 1/2".

1. Depth measurements will be made by digging through the base at intervals no closer than 250', nor greater than 500' apart.
2. Where thickness is less than depth specified minus 1/2", it shall be corrected as directed by the Engineer.

B. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 3/8" in 10', parallel to the center line of the roadway nor more than 1/2" from a template conforming to the cross sections shown on the plans.

C. Deviations: Correct by removing materials, replacing with new materials, and reworking or recompacting as required.

3.5 PLACING PRIME COAT

A. Allow base course to season sufficiently to permit uniform penetration.

B. Do not apply to wet surfaces or when the temperature is below 60°F in the shade and falling, or below 55°F in the shade and rising.

C. Clean surfaces of all dust, dirt, clay, etc. using mechanical brooms, etc.

D. Apply prime material, using pneumatic mounted distributors, at a rate of 0.25 to 0.30 gallon per square yard.

E. Permit no traffic on primed surfaces until bituminous material has penetrated and dried sufficiently that it does not pick up under traffic.

3.6 MEASUREMENT AND PAYMENT

A. No separate measurement or direct payment will be made for this work and all costs for same shall be included in the price bid for the work to which it pertains.

END OF SECTION

SECTION 02513

ASPHALTIC CONCRETE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Provide asphaltic concrete paving where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
2. Section 02210 - Site Grading.
3. Section 02577 - Pavement Markings and Signage.
4. Section 02510 - Stone Base Course.
5. Section 02616 - Milling, Cutting and Replacing Asphalt Pavements.

1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.3 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

B. Product data: Within fifteen (15) calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

1. Materials list of items proposed to be provided under this Section.
2. Certificates, signed by the materials producer and the asphalt paving Subcontractor, stating that materials meet or exceed the specified requirements.

1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and products used shall comply with pertinent sections of the South Carolina Department of Transportation's (SCDOT) "Standard Specifications for Highway Construction" and latest revisions and supplements.

2.2 ASPHALTIC CONCRETE MIXTURE (BINDER COURSE)

A. Materials and composition of mixture shall comply with Section 402 of the SCDOT's "Standard Specifications for Highway Construction" and latest revisions and supplements.

B. Provide hot plant mixed asphaltic concrete paving materials.

1. Temperature leaving the plant: 290°F minimum, 320°F maximum.
2. Temperature at time of placing: 280°F minimum.

2.3 ASPHALTIC CONCRETE MIXTURE (SURFACE COURSE)

A. Materials and composition of mixture shall comply with Section 403 of the SCDOT's "Standard Specifications for Highway Construction" and latest revisions and supplements.

B. Provide hot plant mixed asphaltic concrete paving materials.

1. Temperature leaving the plant: 290°F minimum, 320°F maximum.
2. Temperature at time of placing: 280°F minimum.

2.4 EQUIPMENT

A. Comply with requirements of Section 401 of SCDOT's "Standard Specifications" and latest revisions and supplements.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

1. Sweep primed surfaces if needed.
2. Adjust frames and covers if needed.

3.2 WEATHER RESTRICTIONS

A. Do not apply asphalt mixtures to a wet or frozen surface or when air temperature is below 40°F in the shade and falling, or below 35°F in the shade and rising.

3.3 SPREADING AND FINISHING

A. On arrival at point of use, dump directly into mechanical spreader.

B. Immediately spread and strike off true to the line, grade and cross section indicated, to such loose depth that when work is completed, the indicated thickness or weight per square yard will be secured.

C. Correct irregularities while the mixture is still hot.

D. At locations not readily accessible to mechanical spreaders, acceptable hand spreading methods may be used.

E. Finished surfaces placed adjacent to curbs, gutters, manholes, etc., shall be approximately 1/4" above the edges of these structures.

3.4 COMPACTION

A. Perform initial rolling with 3-wheel steel roller or a steel wheel 2-axle tandem roller.

B. Follow initial rolling with at least four complete coverages by a pneumatic tired roller.

C. Complete rolling with steel wheel 2-axle tandem roller.

D. Rolling shall start longitudinally at the sides and proceed gradually toward the center of the pavement, overlapping on successive trips approximately 1/2 the width of the roller.

E. Use hand or mechanical tampers in areas not accessible to powered rollers.

F. Surface mixture after compaction shall be smooth and true to the established crown and grade.

G. Finished paving smoothness tolerance:

1. Free from birdbaths.
2. No deviations greater than 1/8" in 6'.

3.5 PROTECTION OF SURFACE

A. Allow no traffic on surface until the mixture has hardened sufficiently to prevent distortion.

3.6 FLOOD TEST

A. Flood the entire asphaltic concrete paved area with water by use of a tank truck or hoses.

B. If a depression is found where water ponds to a depth of more than 1/8" in 6', fill or otherwise correct to provide proper drainage.

C. Feather and smooth the edges of fill so that the joint between fill and original surface is invisible.

3.7 MEASUREMENT AND PAYMENT

A. No separate measurement or direct payment will be made for this work and all costs for same shall be included in the price bid for the project.

END OF SECTION

SECTION 02525

CONCRETE CURB AND GUTTER, AND SIDEWALK

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Work included: Provide cast-in-place concrete, including formwork, where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

### 1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Reference standards: Comply with the following codes, specifications and standards, except as otherwise shown or specified:

1. American Concrete Institute (ACI) Publications:
   - -- ACI 305 Recommended Practice for Hot Weather Concreting
   - -- ACI 306 Recommended Practice for Cold Weather Concreting
2. American Society for Testing and Materials (ASTM) Publications:
   - -- A 185 Welded Steel Wire Fabric for Concrete Reinforcement
   - -- C 31 Making and Curing Concrete Test Specimens in the Field
   - -- C 33 Concrete Aggregates
   - -- C 39-72 Compressive Strength of Cylindrical Concrete Specimens
   - -- C 94 Ready-Mixed Concrete
   - -- C 150 Portland Cement
   - -- C 260 Air-Entraining Admixtures for Concrete

C. Testing agency: A testing laboratory will be retained by the Owner to perform material evaluation tests required by these specifications.

D. Qualifications of contractors performing concrete work: Minimum of two (2) years experience on comparable concrete projects.

E. Plant qualification: Plant equipment and facilities shall meet all requirements of the Check List for Certification of Ready Mixed Concrete Production Facilities of the National Ready Mixed Concrete Association and ASTM C 94.

### 1.3 SUBMITTALS

A. Comply with the pertinent provisions of Section 01340.

B. Within 15 calendar days after receiving the Owner's Notice to Proceed, submit proposed mix designs for approval.

1. Proportions shall be determined by means of laboratory tests of concrete made with the cement and aggregate proposed for use.
2. Provide report in detail from an approved testing laboratory showing 7-day and 28-day strengths obtained using materials proposed.
3. Required average strength above specified strength:
   a. Determinations of required average strength above specified strength (f'c) shall be in accordance with ACI 318 and ACI 301.
4. Cost of this work shall be borne by the Contractor.

C. Manufacturer's data: Submit manufacturer's specification with application instructions for proprietary materials and items, including curing compound, form release agents, admixtures, patching compounds, and others as required by the Engineer.

1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

PART 2 - PRODUCTS

2.1 FORMS

A. Use form materials conforming to ACI 347.

B. Form coatings: Form release coating shall be neat oil with surface wetting agent or chemical release agent which effectively prevents absorption of moisture, prevents bonding with concrete, is non-staining to concrete and leaves the concrete with a paintable surface.

1. On surfaces to receive an applied coating, use a residual free chemical form release agent that is compatible with the applied coating and will not prevent the applied finish from satisfactorily bonding to the concrete.

2.2 SIDEWALK REINFORCEMENT

A. Fiber reinforcing:

1. Use fiber reinforcing where indicated on the drawings.
2. Provide polypropylene or co-polymer fibers as manufactured by High Tech Fibers, Inc., Fibermesh Company or an approved equal.
3. Where required, use fiber reinforcing at a rate of 2.0 lbs. per cubic yard unless another rate is indicated on the drawings.

B. Provide welded wire mesh for sidewalk reinforcement in compliance with ASTM A 185.

2.3 PREMOLDED JOINT FILLERS

A. In concrete pavements (exterior) and concrete sidewalks, use asphalt impregnated cellulose fiber joint fillers complying with ASTM D 1751.

2.4 CONCRETE MATERIALS

A. Cement: Use portland cement: ASTM C 150, Type I, Type I-P or Type II, low alkali.

B. Aggregates:

1. Fine aggregate: Conform to ASTM C 33.
2. Coarse aggregate: Conform to ASTM C 33, Size #57.

C. Water: Clean and potable and free from injurious amounts of deleterious materials.

D. Admixtures:

1. Air entraining admixture: ASTM C 260.
2. Water reducing, set controlling admixture: Conform to ASTM C 494.
   a. Type A - water reducing.
   b. Type D - water reducing and retarding.
3. Do not use admixtures containing calcium chloride.

E. Curing compounds:

1. On all vertical and formed surfaces and construction joints, use a non-residual, non-staining curing compound conforming to ASTM C 309 Type 1 and 1D. Acceptable products are:
   a. L&M Cure by L&M Construction Chemicals, Inc.
   b. Horn WB-75 by A.C. Horn Company.
   c. Sonosil by Sonneborn, Inc.
   d. Approved equal.

## 2.5 CONCRETE MIXES

A. Provide concrete with the compressive strength of 3000 psi for a 28-day strength as minimum:

B. Entrained air: 3000 psi concrete, 5% ±1%.

C. Slump: 3000 psi concrete, 4" ±1".

D. Production of concrete:

1. General: Concrete shall be ready mixed and shall be batched, mixed and transported in accordance with ASTM C 94 except as otherwise indicated.
2. Monitor time and mix proportions by plant delivery slips.
3. Air-entraining admixtures: Add air-entraining admixture into the mixture as a solution and measure by means of an approved mechanical dispensing device.
4. Water reducing and retarding admixture: Add water reducing and retarding admixture and measure as recommended by the manufacturer.
5. Addition of water to the mix upon arrival at the job site shall not exceed that necessary to compensate for a 1" loss in slump, nor shall the design maximum water-cement ratio be exceeded. Water shall not be added to the batch at any later time.
6. Weather conditions: Control temperature of mix as required by ACI 306 "Cold Weather Concreting" and by ACI 305 "Hot Weather Concreting".

## PART 3 - EXECUTION

### 3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

B. Water, mud, organic, and other detrimental material shall be removed from excavations before concrete is deposited.

C. Notify the Engineer prior to placing concrete and place no concrete until the formwork, reinforcing and embedded items have been inspected by the Engineer.

### 3.2 FORMWORK

A. General:

1. Construct forms in conformance with ACI 347.
2. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement.
3. Coat form contact surfaces with approved form coating compound prior to placing reinforcing steel.

B. Formwork reuse: Reuse only forms that are in good condition and which maintain a uniform surface texture on exposed concrete surfaces.

1. Apply a light sanding as necessary to obtain a uniform texture.

C. Removal of forms:

1. Do not disturb or remove forms until the concrete has hardened sufficiently to permit form removal with complete safety.
2. Exercise care in removing forms from finished concrete surfaces so that surfaces are not marred or gouged and that corners are true, sharp and unbroken.
3. Whenever the formwork is removed during the curing period, continue to cure the exposed concrete by one of the methods specified herein.

### 3.3 PLACING CONCRETE

A. Preparation:

1. Remove foreign matter accumulated in the forms.
2. Rigidly close openings left in the formwork.
3. Wet wood forms sufficiently to tighten up cracks. Wet other material sufficiently to maintain workability of the concrete.
4. Use only clean tools.
5. Provide and maintain sufficient tools and equipment on hand to facilitate uninterrupted placement of the concrete.
6. Before commencing concrete, inspect and complete installation of formwork and wire mesh.

B. Conveying:

1. Transport and handle concrete from the truck to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients to maintain the quality of the concrete.

2. Provide equipment for lifting, dumping, chuting, pumping or conveying the concrete, of such size and design as to ensure a practically continuous flow of concrete at the delivery and without separation of materials.
3. Do not use concrete that is not placed within 1½ hours after water is first introduced into the mix unless the slump is such that it meets the specified limits without the addition of water to the batch.

C. Placing:

1. Deposit concrete as nearly as practicable in its final location so as to avoid separation due to rehandling and flowing.
2. Place concrete at such a manner that concrete upon which fresh concrete is deposited is still plastic.

D. Hot weather placement: Place concrete in hot weather in accordance with ACI 305 "Hot Weather Concreting" and as specified herein.

1. Do not place concrete whose temperature exceeds 100°F.
2. Thoroughly wet forms and reinforcing prior to placement of concrete.
3. Use additional set retarder as necessary to increase set time.
4. Start curing as soon as the concrete is sufficiently hard to permit without damage.

E. Cold weather placement: Place concrete in cold weather in accordance with ACI 306 and as specified herein.

1. Do not place concrete when the atmospheric temperature is below 40°F.
2. Do not add salts, chemicals, or other materials to the concrete mix to lower the freezing point of the concrete.

F. Consolidation:

1. Consolidate each layer of concrete immediately after placing, by use of internal concrete vibrators supplemented by hand spading, rodding, or tamping.
   a. Use vibrators having a 2" head diameter and a minimum frequency of 8000 vibrations per second.
   b. Provide sufficient number of vibrators to properly consolidate the concrete, keeping up with placement operations.
   c. Provide at least one spare vibrator on site.
2. Insert and withdraw vibrators at points approximately 18" apart.
3. Do not vibrate forms.
4. Do not use vibrators to transport concrete inside the forms.

## 3.4 PROTECTION

A. Protect the surface finish of newly placed concrete from damage by rainwater or construction traffic.

B. Do not apply design loads to structures until the concrete has obtained the specified strength.

## 3.5 CURING

A. Beginning immediately after placement, protect concrete from premature drying, excessively hot and cold temperatures and mechanical injury.

B. Curing compound: Apply curing compound immediately after completion of the finish on uniformed surfaces and within two hours after removal of forms on formed surfaces.

1. Spray the entire surface with two coats of liquid curing compound, applying the second coat in the direction of 90° to the first coat.
2. Apply compound in accordance with the manufacturer's instructions to cover the surface with a uniform film that will seal thoroughly.

## 3.6 CONCRETE FINISHING

A. Finish schedule: Unless otherwise indicated on the drawings, finish all concrete surfaces in accordance with the following schedule:

1. Form finish: Formed surfaces not ordinarily exposed to view, including the underside of slabs not exposed to view.
2. Broom finish: Exterior, outdoor slabs exposed to view including:
   a. Outdoor floor slabs and walkways.
   b. Other floors which may become wet or otherwise require a non-skid surface.
   c. Sidewalks and concrete pavements.
3. Edge finish: Exposed edges of slabs not receiving chamfer including:
   a. Sidewalk edges and joints.
   b. Pavement edges and joints.
   c. Other slab edges not chamfered.

B. Finishing procedures:

1. Form finish:
   a. Repair defective concrete.
   b. Fill depressions deeper than 1/4".
   c. Fill tie holes.
   d. Remove fins exceeding 1/8" in height.
2. Broom finish:
   a. Float finish as specified herein.
   b. Provide a scored texture by drawing a broom across the surface.
3. Edge finish: Tool slab edges and joints with a 1/4" radius edging tool.

## 3.7 SURFACE REPAIR

A. Patching mortar:

1. Make a patching mortar consisting of 1 part portland cement to 2-1/2 parts sand by damp loose volume.
2. Mix the mortar using one part acrylic bonding admixture to two parts water.

B. Surface defects:

1. Remove all defective concrete down to sound solid concrete.
2. Chip edges perpendicular to the concrete surface or slightly undercut, allowing no featheredges.
3. Dampen surfaces to be patched.
4. Patch defects by filling solidly with repair mortar.

C. Allow the Engineer to inspect the work before placing the patching mortar.

D. Repair defective areas greater than 1 sq. ft. or deeper than 1-1/2" as directed by the Engineer using materials approved by the Engineer at no additional expense to the Owner.

3.8 JOINTS

A. Construction joints:

1. Unless otherwise approved by the Engineer, provide construction joints every ten (10) feet, or as shown on the drawings.
2. Continue all reinforcing across construction joints and provide 1-1/2 " deep keyways unless indicated otherwise on the drawings.

B. Expansion joints:

1. Provide 1/2" expansion joints with premolded joint filters every thirty (30) feet.

3.9 FIELD QUALITY CONTROL

A. Concrete cylinder tests:

1. During construction, prepare test cylinders for compressive strength testing, using 6" diameter by 12" long single use molds, complying with ASTM C 31.
   a. Make a set of three test cylinders from each pour.
   b. Identify each and tag cylinder as to date of pour and location of concrete which it represents.
   c. Deliver cylinders to testing lab selected by the Owner.
   d. Cost for preparation and delivery of cylinders shall be borne by the Contractor. Cost for testing cylinders will be borne by the Owner.
2. Should strengths shown by test cylinders fail to meet specified strengths for the concrete represented, then:
   a. Engineer shall have the right to require changes in the mix proportions as he deems necessary on the remainder of the work.
   b. Additional curing of those portions of the structure represented by the failed test cylinders shall be accomplished as directed by the Engineer.
   c. Upon failure of the additional curing to bring the concrete up to specified strength requirements, strengthening or replacement of those portions of the structure shall be as directed by the Engineer.
   d. The Engineer may require additional testing of concrete in question by either non-destructive methods such as the Swiss Hammer, Windsor Probe or Ultrasonics or by coring and testing the concrete in question in accordance with ASTM C 42. Such testing shall be performed at no additional cost to the Owner.

B. Other field concrete tests:

1. Slump tests: A testing laboratory representative will make slump tests of concrete as it is discharged from the mixer.
   a. Slump test may be made on any concrete batch at the discretion of the Engineer.
   b. Failure to meet specified slump requirements will be cause for rejection of the concrete.
2. Temperature: The concrete temperature may be checked at the discretion of the Engineer.
3. Entrained air: Air content of the concrete will be checked by a representative of the testing laboratory at the discretion of the Engineer.

C. Coordination of laboratory services: The Contractor shall be responsible for coordination of laboratory services.

1. Maintain a log recording quantities of each type of concrete placed, date and location of pour.

2. Inform the testing laboratory of locations and dates of concrete placement and other information as required to be identified in the laboratory's test reports.

D. Tests required because of extensive honeycombing, poor consolidation of the concrete or any suspected deficiency in the concrete will be paid for by the Contractor.

E. Dimensional tolerances for allowable variations from dimensions or locations of concrete work, including the locations of embedded items shall be as given in ACI 301.

F. Concrete which fails to meet strength requirements, dimensional tolerances, watertightness criteria, or is otherwise deficient due to insufficient curing, improper consolidation or physical damage shall be replaced or repaired as instructed by the Engineer at no expense to the Owner.

3.10 MEASUREMENT AND PAYMENT

A. No measurement or direct payment will be made for the work under this Section and all costs for same shall be included in the price bid for the project.

END OF SECTION

SECTION 02577

PAVEMENT MARKING AND SIGNAGE

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Work included: Prepare and paint the asphaltic concrete and/or concrete traffic or parking surfaces as indicated or specified and as needed for a complete and proper installation. This will include the following:

1. 24" wide, white stop lines at all stop signs.
2. White parking spaces.
3. Edge of pavement roadway markings.
4. Centerline roadway markings.
5. Median markings.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
2. Section 02513 - Asphaltic Concrete Paving.

### 1.2 QUALITY ASSURANCE

A. Referenced manufacturer is Sherwin Williams of Cleveland, OH. Equal products of other manufacturers may be provided upon approval by the Engineer.

B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

### 1.3 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

B. Product data: Within 15 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

1. Materials list of items proposed to be provided under this Section.
2. Manufacturer's specification and other data needed to prove compliance with the specified requirements.

### 1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

B. Deliver all material to site in original, new, unopened containers, labeled and bearing manufacturer's name, stock number, product, brand name, contents by volume for major constituents, instructions for mixing, reducing and application instructions.

C. Provide secure and adequate storage facilities for all materials stored on site.

## PART 2 - PRODUCTS

### 2.1 PAINT MATERIALS

A. Within SCDOT roadway right-of-way provide thermoplastic pavement markings in accordance with Section 627 of the SCDOT's "Standard Specifications for Highway Construction" and latest revisions and supplements.

B. Outside SCDOT right-of-way provide permanent pavement markings, fast dry waterborne paint in accordance with Section 625 of the SCDOT's "Standard Specifications for Highway Construction" and latest revisions and supplements.

C. Provide colors as indicated on the plans and details or follow SCDOT standard specifications, if not shown on plans.

D. Provide reflective striping as specified or indicated on the plans containing properly graded glass spheres or beads.

### 2.2 REFLECTIVE GLASS BEADS

A. Reflective glass spheres shall be properly graded and conform to Section 625 and 627 of SCDOT's "Standard Specifications for Highway Construction" and latest revisions and supplements.

### 2.3 ROADWAY SIGNAGE AND STRIPING

A. Roadway signage and striping shall conform to the FHWA Manual on Uniform Traffic Control Devices for Streets and Highways, Latest Edition.

## PART 3 - EXECUTION

### 3.1 SURFACE CONDITIONS

A. Surfaces to be painted are to be free of dirt, grease, oil and grit.

B. New asphalt surfaces are to be adequately cured before application of paint. Apply a test stripe in an inconspicuous area and allow for complete drying to determine readiness for painting.

### 3.2 ENVIRONMENTAL CONDITIONS

A. Do not apply paint when the temperature is below 50°F or when the relative humidity is above 85% or when the dew point is within 5°F of the surface temperature.

### 3.3 MATERIAL PREPARATIONS

A. Mix and prepare paint material in strict accordance with the manufacturer's recommendations.

B. When not in use, store materials in tightly covered containers.

C. Follow all manufacturers' safety, handling and disposal recommendations.

### 3.4 APPLICATION

A. Paint with mechanical equipment designed to apply traffic lane material with glass spheres in a uniform width with straight, neat edges.

B. Apply binder coat at the manufacturer's recommended rate but not less than 15 mils unless approved by the Engineer.

C. Glass spheres shall be applied, immediately after the striping paint has been applied, through a pressurized glass gun set 1" to 4" behind the paint spray gun. Other methods may be acceptable if approved by the Engineer.

D. Glass spheres shall be applied at the rate of 6 lbs. per gallon of binder paint.

3.5 PROTECTION OF FINISH

A. Provide temporary barriers and/or traffic control to prevent damage or traffic pick-up of paint until paint has dried to a state where no traffic pick-up occurs.

3.6 TOUCH UP

A. After complete drying of the initial paint application, touch up any damaged areas being careful to maintain uniform stripe alignment.

B. Remove or paint over in black any excess spray, spills, or traffic tracking of paint into areas not intended to receive paint.

3.7 MEASUREMENT AND PAYMENT

A. No measurement or direct payment will be made for the work under this Section and all costs for same shall be included in the price bid for the project.

END OF SECTION

SECTION 02616

MILLING, CUTTING AND REPLACING PAVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Milling, cutting and replacement of existing pavements for installation of storm drainage lines, as specified herein, and as needed for a complete and proper installation of transitions to existing pavement at project boundaries.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these specifications.
2. Section 02210 - Site Grading.
3. Section 02221 - Trenching, Backfilling for Utilities.
4. Section 02513 - Asphaltic Concrete Paving.
5. Section 02721 - Sewers: Storm Drainage.

1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods for proper performance of the work of this Section.

1.3 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

1.5 WARRANTY

A. All remove and replace pavement work within the South Carolina Department of Transportation (SCDOT) rights-of-way shall be warranted for two years beginning on the date of acceptance by the SCDOT.

PART 2 - PRODUCTS

2.1 ASPHALTIC CONCRETE

A. Comply with Section 02513.

2.2 AGGREGATE BASE COURSE WITH PRIME

A. Comply with Sections 02510 and 02513.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Remove to neat lines and dispose of as directed.

B. Replace with bases and pavements as required by Sections 02510 and 02513 and the Construction Plans.

### 3.2 CUTTING

A. Asphalt pavement or base:

1. Cut on straight and true lines, to a minimum depth of 2", using powered concrete saw.
2. Shear off remaining depth with pneumatic tools.

B. Concrete sidewalks shall be removed back to the nearest joint on each side of the crossing.

C. Cut to straight and true lines with powered concrete saw.

### 3.3 MILLING

A. Use self-propelled milling equipment capable of maintaining accurate cut depth and slope and providing smooth cut edges.

B. Ensure the equipment can accurately and adequately establish profile grade and control cross slope.

C. Equip the milling machine with integral material pickup and truck discharges.

D. Ensure the milling machine has effective means for dust control.

E. Material size to comply with SCDOT specifications.

### 3.4 REPLACEMENT

A. Concrete sidewalks:

1. Replace with 4000 psi concrete.
2. Depth shall be equal to existing section removed, but not less than 4".
3. Finish surface to match existing sidewalk.

B. Flexible pavements:

1. Compact subgrade according to Section 02210 - Site Grading.
2. Undercut each edge 6" to form a shelf.
3. Replace with bases and pavements as required by Sections 02510 and 02513 and the Construction Plans.

## 3.5 MEASUREMENT AND PAYMENT

A. No measurement or direct payment will be made for the work under this Section and all costs for same shall be included in the price bid for the project.

END OF SECTION

SECTION 02660

WATER DISTRIBUTION SYSTEM

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Work included: Provide water distribution system as shown on the Drawings, specified herein, and needed for a complete and proper installation.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these specifications.
2. Section 02221 - Trenching, Backfilling for Utilities.

### 1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. All materials in this Section are to be manufactured in the United States.

### 1.3 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

B. Product data: Within fifteen (15) calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

1. Materials list of items proposed to be provided under this Section.
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.

### 1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

B. Shipment of pipe:

1. Protect pipe with tarp or other means during shipment to prevent truck exhaust from damaging pipe.

C. Avoid severe impact blows, gouging or cutting by metal surfaces or rocks.

PART 2 - PRODUCTS

2.1 GENERAL

A. Use any pipe material and associated fittings as specified herein, except where use of a particular material is indicated on the plans, or specified herein.

2.2 PIPE AND FITTINGS

A. General:

1. Pipe sizes 3" and larger: Use ductile iron.
2. Any pipe, solder, or flux used shall be lead free (lead free is defined as less than 0.2% lead in solder or flux and less than 8.0% lead in pipes and fittings).
3. Gaskets are to be factory-installed and integral with the pipe.
4. All pipe 4" and larger shall be National Sanitary Foundation (NSF) approved and shall be third party certified as meeting the specifications of ANSI/NSF Standard 61.
5. All materials and products that contact potable water shall be third party certified as meeting the specifications of ANSI/NSF Standard 61.
6. All chemical or products added to the public water supply must be third party certified as meeting the specifications of ANSI/NSF Standard 60.
7. For valves cast all markings integral on the valve body with the size of valve, year of manufacture and the class working pressure.
   a. Certifications to rate a 150B valve body to a Class 250 valve will not be acceptable.
8. For valves spray coat all interior wetted ferrous surfaces with two-component epoxy applied to a nominal thickness of 3 to 4 mils.
   a. Coating material to be AWWA and U.S. Food and Drug Administration approved for use with potable water.
9. Exterior Coatings: For ductile iron pipe
   a. For buried service provide bituminous coating.

B. Pipe:

1. Ductile iron pipe (DIP):
   a. Comply with ANSI/AWWA C150/A21.50 or AWWA C151/A21.51, latest revision.
   b. The class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, country where cast, year in which the pipe was produced, and the letters "DI" or "Ductile" shall be cast or stamped on the pipe.
   c. Wall thickness in accordance with Table 51.1 of ANSI/AWWA C151/A21.51 with working pressure of 150 psi, depth of cover indicated and Type 3 bedding conditions, minimum Class 50.
   d. Use cement mortar lining complying with ANSI/AWWA C104/A21.4, standard thickness.

C. Joints:

1. Ductile iron pipe:
   a. Use mechanical or push-on joints complying with ANSI/AWWA C111/A21.11 as modified by ANSI/AWWA C151/A21.51.
   b. Use gaskets and lubricant complying with ANSI/AWWA C111/A21.11. Natural rubber gaskets are not acceptable.
   c. Lubricants shall be compatible with pipe and gasket materials, shall not support bacteria growth and shall not adversely affect potable

quality of line contents. Vegetable shortening shall not be used to lubricate joints.
1) NSF approved.

d. Exposed pipe:
1) Class 53 minimum.
2) Use flanged joints complying with ANSI/AWWA C115/A21.11, latest revision; and
i) Flanges to be solid type.
ii) Use full face, red rubber, factory cut, 1/16" thick for pipe up to 10" diameter and 1/8" thick for larger sizes.
iii) Bolts and nuts shall be standard carbon steel machine bolts, hex head complying with ANSI A21.11/AWWA C111.

D. Fittings and specials:

1. Ductile iron pipe:

a. Use 250 psi pressure rated ductile iron fittings or specials unless otherwise indicated, complying with ANSI/AWWA C110/A21.10.
b. Compact fittings for piping 3" - 16" may be provided in accordance with ANSI/AWWA C153/A21.53.88.b.
c. Fittings for use with push-on joint pipe, comply with ANSI/AWWA C111/A21.11.
d. Use cement mortar lining complying with ANSI/AWWA C104/A21.4, standard thickness.
e. The maximum phosphorous level in the casting will be 0.08%.
f. The fitting surface finish will conform to MSS SP-112 Quality Standard for Evaluation of Cast Surface Finishes.
g. The manufacturer shall be ISO 9000 certified.
h. Markings
* Each fitting shall have the following markings cast integrally to the fitting:
1. Manufacturer's Name or Logo
2. "MJ"
3. Country of origin
4. Manufacturer's Foundry Mark
5. AWWA C-153 or C110
6. Pressure Rating
7. Nominal Diameter (each leg)
8. "DI" or "Ductile"
9. No. of Degrees (bends)

E. Couplings:

1. Provide couplings where needed to make piping connections and where located on the plans.
2. Provide mechanical joint ductile iron sleeve, full length, minimum 12".
3. Provide cutting-in sleeve where installing fittings in an existing line.
a. Provide ductile iron with mechanical joint.
4. Provide restrained joint couplings where restrained joints are indicated on the plans.

F. Restrained joint pipe and fittings:

1. Provide restrained joint pipe and fittings where indicated on the plans.
   a. Ductile iron pipe:
      1) Provide retainer glands for use with mechanical joint pipe and fittings.
      2) Provide wedge type.
      3) Provide ductile iron gland conforming to ASTM A 536-80. Provide split gland where standard gland cannot be installed.
      4) Provide ductile iron set screws, heat-treated to a minimum hardness of 370 BHN with twist-off nuts and permanent standard hex head remaining.
      5) Provide for the following rated pressure with minimum 2 to 1 safety factor; 3" - 16" 350 psi, 18" - 48" 250 psi.
      6) Provide tee-head bolts conforming to ANSI/AWWA C111/A21.11 latest revision.
      7) Provide "MEGALUG" series 1100 or series 1200 as manufactured by EBAA Iron, Inc. of Eastland, Texas, or approved equal.

G. Tee head bolts: Provide Cor-Ten steel tee head bolts for use on mechanical joints complying with ASTM A242.

H. Plugs or caps:

1. Provide at all pipe ends and unused branches of fittings.
2. All plugs and caps shall be tapped 2" and provided with 2" plug.
3. Plugs and caps to be restrained joint.

2.3 COPPER TRACER WIRE

A. Provide a continuous 12 gauge blue insulated copper tracer wire when PVC or polyethylene pipe is used.

B. Approved for direct burial by the manufacturer.

C. Locate tracer wire a minimum of 6" above top of water main.

D. Terminate tracer wire at each valve and meter and make provisions to allow for connection of testing apparatus without interfering with the proper operation of valves and meters.

E. Connect to the water line with duct tape at every bell connection or every 20' to ensure that the wire is directly over the top of the pipe.

F. Place in the trench with all service lines.

G. Splice at each service lateral and tee connection with an approved copper

## 2.4 VALVES

A. General:

1. 2" through 12": Use gate valves.
2. Open by turning counterclockwise.
3. End connections as required for the piping in which they are installed.
4. Two-inch metal operating nut with arrow indicating direction of opening.
5. Use valves designed for a working pressure of not less than 150 psi.
6. Provide stem extensions on all valves where the top of the operator nut is located greater than 36" below the top of the valve box.
7. Fully coat all internal ferrous metal surfaces with two part thermosetting epoxy.
8. Design for external stem failure when excessive closing torque is applied with no failure of the pressure retaining parts.
9. Provide double disc gate valves with bevel gears, grease case, and other necessary appurtenances for horizontal installation.
10. Provide valved bypass on valves 14" and larger.
11. Provide stainless steel bolting.
12. Valves to be manufactured in the United States.
13. Provide all wetted rubber compounds of synthetic rubber.

B. Gate valves 2" through 12":

1. Use double disc valves complying with ANSI/AWWA C500 or resilient seated wedge valves complying with ANSI/AWWA C509.
2. Provide integrally cast bronze stem nut on resilient seated wedge valves.
3. Suitable for working pressure of not less than 250 psi.
4. Design for external stem failure outside of the valve body or bonnet when excessive closing torque is applied with no failure of the pressure retaining parts per AWWA Section 3.2.
   a. Factory test with no leakage from either side of the disc.
   b. Test shell to 500 psig.
5. Provide certified to NSF 61.
6. Resilient wedge valves:
   a. Completely encapsulate resilient iron wedge by an elastomer, without thin spots or voids.
   b. Provide polymer wedge guide bearing caps bearing surface between the encapsulated wedge and the interior epoxy coating, lowering operation torque and extending service life of the valve.
   c. The manufacturing plant to have ISO9001 certification.

C. Valve operator:

1. Provide one T-handle operator for each ten buried valves with nut operator.
2. Provide one stainless steel T-handle operator for each four buried valves with "T" head.

D. Provide valve boxes and position indicators for all buried service valves and operators.

1. Hermetically sealed for installation in a C.I. valve box.
2. Show valve disc position, direction of rotation and number of turns from full open to full close.
3. Shaft extension and pins to be stainless steel.
4. Base plate and housing to be aluminum.
5. Provide all bronze gearing.
6. Provide 2" AWWA square nut.
7. Locate top of indicator no more than 6" below grade.
8. Approved manufacturer: Valcom or approved equal.

## 2.5 HYDRANTS

A. Fire hydrants:

1. Comply with ANSI/AWWA C502.
2. Waterway valve opening, 5-1/2".
3. Six inch hub connection, two 2-1/2" hose connections, one 4-1/2" steamer connection.
4. National Standard screw threads on outlet nozzles.
5. Hydrants shall open in clockwise direction with arrow cast on top indicating direction of opening.
6. Hydrants shall be no less than 3', or more than 6' from the curb, or 4-1/2' to 6' from edge of pavement.
7. Minimum cover 2'6".
8. Finish painting not required.
9. Minimum distance between valve and hydrant shall be 3'.
10. Hydrant valves open right.
11. Provide one hydrant wrench for each ten hydrants.
12. Hydrant shall be Mueller Company "Super Centurion" Model 250, American Valve and Hydrant Company Model B-62-B, U.S. Pipe and Foundry Company, Model "Metropolitan 250", or approved equal.

## 2.6 VALVE BOXES

A. Provide at each buried valve.

B. Cast iron extension type, suitable for minimum cover of 3'6" over the pipe.

C. Minimum inside diameter at the top of 5", minimum riser wall thickness 1/4" and thickness at the top of 11/16".

D. Have the word "WATER"; "SEWER"; "SLUDGE", etc., as applicable, cast into the cover.

E. Provide Tyler Series 6850.

F. Where depth requires more than a two piece box use adjustable cast iron extensions.

G. Coat box and cover with two (2) shop coats of bitumastic paint.

## 2.7 VALVE BOX PROTECTION RING

A. Provide at each valve box a precast concrete protection ring.

B. Provide two rings of No. 3 reinforcing steel, one 14" in diameter, and one 23" in diameter.

C. Inside dimensions to be 9-1/4".

D. Outside diameter to be 27".

E. Provide 5" thickness at interior with a continuous slope to 2" thickness at the outside.

F. Minimum weight of 110 lbs.

## 2.8 SERVICE SADDLE

A. Provide of the following materials:

| | |
|---|---|
| Body | Type 304 Stainless Steel |
| Bales and Strips | Type 304 Stainless Steel |
| Studs | Type 304 Stainless Steel |
| Hardware | Type 304 Stainless Steel |

B. Provide double-strap for sizes 5" and larger.

C. Provide Romac 304 and 305 or approved equal.

D. Connect to pipeline using a 6" stainless steel nipple.

1. Do not use a threaded PVC connection.

## 2.9 MISCELLANEOUS PARTS AND ACCESSORIES

A. Use standard commercial grade suitable for the type of installation or system involved, and conforming to the applicable standards and specifications of the AWWA.

# PART 3 - EXECUTION

## 3.1 HANDLING

A. Handle pipe accessories so as to ensure delivery to the trench in sound, undamaged condition:

1. Carry pipe into position - do not drag.
2. Use pinch bars or tongs for aligning or turning the pipe only on the bare end of the pipe.
3. Use care not to injure pipe linings.
4. Do not damage pipe with chokers or lifting equipment.

B. Thoroughly clean interior of pipe and accessories before lowering pipe into trench. Keep clean during laying operations by plugging or other method approved by the Engineer.

C. Before installation, inspect each piece of pipe and each fitting for defects.

1. Material found to be defective before or after laying: Replace with sound material meeting the specified requirements, and without additional cost to the Owner.

D. Gaskets: Store in a cool dark place until just prior to time of installation.

3.2 PIPE CUTTING

A. Cut pipe neatly and without damage to the pipe.

B. Unless otherwise recommended by the pipe manufacturer, and authorized by the Engineer, cut pipe with mechanical cutter only.

1. Use wheel cutters when practicable.
2. Cut plastic pipe square, remove all burrs, and grind bevel on end.

3.3 LOCATING

A. Water mains shall be laid at least 10' edge-to-edge horizontally distanced from any existing or proposed sewer pipes.

B. Should a 10' separation not be practical, then the water main may be located closer with South Carolina Department of Health and Environmental Control (SCDHEC) approval provided:

1. It is laid in a separate trench.
2. It is laid in the same trench with the water main located at one side on a bench of undisturbed earth.
3. In either of the above cases, crown elevation of the sewer shall be at least 18" below invert elevation of water line.

C. Where water lines cross over sewers, maintain 18" vertical separation between the outside of the sewer and the outside of the water line.

D. Where water lines cross under sewers, each line shall be cast iron or ductile iron.

1. A full length of water line shall be located over an existing sewer so that joints of each line will be as far from each other as possible.
2. Where a new water main crosses a new sewer line, a full length of pipe shall be used for both the water main and sewer line and the crossing shall be arranged so that the joints of each line will be as far as possible from the point of crossing and each other.

E. No water pipe shall pass through or come in contact with any part of a sewer manhole.

F. Water lines shall not be laid within 25' horizontally from any portion of a wastewater tile or spray field.

G. Water lines shall be located outside all contaminated areas, unless using pipe materials that will protect the water supply.

H. No flushing device or drain directly connected to any type of sewer is allowed.

I. No cross connections between water lines and any pipes, valves, tanks or pumps that are not part of the potable water system are allowed.

J. Water lines may come in contact with storm sewers or catch basins if there are no other practical alternatives provided that ductile iron is used and no joints of the water line are within the storm sewer or catch basin, and, provided that the joints are located as far as possible from the storm sewer or catch basin.

K. Structures containing valves, blowoffs, meters, air release valves, etc., shall not be connected directly to any storm drainage or sewer system.

3.4 EXCAVATION AND BACKFILLING

A. Comply with pertinent provisions of Section 02221 and Section 02615 of these Specifications.

B. For P.E. Pipe, comply with manufacturer's recommendations.

3.5 ALIGNMENT OF PIPE

A. Pipe lines intended to be straight shall be so laid.

B. Where vertical or horizontal alignment requires deflection from straight line or grade, such deflection shall not exceed maximum deflection recommended by the pipe manufacturer.

C. If alignment requires deflection exceeding recommended limits, furnish special bends or a sufficient number of shorter lengths of pipe to provide angular deflections within the allowable limits.

3.6 PLACING AND LAYING

A. General:

1. Lower pipe and accessories into trench by means of derrick, ropes, belt slings, or other equipment approved by the Engineer.
2. Do not dump or drop any of the materials of this Section into the trench.
3. Except where necessary in making connections to other lines, lay pipe with the bells facing in the direction of laying.
4. Rest the full length of each section of pipe solidly on the pipe bed, with recesses excavated to accommodate bells, couplings, and joints.
5. Take up and relay pipe that has the grade or joint disturbed after laying.
6. Do not lay pipe in water, or when trench conditions are unsuitable for the work; keep water out of the trench until jointing is completed.
7. Securely close open ends of pipe, fittings, and valves when work is not in progress.
8. Where any part of coating or lining is damaged, repair to the approval of the Engineer and at no additional cost to the Owner.
9. Structures containing valves, blowoffs, meters, air release valves, etc., shall not be connected to any storm drain or sewer system.

B. Ductile iron pipe:

1. Mechanical, push on and flanged joints, install in accordance with ANSI/AWWA C600.
2. Gaskets: Handle, lubricate where necessary and install in strict accordance with manufacturer's recommendations.

C. Flanged joints:

1. Provide true face flanges, field clean and fit with one full face gasket and make bolts up finger tight.
2. Use torque wrench to alternately tighten bolts 180° apart until full gasket flow and seal are secured.
3. Bias cut or unusual refacing of any flange will not be acceptable.

D. Restrained joints:

1. Install in accordance with manufacturer's instructions.
2. Tighten set screws to the manufacturer's rated torque using a torque wrench. If twist-off nuts are provided, tighten screws until nut breaks loose.

## 3.7 SETTING VALVES AND VALVE BOXES

A. General:

1. Center valve boxes on the valves, setting plumb.
2. Tamp earth fill around each valve box to a distance of 4' on all sides, or to the undisturbed trench face if less than 4'.
3. Install shaft extensions plumb without any binding.
4. Fully open and close each valve to assure that all parts are in working condition.
5. Place valve box protection ring around top of valve box as indicated on the plans.
   a. Install ring level with top 1" above finished grade.
   b. Top of ring to be level with or no more than 1" above the top of the valve box.

## 3.8 INSTALLATION OF HYDRANTS

A. General:

1. Inspect carefully, ensuring that all foreign material is removed from the barrel.
2. Set plumb and at such elevation that connecting pipe and distribution main have same depth of cover.
3. Install stone drainage bed and thrust blocking as indicated.
4. No connection or location of hydrant drains within 10' of sewer systems is allowed.
5. Hydrant leads to be a minimum of 6" in diameter and to include an auxiliary gate valve.
6. Fully open and close each hydrant to assure that all parts are in working condition.
7. Install blue hydrant reflector on centerline of paved roadway marking the perpendicular location of hydrant with reference to the road centerline.

## 3.9 HYDROSTATIC TESTING

A. General:

1. Pressure and leakage testing must be conducted in accordance with AWWA Standards C600.
2. Clean and flush line of air, dirt and foreign material.
3. Do not perform hydrostatic tests until at least five days after installation of concrete thrust blocking.
4. Test pump, pipe connection, pressure gauges, measuring devices and all other necessary appurtenances to conduct tests are to be provided by the Contractor.
5. Install brass corporation cocks at all high points that do not have permanent air vents. Corporation cocks are to be left in place and all costs for providing such cocks are to be borne by the Contractor.
6. Conduct tests on each line or valved section of line.
7. Test pressures to be 150 psi, or 1.5 times the maximum working pressure, whichever is greater, based on the elevation of the lowest point of the section under test and corrected to the elevation of the test gauge.
8. Do not test pipe at pressures exceeding manufacturer's recommendations.
9. The Contractor must provide documentation of the pressure and leakage tests. Documentation must include length of lines, diameter of pipe(s), amount of water required to fill line after test was performed, and amount of allowable leakage.
10. The witness to the hydrostatic testing is to be someone other than the Contractor or the utility installing the lines.

B. Pressure tests:

1. After the pipe is laid, the joints completed, and the trench backfilled, subject the newly laid piping and valved sections of the piping to the test pressure specified in Part A above.
2. Open and close each valve within the section being tested several times during the test period.
3. Replace or remake joints showing leakage.
   a. Remove cracked pipe, defective pipe, and cracked or defective joints, fittings and valves. Replace with sound material and repeat the test until results are satisfactory.
   b. Make repair and replacement without additional cost to the Owner.

C. Leakage test:

1. Conduct leakage test after the pressure test has been completed satisfactorily.
2. Duration of each leakage test: At least two hours.
3. During the test, subject water lines to the test pressure specified in Part A above.

4. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
   a. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula(s):

      1) Ductile iron piping:

         $L = S \times D \times \sqrt{P} / 133{,}200$; where

         L = allowable leakage in gallons per hour;
         S = length of pipe tested in feet;
         D = nominal diameter of pipe in inches; and
         P = average test pressure psi gauge.

      2) PVC piping:

         $L = N \times D \times \sqrt{P} / 7400$; where

         L = allowable leakage in gallons per hour;
         N = number of joints in pipeline being tested;
         D = nominal diameter of pipe in inches; and
         P = average test pressure psi gauge.

   b. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gallons per hour per inch of nominal valve size will be allowed.
      1) Should any test of pipe disclose leakage greater than that specified above, locate and repair the defective joint or joints until the leakage is within the specified allowance, and at no additional cost to the Owner.
      2) Repair all visible leaks regardless of test results.

## 3.10 STERILIZATION

A. General:

1. Upon completion of testing, sterilize all water lines to meet requirements of the South Carolina Department of Health and Environmental Control.
2. Newly laid valves or other appurtenances shall be operated several times while line is filled with chlorinating agent.
3. Should initial treatment fail to meet results specified, repeat procedures until satisfactory results are obtained, at no additional cost to the Owner.
4. All pipe taps, feeders, chemicals, etc., for sterilization shall be provided by the Contractor.

B. Procedure:

1. Flush line to extent possible with available pressure and outlets, prior to sterilization.
   a. Hydrant openings required to produce proper flushing velocity at 40 psi are:

| Pipe Size (Inches) | Hydrant Openings |
|---|---|
| 4 through 12 | one 2-1/2" |
| 14 through 18 | two 2-1/2" |
| 20 | one 4-1/2" |

2. Comply with the latest revision of AWWA C651 and the following:
   a. Apply chlorine as liquid chlorine or chlorine compound such as calcium hypochlorite with known chlorine content.
   b. Apply through corporation cock in top of main located no greater than ten (10) sections from the beginning of section being sterilized.
   c. Control water flow to a slow flow into the line.
   d. Use proper feeder and flow regulator to introduce chlorinating agent.
   e. Application rate shall be not less than 25 ppm and no greater than 50 ppm.
   f. Retain chlorinated water in main not less than 24 hours.
   g. At end of retention period, at least 10 ppm of chlorine shall remain in the water at the extreme end of section.
   h. Dechlorinate and flush line thoroughly.

C. Acceptance:

1. Provide two separate samples for each sample location, taken at 24-hour intervals, free of coliform bacteria.
   a. Contractor to take 1st and 2nd samples, deliver to South Carolina Department of Health and Environmental Control (SCDHEC) approved laboratory for testing.
   b. The first and second sample results shall include the free chlorine residual at the time the samples were collected.
   c. Notify SCDHEC to take a 3rd sample.
2. At a minimum, sample locations shall be as required by SCDHEC and the following:
   a. The tie-in location of new and existing water lines.
   b. The end of all dead end lines.
   c. At intervals of no more than 1,200' for all new lines longer than 1,200' in length.
3. All sample locations are to be given an identifying label and a corresponding identification label is to be included on the record drawings indicating each sample location.

## 3.11 DECHLORINATION OF CHLORINATED STERILIZATION WATER

A. Dechlorinate the chlorinated water used for sterilizing water lines.

B. Apply dechlorinating agent as liquid sulfur dioxide or sulfite salts.

C. Prepare a mixing chamber using a 55-gallon tank. Feed the discharge and dechlorinating agent at the bottom of the tank with overflow at the top.

D. Discharge total chlorine residual to be less than 0.5 milligrams per liter.

## 3.12 MEASUREMENT AND PAYMENT

A. No separate measurement or direct payment will be made for the items under this Section and all costs shall be included in the Lump Sum price bid for the project.

END OF SECTION

SECTION 02930

GRASSING

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Work included: Provide grassing of the areas specified herein, or as indicated, for a complete and proper installation.

1. Site: All cleared areas and areas disturbed by the construction operation that will remain undeveloped for more than two weeks.

B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

### 1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Seed: Conform to all State laws and to all requirements and regulations of the South Carolina Department of Agriculture.

1. Deliver to site each variety of seed individually packaged and tagged to show name, net weight, origin and lot number.

C. Fertilizer: Conform to State fertilizer law.

### 1.3 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

B. Product data: Within fifteen (15) calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

1. Complete materials list of items proposed to be provided under this Section.

### 1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

B. At time of delivery, furnish the Engineer invoices of all materials received in order that application rates may be determined.

C. Immediately remove from the site materials that do not comply with the specified requirements, and promptly replace with materials meeting the specified requirements.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Provide commercial balanced 16-4-12 or 12-4-8 fertilizer delivered to the site in bags labeled with the manufacturer's guaranteed analysis.

2.2 GRASS SEED

A. Provide grass seed that is:

1. Free from noxious weed seeds, and recleaned.
2. Grade A recent crop seed.
3. Treated with appropriate fungicide at time of mixing.
4. Delivered to the site in sealed containers with dealer's guaranteed analysis.

2.3 LIME

A. Provide agricultural grade, standard ground limestone conforming to current "Rules, Regulations and Standards of the Fertilizer Board of Control" issued at Clemson University.

B. Bag tags or delivery slip for bulk loads shall indicate brand or trade name, calcium carbonate equivalent, and other pertinent data to identify the lime.

2.4 STRAW MULCH

A. Provide straw or hay material.

1. Straw to be stalks of wheat, rye, barley or oats.
2. Hay to be timothy, peavine, alfalfa, or coastal bermuda.

B. Material to be reasonably dry and reasonably free from mature seed bearing stalks, roots, or bulblets or Johnson Grass, Nutgrass, Wild Onion and other noxious weeds.

2.5 EXCELSIOR FIBER MULCH

A. To consist of 4" to 6", average length, wood fibers cut from sound, green timber.

B. Make cut in such a manner as to provide maximum strength of fiber, but at a slight angle to natural grain of the wood.

2.6 EROSION CONTROL BLANKET

A. Provide on areas as shown on the plans.

B. Provide Erosion Control Blanket S150, from North American Green, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Seed these areas immediately upon completion of grading or construction and clean-up operations.

1. All areas disturbed by construction that will remain undeveloped for more than two weeks.

B. Areas ready for planting shall be planted with a temporary cover of Schedule No. 2.

C. Use Rate A lbs. per 1000 sq. ft. on slopes over 5' horizontal to 1' vertical in height and use Rate B lbs. per 1000 sq. ft. on slopes less than 5' horizontal to 1' vertical.

3.2 SEEDING SCHEDULES

A. Mixtures of different types of seed for the various schedules shall be weighed and mixed in proper proportions in the presence of the Engineer.

B. Schedule No. 2 - All Temporary Grassing

| **Common Name of Seed** | **Rate A** | **Rate B** |
|---|---|---|
| Brown Top Millet | 5.0 | 0.0 |
| Annual Rye Grass | 0.0 | 2.0 |
| Common Bermuda (hulled) | 0.0 | 0.5 |
| Common Bermuda (unhulled) | 0.0 | 1.5 |
| 10-10-10 Fertilizer | 25.0 | 25.0 |
| Agricultural Lime | 75.0 | 75.0 |

3.3 GROUND PREPARATION

A. Bring all areas to proper line, grade and cross section indicated on the plans.

B. Repair erosion damage prior to commencing seeding operations.

C. Loosen seed bed to minimum depth of 3".

D. Conduct soil test to determine pH factor.

1. If pH is not in the range of 6.0 to 6.5, adjust.

3.4 APPLICATION OF FERTILIZER

A. Spread uniformly over areas to be seeded at:

1. Rate of 18 lbs. per 1000 sq. ft. when using 16-4-12.
2. Rate of 25 lbs. per 1000 sq. ft. when using 12-4-8.
3. Use approved mechanical spreaders.

B. Mix with soil to depth of approximately 3".

3.5 SOWING METHODS

A. General:

1. Perform seeding during the periods and at the rates specified in the seeding schedules.
2. Do not conduct seeding work when ground is frozen or excessively wet.
3. Produce satisfactory stand of grass regardless of period of the year the Work is performed.

B. Seeding, slopes less than four horizontal to one vertical:

1. Shall conform to Methods EA, WF or WCF as specified hereinafter.
2. Method EA (Emulsified Asphalt):
   a. Sow seed not more than 24 hours after application of fertilizer.

b. Use mechanical seed drills on accessible areas, rotary hand seeders, power sprayers, etc. may be used on steep slopes or areas not accessible to seed drills.
c. Cover seed and lightly compact with cultipacker if seed drill does not.
d. Within 24 hours following compaction of seeded areas, uniformly apply 0.2 gallons per square yard of emulsified asphalt over the seeded area.

3. Method WF:
   a. Sow seed as specified for Method EA.
   b. Within 24 hours following covering of seeds, uniformly apply excelsior fiber at the rate of 100 lbs. per 1000 sq. ft.
   c. Apply material hydraulically.
   d. Seeded areas to be lightly rolled to form a tight mat of the excelsior fibers.
4. Method WCF:
   a. Apply seed, fertilizer and wood fiber mulch using hydraulic equipment.
   b. Equipment to have built-in agitation system with capacity to agitate, suspend and homogeneously mix a slurry of the specified amount of fiber, fertilizer, seed and water.
   c. Minimum capacity of slurry tank: 1000 gallons.
   d. Apply fiber mulch at rate of 35 lbs. per 1000 sq. ft.
   e. Regulate slurry mixture so that amounts and rates of application will result in uniform application of all materials at not less than the specified amounts.
   f. Apply slurry in a sweeping motion, in an arched stream, so as to fall like rain, allowing the wood fibers to build upon each other.
   g. Use color of wood pulp as guide, spraying the prepared seed bed until a uniform visible coat is obtained.

C. Seeding, slopes greater than four horizontal to one vertical:

1. Sow seed as specified for Method EA, unmulched.
2. Cover seeded area with erosion control blanket.

## 3.6 SECOND APPLICATION OF FERTILIZER

A. When plants are established and showing satisfactory growth, apply nitrogen at the rate of 1.0 lb. per 1000 sq. ft.

B. Apply in dry form unless otherwise directed by the Engineer.

C. Do not apply to stands of temporary grasses.

## 3.7 MAINTENANCE

A. Maintain all seeded areas in satisfactory condition until final acceptance of the Work.

B. Areas not showing satisfactory evidence of germination within six weeks of the seeding date shall be immediately reseeded, fertilized and/or mulched.

C. Repair any eroded areas.

D. Mow as necessary to maintain healthy growth rate until final acceptance of the Work.

## 3.8 ACCEPTANCE

A. No acceptance will be made of temporary seeded areas (Schedule No. 2).

## 3.9 MEASUREMENT AND PAYMENT

A. No measurement and payment will be made for the work under this Section and all costs for same shall be included in the price bid for the item to which it pertains.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included: Provide cast-in-place concrete, including formwork and reinforcement, where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Related work:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Reference standards: Comply with the following codes, specifications and standards, except as otherwise shown or specified:

1. American Concrete Institute (ACI) Publications:
   - -- ACI 301 Specification for Structural Concrete for Buildings
   - -- ACI 305 Recommended Practice for Hot Weather Concreting
   - -- ACI 306 Recommended Practice for Cold Weather Concreting
   - -- ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
   - -- ACI 318 Building Code Requirements for Reinforced Concrete
   - -- ACI 347 Recommended Practice for Concrete Framework
2. American Society for Testing and Materials (ASTM) Publications:
   - -- A185 Welded Steel Wire Fabric for Concrete Reinforcement
   - -- A615 Deformed and Plain Billet Steel Bars for Concrete Reinforcement
   - -- C31 Making and Curing Concrete Test Specimens in the Field
   - -- C33 Concrete Aggregates
   - -- C39-72 Compressive Strength of Cylindrical Concrete Specimens
   - -- C94 Ready-Mixed Concrete
   - -- C150 Portland Cement
   - -- C260 Air-Entraining Admixtures for Concrete
3. Concrete Reinforcing Steel Institute (CRSI):
   - -- "Manual of Standard Practice"
4. American Welding Society (AWS) Publication:
   - -- D12.1-61 Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete

C. Testing agency: A testing laboratory will be retained by the Owner to perform material evaluation tests required by these specifications.

D. Qualifications of contractors performing concrete work: Minimum of two (2) years experience on comparable concrete projects.

E. Plant qualification: Plant equipment and facilities shall meet all requirements of the Check List for Certification of Ready Mixed Concrete Production Facilities of the National Ready Mixed Concrete Association and ASTM C94.

1.3 SUBMITTALS

A. Comply with the pertinent provisions of Section 01340.

B. Within 15 calendar days after receiving the Owner's Notice to Proceed, submit proposed mix designs for approval.

1. Proportions shall be determined by means of laboratory tests of concrete made with the cement and aggregate proposed for use.
2. Provide report in detail from an approved testing laboratory showing 7-day and 28-day strengths obtained using materials proposed.
3. Required average strength above specified strength:
   a. Determinations of required average strength above specified strength (f'c) shall be in accordance with ACI 318 and ACI 301.
   b. Establish the required average strength of the design mix using the materials proposed to be employed. Standard deviations shall be determined by thirty tests. Average strength used for selecting proportions shall exceed specified strength (f'c) by at least:

| | |
|---|---|
| 400 psi | Standard deviation is less than 300 |
| 550 psi | Standard deviation is 300 to 400 |
| 700 psi | Standard deviation is 400 to 500 |
| 900 psi | Standard deviation is 500 to 600 |
| 1200 psi | Standard deviation is above 600 or unknown |

   c. When the ready-mix producer does not have a record of past performance, the combination of materials and the proportions selected shall be selected from trial mixes having proportions and consistencies suitable for the work using at least three (3) different water/cement ratios which will produce a range of strengths encompassing those required. Average strength required shall be 1200 psi above specified strength.
4. Cost of this work shall be borne by the Contractor.

C. Manufacturer's data: Submit manufacturer's specification with application instructions for proprietary materials and items, including curing compound, form release agents, admixtures, patching compounds, and others as required by the Engineer.

D. Shop drawings: Submit the following shop drawings to the Engineer for approval before work is started:

1. Reinforcing steel drawings: Prepare in accordance with ACI 315. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, dimensions and details of bar reinforcing and accessories.
2. Cementitious coating.

1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

B. Store reinforcement in a manner that will avoid excessive rusting or coating by grease, oil, dirt and other objectionable materials.

C. Keep reinforcement in separate piles or racks so as to avoid loss of identification after bundles are broken.

## PART 2 - PRODUCTS

### 2.1 FORMS

A. Use form materials conforming to ACI 347.

B. Form lumber: Use lumber of sufficient quality and grade, size and stiffness to adequately support the work and ensure dimensional accuracy.

C. Form ties: Use form ties which do not leave an open hole through the concrete and which permit neat and solid patching at every hole.

1. Use ties with cones that allow a 1" break back and facilitate patching.
2. On structures containing water or other liquid or below grade structures, use embedded rod ties with integral waterstops in addition to cones.
3. Through-bolts that utilize a removable tapered sleeve in water containing and below grade applications: Use mechanical EPDM rubber plugs to seal holes made after removal of taper ties. Acceptable product is X-Plug by the Greenstreak Group, Inc. 800-325-9504. Follow manufacturers' instructions for installation. Friction fit plugs are not allowed.
4. Wire ties and wood spreaders will not be permitted.

D. Form coatings: Form release coating shall be neat oil with surface wetting agent or chemical release agent which effectively prevents absorption of moisture, prevents bonding with concrete, is non-staining to concrete and leaves the concrete with a paintable surface.

1. On surfaces to receive an applied coating, use a residual free chemical form release agent which is compatible with the applied coating and will not prevent the applied finish from satisfactorily bonding to the concrete.

E. Chamfer strips: Chamfer strips shall be wood or polyvinyl strips or approved equal, designed to be nailed in the forms to provide a 3/4" chamfer (unless indicated otherwise) at all exposed edges and corners of concrete members.

### 2.2 REINFORCEMENT

A. Comply with the following as minimums:

1. Bars: ASTM A615, Grade 60, unless otherwise shown on the Drawings, using deformed bars for Number 3 and larger.
2. Welded wire fabric: ASTM A185.
   a. Use sheet (mat) welded wire fabric only.
   b. Welded wire fabric supplied in rolls will not be accepted.
3. Bending: ACI 315 and ACI 318.

B. Fabricate reinforcement to the required shapes and dimensions, within fabrication tolerances stated in the CRSI "Manual of Standard Practices".

C. Do not use reinforcement having any of the following defects:

1. Bar lengths, depths, or bends exceeding the specified fabricating tolerances.

2. Bends or kinks not indicated on the Drawings or required for this Work.
3. Bars with excessive rust, scale, dirt, oil or other defects which will reduce the bond or the effective cross section of the bar.

D. Furnish all support bars, tie bars, chairs, bolsters, etc. required for properly supporting and spacing bars in the forms.

1. For slabs on grade, use supports with stand plates or horizontal runners where wetted base materials will not support chair legs. Other supports must be approved by the Engineer.
2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are hot-dip galvanized, plastic protected or stainless steel.
3. Supply supports for welded wire fabric as follows:

**Welded Wire Fabric Support Spacing**

| Welded Wire Reinforcement (diameter) | Welded Wire Spacing (inches) | Maximum Support Spacing (feet) |
|---|---|---|
| W9 or larger | 12 and greater | 4 |
| W5 to W8 | 12 and greater | 3 |
| W9 and larger | Less than 12 | 3 |
| W4 to W8 | Less than 12 | 2 |
| Less than W4 | Less than 12 | 1.5 |

E. Tie wire: FS QQ-W-461, annealed steel, black, 16 gauge minimum.

F. Welding electrodes: AWS A5.1, low hydrogen, E70 series.

G. Splice devices: Shall be sized to develop one hundred twenty-five (125%) percent of yield strength of bar.

2.3 CONCRETE MATERIALS

A. Cement: Use portland cement: ASTM C150, Type I, Type I-P or Type II, low alkali.

1. Where concrete will be exposed to sewage, use Type II or I-P cement.
2. Fly ash shall conform to ASTM C618, Class C or F.
3. Fly ash content shall not exceed 20% by weight of the total amount of cementitious materials (portland cement plus fly ash).

B. Aggregates:

1. Fine aggregate: Conform to ASTM C33.
2. Coarse aggregate: Conform to ASTM C33, Size #57.

C. Water: Clean and potable and free from injurious amounts of deleterious materials.

D. Admixtures:

1. Air entraining admixture: ASTM C260.
2. Water reducing, set controlling admixture: Conform to ASTM C494.
   a. Type A - water reducing.
   b. Type D - water reducing and retarding.
3. Superplasticizers: Conform to ASTM C494, Types F and G.

a. Use superplasticizers in thin section placements and in areas of congested reinforcing and/or embedded items, or where otherwise approved by the Engineer.
b. Use where conventional consolidation techniques are impractical.

4. Do not use admixtures containing calcium chloride.

E. Fiber reinforcing:

1. Use fiber reinforcing where indicated on the drawings.
2. Provide polypropylene or co-polymer fibers as manufactured by High Tech Fibers, Inc., Fibermesh Company or an approved equal.
3. Where required, use fiber reinforcing at a rate of 2.0 lbs. per cubic yard unless another rate is indicated on the drawings.

F. Curing compounds:

1. On all vertical and formed surfaces, construction joints, basin slabs, surfaces to receive an applied coating or finish, and other surfaces except as otherwise indicated or specified, use a non-residual, non-staining curing compound conforming to ASTM C309 Type 1 and 1D. Acceptable products are:
   a. L&M Cure by L&M Construction Chemicals, Inc.
   b. Horn WB-75 by A.C. Horn Company.
   c. Sonosil by Sonneborn, Inc.
   d. Approved equal.
2. On building floor slabs not otherwise receiving an applied coating or finish and on other flatwork as indicated on the Drawings, provide an acrylic copolymer curing and sealing compound conforming to ASTM C309 Type 1 and the following:
   a. Non-yellowing.
   b. Minimum 20% solids.
   c. Maximum unit moisture loss in accordance with ASTM C156 - 0.40 kg./sq.m at 72 hours.
   d. Acceptable products are Dress & Seal by L&M Construction Chemicals, Inc., Clear Seal Standard by A. C. Horn Company, Kure-N-Seal 0800 by Sonneborn, Inc., or approved equal.

## 2.4 CONCRETE MIXES

A. Provide concrete with the compressive strengths shown on the Drawings. When such strengths are not shown on the Drawings, provide the following 28-day strengths as minimum:

| | | |
|---|---|---|
| 1. | All structural concrete except as indicated in Nos. 2 and 3 below or as noted otherwise on the plans | 4000 psi |
| 2. | All sidewalks, curbs and gutters, and unreinforced foundations | 4000 psi |
| 3. | Thrust blocking, backfill or encasement for piping, and concrete fill | 2500 psi |
| 4. | Prestressed or precast concrete: | 5000 psi |

B. Maximum water cement ratios:

| | |
|---|---|
| 4000 psi concrete | 0.5 |
| 3000 psi concrete | 0.53 |
| 2500 psi concrete | 0.67 |

C. Entrained air:

| | |
|---|---|
| 3000 and 4000 psi concrete | 5% ± 1% |
| 2500 psi concrete | Not Required |

D. Slump:

| | |
|---|---|
| 3000 and 4000 psi concrete | 4" ± 1" |
| 2500 psi concrete | 5" ± 1" |

E. Production of concrete:

1. General: Concrete shall be ready mixed and shall be batched, mixed and transported in accordance with ASTM C94 except as otherwise indicated.
2. Monitor time and mix proportions by plant delivery slips.
3. Air entraining admixtures: Add air entraining admixture into the mixture as a solution and measure by means of an approved mechanical dispensing device.
4. Water reducing and retarding admixture: Add water reducing and retarding admixture and measure as recommended by the manufacturer.
5. Addition of water to the mix upon arrival at the job site shall not exceed that necessary to compensate for a 1" loss in slump, nor shall the design maximum water-cement ratio be exceeded. Water shall not be added to the batch at any later time.
6. Weather conditions: Control temperature of mix as required by ACI 306 "Cold Weather Concreting" and by ACI 305 "Hot Weather Concreting".

## PART 3 - EXECUTION

### 3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

B. Water, mud, organic, and other detrimental material shall be removed from excavations before concrete is deposited.

C. Notify the Engineer prior to placing concrete and place no concrete until the formwork, reinforcing and embedded items have been observed by the Engineer.

### 3.2 FORMWORK

A. General:

1. Construct forms in conformance with ACI 347.
2. Design, erect, support, brace and maintain formwork so it will safely support vertical and lateral loads which might be applied until such loads can be supported safely by the concrete structure.
3. Construct forms to the exact sizes, shapes, lines and dimensions shown, and as required to obtain accurate alignment, location, grades, level and plumb work in the finished structure.
4. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and prevent fins.

B. Form construction and erection:

1. Construct forms in conformance with ACI 347.
2. Provide for openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts and other embedded items as required.
3. Hold inner and outer forms for vertical concrete together with combination steel ties and spreaders approved by the Engineer.
4. Unless specifically stated otherwise, provide 3/4" chamfer at all exposed edges of concrete.
5. Provide temporary openings in the formwork where necessary to facilitate cleaning and inspection of the formwork.
6. Coat form contact surfaces with approved form coating compound prior to placing reinforcing steel.
7. Do not allow excess form coating material to accumulate in the forms or to come in contact with reinforcing surfaces which will bond to fresh concrete.
8. Side forms for footings may be omitted, and concrete may be placed directly against excavation only when requested by the Contractor and approved by the Engineer.
9. Provide a positive means of adjustment of shores and struts and ensure that all settlement is taken up during concrete placing.
10. Construct blockouts and formed openings of sufficient size and proper location to permit final alignment of items within it or passing through it.
    a. Allow sufficient space for grouting, packing or sealing around any items penetrating the opening as may be required to ensure watertightness.
    b. Provide openings with continuous keyways with waterstops where required, and provide a slight flare to facilitate grouting and the escape of entrapped air during grouting.
    c. Provide only blockouts or openings that are shown on the drawings or otherwise approved by the Engineer.

C. Formwork reuse: Reuse only forms that are in good condition and which maintain a uniform surface texture on expose concrete surfaces.

1. Apply a light sanding as necessary to obtain a uniform texture.
2. Plug unused tie holes and penetrations flush with the form surface.

D. Removal of forms:

1. Do not disturb or remove forms until the concrete has hardened sufficiently to permit form removal with complete safety. Do not remove shoring until the member has acquired sufficient strength to support its own weight, the load upon it, and the added load of construction.
2. Do not remove forms before the following minimum times without prior approval from the Engineer:

| | | |
|---|---|---|
| a. | Sides of footings or slabs on grade | 24 hrs |
| b. | Walls not supporting load | 48 hrs |
| c. | Vertical sides of beams | 48 hrs |
| d. | Columns not supporting load | 48 hrs |
| e. | Suspended slabs or beam bottoms (forms only) | 10 days |

3. In determining the minimum stripping times, consider only the cumulative time during which the ambient temperature of the air surrounding the concrete is above 50°.
4. Do not remove shoring for suspended slabs or beams until the concrete has reached 75% of the specified 28 day strength.
5. When reshoring or backshoring is permitted or required, plan the operations in advance and submit procedures to the Engineer for approval.

a. Design and plan all reshoring operations to support all construction loading and in accordance with ACI 347.

6. Exercise care in removing forms from finished concrete surfaces so that surfaces are not marred or gouged and that corners are true, sharp and unbroken.
7. Do not permit steel spreaders, form ties, or other metal to project from or be visible on any concrete surface except where so shown on the drawings.
8. Whenever the formwork is removed during the curing period, continue to cure the exposed concrete by one of the methods specified herein.

## 3.3 EMBEDDED ITEMS

A. Embedded items: Set anchor bolts and other embedded items accurately and securely in position in the forms until the concrete is placed and set.

1. Use templates where practical for all anchor bolts.
2. Check locations of all anchor bolt and special castings prior to placing concrete and verify locations after concreting.

B. Piping cast in concrete:

1. Install and secure sleeves, wall pipes and pipe penetrations before placing concrete.
2. Do not weld or otherwise attach piping to reinforcing steel.
3. Support piping to be encased in concrete securely and on firm foundation so as to prevent movement or settlement during concreting.

C. Locate electrical conduit so that it will not impair the strength of the construction.

1. Do not use conduits running within (not passing through) a slab, wall or beam that are larger in outside diameter than 1/3 overall concrete thickness unless otherwise approved by the Engineer.
2. Do not space conduits closer than three conduit diameters apart unless otherwise approved by the Engineer.

## 3.4 REINFORCEMENT

A. General: Comply with the specified codes and standards and Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports and as herein specified.

1. Clean reinforcement and remove loose dust and mill scale, earth, and other materials which reduce or destroy bond with concrete.
2. Position and secure reinforcement against displacement by forms, construction, and the concrete placement operations.
3. Use adequate number of ties to secure reinforcing.
4. Do not weld or field bend reinforcing without prior approval by the Engineer.

B. Placing reinforcing:

1. Provide and install all chairs, runners, bolsters, standees and other accessories in sufficient quantities to satisfactorily position the reinforcing and hold it in place during concrete placement.
2. Support reinforcing for slabs on ground on chairs or bolsters with stand plates or a properly sized concrete cube.
   a. Use concrete bricks as supports only as approved by the Engineer.
3. Secure and tie dowels in place prior to placing concrete. Do not press dowels into wet concrete.

C. Concrete cover: Unless otherwise indicated on the drawings or specified herein, install reinforcing with clear concrete coverage in conformance with ACI 318.

1. All reinforcement, regardless of size, exposed to water or sewage shall have 2" cover.
2. Place reinforcement a minimum of 2" clear of any openings or metal pipe or fittings.

D. Splicing reinforcement: Splice reinforcement steel in accordance with the latest revisions of ACI 318 "Building Code Requirements for Reinforced Concrete" unless shown otherwise on the drawings.

1. All splices at wall corners or intersections and at wall and foundation intersections shall be Class B tension splices per ACI 3-18, Sections 12.2.2 and 12.15.
2. All other splices of vertical or horizontal steel in walls shall be Class B tension splices as per ACI 318 per ACI 318, Sections 12.2.2 and 12.15.
3. Horizontal ring steel in circular, non-prestressed concrete tanks shall be Class B tension splices and the splices shall be staggered so that no more than 50% of the bars are spliced at any one location.
4. All welded or mechanical splicing devices shall develop 125% of the yield strength of the bar.
5. Column vertical bars shall lap 30 bar diameters with dowels at the base of the column unless otherwise noted. Dowels shall be the same size and quantity as column vertical bars unless otherwise noted.
6. All splices not otherwise shown or specified shall be Class B tension lap splices per ACI 318, Sections 12.2.2 and 12.15.

E. Tolerances: Place bars in the locations indicated within the tolerances conforming to the CRSI "Manual of Standard Practice".

F. Welded wire mesh: Install welded wire fabric in as long of a length as practicable and lay flat before placing concrete.

1. Use only mat welded wire fabric. Do not use welded wire fabric from rolls.
2. Support and tie mesh to prevent movement during concrete placement.
3. Lap adjoining pieces at least one full mesh and lace splices with wire.
4. Provide, at a minimum, supports for welded wire fabric according to the Table in Section 2.2.D.3. Confirm the adequacy of the support spacings listed therein for the anticipated construction loads. Increase the number of supports, if necessary, to assure that the final position of the welded wire fabric will conform to that shown on the drawings.
5. Do not place welded wire fabric on the subbase surface and then hook or "pull up" the reinforcement during concrete placement.
6. Do not lay welded wire fabric on top of the freshly placed concrete and then "walk it" into place.

## 3.5 PLACING CONCRETE

A. Preparation:

1. Remove foreign matter accumulated in the forms.
2. Rigidly close openings left in the formwork.
3. Wet wood forms sufficiently to tighten up cracks. Wet other material sufficiently to maintain workability of the concrete.
4. Use only clean tools.
5. Provide and maintain sufficient tools and equipment on hand to facilitate uninterrupted placement of the concrete.

6. Before commencing concrete, inspect and complete installation of formwork, reinforcing steel and all items to be embedded or cast-in.

B. Conveying:

1. Transport and handle concrete from the truck to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients to maintain the quality of the concrete.
2. Provide equipment for lifting, dumping, chuting, pumping or conveying the concrete, of such size and design as to ensure a practically continuous flow of concrete at the delivery and without separation of materials.
3. Use hopers and elephant trunks where necessary to prevent the free fall of concrete for more than 4'.
4. Do not use concrete that is not placed within 1-1/2 hours after water is first introduced into the mix unless the slump is such that it meets the specified limits without the addition of water to the batch.

C. Placing:

1. Deposit concrete as nearly as practicable in its final location so as to avoid separation due to rehandling and flowing.
2. Deposit concrete in horizontal layers not deeper than 2', avoiding inclined layers.
3. Place concrete at such a manner that concrete upon which fresh concrete is deposited is still plastic.
4. Bring slab surfaces to the correct level with screeds set to the proper elevation.

D. Hot weather placement: Place concrete in hot weather in accordance with ACI 305 "Hot Weather Concreting" and as specified herein.

1. Do not place concrete whose temperature exceeds 100°F.
2. Thoroughly wet forms and reinforcing prior to placement of concrete.
3. Use additional set retarder as necessary to increase set time.
4. Limit the size of the pour where it may reduce the likelihood of cold joints due to reduced set time.
5. Shade the fresh concrete as soon as possible after placing.
6. Start curing as soon as the concrete is sufficiently hard to permit without damage.

E. Cold weather placement: Place concrete in cold weather in accordance with ACI 306 and as specified herein.

1. Except when authorized specifically by the Engineer, do not place concrete when the atmospheric temperature is below 40°F.
2. When cold weather placement is approved by the Engineer, heat either the mixing water or aggregate or both so that the concrete temperature is between 65°F and 85°F.
3. Protect the freshly placed concrete by adequate housing or covering and provide heat to maintain a temperature of not less than 50°F for not less than four days.
4. Do not add salts, chemicals, or other materials to the concrete mix to lower the freezing point of the concrete.

F. Consolidation:

1. Consolidate each layer of concrete immediately after placing, by use of internal concrete vibrators supplemented by hand spading, rodding, or tamping.

a. Use vibrators having a 2" head diameter and a minimum frequency of 8000 vibrations per second.
b. Provide sufficient number of vibrators to properly consolidate the concrete, keeping up with placement operations.
c. Provide at least one spare vibrator on site.

2. Insert and withdraw vibrators at points approximately 18" apart.
3. Do not vibrate forms or reinforcement.
4. Do not use vibrators to transport concrete inside the forms.

## 3.6 PROTECTION

A. Protect the surface finish of newly placed concrete from damage by rainwater or construction traffic.

B. Do not apply design loads to structures until the concrete has obtained the specified strength.

1. Do not backfill against walls until they have reached the specified strength and all supporting or bracing walls, slabs, etc. have also reached the specified strength, unless otherwise permitted by the Engineer.
2. Protect structures from construction overloads.

## 3.7 CURING

A. Beginning immediately after placement, protect concrete from premature drying, excessively hot and cold temperatures and mechanical injury.

B. Continuously cure concrete for a period of not less than 7 days after placement.

1. When seven-day cylinder breaks indicate, in the opinion of the Engineer, the possibility of low strength concrete, provide additional curing as per the request of the Engineer.
2. When temperatures during the curing period fall below 40°F, provide additional curing time as directed by the Engineer.

C. Unless otherwise directed by the Engineer, cure concrete not in contact with forms in accordance with one of the following procedures:

1. Ponding or sprinkling: Keep entire concrete surface wet by continuously sprinkling or by allowing water to pond, covering all surfaces.
2. Wet burlap: Thoroughly wet and cover all concrete surfaces with wet burlap mats as soon as the concrete has set sufficiently to avoid marring the surface.
   a. Keep the burlap continuously wet during the curing period.
3. Curing blankets: Thoroughly wet concrete surfaces to be cured and cover with curing blankets as soon as the concrete has set sufficiently to avoid marring the surface.
   a. Weight the blankets down to maintain close contact with the concrete surface.
   b. Use sheets of waterproof kraft paper with the joints between sheets taped continuously; or
   c. Use sheets of 4 mil or thicker polyethylene with the joints between sheets continuously taped.
4. Wet sand: Apply a layer of sand over the entire surface and keep it continuously wet.
5. Curing compound: Apply curing compound immediately after completion of the finish on uniformed surfaces and within two hours after removal of forms on formed surfaces.

a. Spray the entire surface with two coats of liquid curing compound, applying the second coat in the direction of 90° to the first coat.
b. Apply compound in accordance with the manufacturer's instructions to cover the surface with a uniform film which will seal thoroughly.

D. Hot weather: When necessary, provide wind breaks, shading, fog spraying, sprinkling, ponding or wet covering with a light colored material applying as quickly as concrete hardening and finishing operations will allow.

## 3.8 CONCRETE FINISHING

A. Finish schedule: Unless otherwise indicated on the drawings, finish all concrete surfaces in accordance with the following schedule:

1. Form finish: Formed surfaces not ordinarily exposed to view, including:
   a. Interior walls of open tanks below a line one foot lower than the lowest normal water level.
   b. The underside of slabs not exposed to view.
   c. Walls below grade.
2. Cementitious coating: All formed surfaces exposed to view including:
   a. Interior walls of tanks above a line one foot lower than the lowest normal water level.
   b. The underside of slabs, soffits, etc. exposed to view.
3. Float finish: Slab surfaces not exposed to view or not receiving an applied thin finish, including:
   a. Bottom slabs of tanks or structures containing water sewage or other liquid.
   b. Foundations not exposed to view.
   c. Roof slabs to be covered with insulation and/or built-up roofing.
4. Trowel finish: Interior slab surfaces exposed to view or to receive an applied thin film coating or floor finish, including:
   a. Interior, indoor slabs and floors of buildings.
   b. Surfaces on which mechanical equipment moves.
   c. Floors receiving vinyl tile, resilient flooring, carpet, paint, etc.
5. Broom finish: Exterior, outdoor slabs exposed to view including:
   a. Outdoor floor slabs and walkways.
   b. Other floors which may become wet or otherwise require a non-skid surface.
   c. Sidewalks and concrete pavements.
6. Scratch finish: Surfaces which are to receive a thick topping or additional concrete cast against them including:
   a. Surfaces receiving concrete equipment pads.
   b. Floors receiving concrete topping.
   c. Construction joints not otherwise keyed.
7. Edge finish: Exposed edges of slabs not receiving chamfer including:
   a. Sidewalk edges and joints.
   b. Pavement edges and joints.
   c. Other slab edges not chamfered.

B. Finishing procedures:

1. Form finish:
   a. Repair defective concrete.
   b. Fill depressions deeper than 1/4".
   c. Fill tie holes.
   d. Remove fins exceeding 1/8" in height.
2. Cementitious finish:
   a. Patch all tie holes and defects and remove all fins.

b. Within one day of form removal, fill all bug holes, wet the surfaces and rub with carborundum brick until a uniform color and texture are produced; or

c. Dampen surfaces, brush apply a grout slurry consisting of 1 part portland cement to 1-1/2 parts sand, and rub the surface vigorously with a stone. Remove all excess grout.

d. Provide a two coat cement base waterproofing, sealing finish of Thoroseal and Thoroseal Plaster Mix as manufactured by Standard Dry Wall Products, Inc. or an approved equal.

1) Patch all tie holes and defects and removal all fins, and clean surface of all dirt, laitance, grease, form treatments, curing compounds, etc.

2) Key coat: Apply key coat of Thoroseal at a rate of two (2) lbs. per sq. yd. by fiber brush. Mix material using one part of Acryl 60 to three parts clean water. Should material start to drag during application, dampen surface with water. During hot weather periods, dampen surfaces with water prior to application of key coat material. Key coat shall be allowed to cure for five (5) days before applying finish coat.

3) Apply a finish coat consisting of a four (4) to six (6) lbs. per sq. yd. application of Thoroseal Plaster Mix using steel trowel or spray gun. Color to be selected by the Owner. Mix dry material using one (1) part Acryl 60 to three (3) parts clean water. Firmly press the mix into all voids and level with a steel trowel. When surface is set so that it will not roll or lift, float it uniformly using a sponge float.

3. Float finish:
   a. Begin floating when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation.
   b. Cut down all high spots and fill all low spots and float the slab to a uniform sandy texture.
4. Trowel finish:
   a. Float finish as specified herein.
   b. Power trowel to a smooth surface free of defects.
   c. After the surface has hardened sufficiently, hand trowel until a ringing sound is produced as the trowel is moved over the concrete surface.
5. Broom finish:
   a. Float finish as specified herein.
   b. Provide a scored texture by drawing a broom across the surface.
6. Scratch surface:
   a. Screed the surface to the proper elevations.
   b. Roughen with rakes or stiff brushes.
7. Edge finish: Tool slab edges and joints with a 1/4" radius edging tool.

## 3.9 SURFACE REPAIR

A. Patching mortar:

1. Make a patching mortar consisting of 1 part portland cement to 2-1/2 parts sand by damp loose volume.
2. Mix the mortar using one part acrylic bonding admixture to two parts water.

B. Tie holes: Clean and dampen all tie holes and fill solidly with patching mortar.

C. Surface defects:

1. Remove all defective concrete down to sound solid concrete.
2. Chip edges perpendicular to the concrete surface or slightly undercut, allowing no feather edges.

3. Dampen surfaces to be patched.
4. Patch defects by filling solidly with repair mortar.

D. Allow the Engineer to observe the work before placing the patching mortar.

E. Repair defective areas greater than 1 sq. ft. or deeper than 1-1/2" as directed by the Engineer using materials approved by the Engineer at no additional expense to the Owner.

3.10 JOINTS

A. Construction joints:

1. Unless otherwise approved by the Engineer, provide construction joints as shown on the drawings.
2. If additional construction joints are found to be required, secure the Engineer's approval of joint design and location prior to start of concrete placement.
3. Continue all reinforcing across construction joints and provide 1-1/2" deep keyways unless indicated otherwise on the drawings.
   a. Form keyways in place.
4. Provide waterstops in all construction joints of liquid containing structures, structures below grade or other structures as shown on the drawings.

B. Expansion joints:

1. Provide expansion joints of size, type and locations as shown on the drawings.
2. Do not permit reinforcement or other embedded metal items that are being bonded with concrete (except smooth dowels bonded on only one side of the joints, where indicated on the drawings) to extend continuously through any expansion joint.
3. Provide waterstops where required.

C. Control or contraction joints:

1. Locate and construct control and contraction joints in accordance with the Drawings.
2. Where no specific joint pattern is indicated in slabs on grade or concrete pavements, submit a proposed joint layout to the Engineer for approval.
3. Where no specific joint details are shown on the drawings, joints may be tooled, preformed or saw-cut.
4. Saw-cut joints as soon as the concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw.

3.11 FIELD QUALITY CONTROL

A. Concrete cylinder tests:

1. During construction, prepare test cylinders for compressive strength testing, using 6" diameter by 12" long single use molds, complying with ASTM C31.
   a. Make a set of three test cylinders from each pour of 50 cubic yards or less, plus one additional set of cylinders for each additional 50 cubic yards or fraction thereof.
   b. Identify each and tag cylinder as to date of pour and location of concrete which it represents.
   c. Deliver cylinders to testing lab selected by the Owner.
   d. Cost for preparation and delivery of cylinders shall be borne by the Contractor. Cost for testing cylinders will be borne by the Owner.

2. Should strengths shown by test cylinders fail to meet specified strengths for the concrete represented, then:
   a. Engineer shall have the right to require changes in the mix proportions as he deems necessary on the remainder of the work.
   b. Additional curing of those portions of the structure represented by the failed test cylinders shall be accomplished as directed by the Engineer.
   c. Upon failure of the additional curing to bring the concrete up to specified strength requirements, strengthening or replacement of those portions of the structure shall be as directed by the Engineer.
   d. The Engineer may require additional testing of concrete in question by either non-destructive methods such as the Swiss Hammer, Windsor Probe or Ultrasonics or by coring and testing the concrete in question in accordance with ASTM C42. Such testing shall be performed at no additional cost to the Owner.

B. Other field concrete tests:

1. Slump tests: Either the Engineer or a testing laboratory representative will make slump tests of concrete as it is discharged from the mixer.
   a. Slump test may be made on any concrete batch at the discretion of the Engineer.
   b. Failure to meet specified slump requirements (prior to addition of any superplasticizers) will be cause for rejection of the concrete.
2. Temperature: The concrete temperature may be checked at the discretion of the Engineer.
3. Entrained air: Air content of the concrete will be checked by a representative of the testing laboratory at the discretion of the Engineer.

C. Coordination of laboratory services: The Contractor shall be responsible for coordination of laboratory services.

1. Maintain a log recording quantities of each type of concrete placed, date and location of pour.
2. Inform the testing laboratory of locations and dates of concrete placement and other information as required to be identified in the laboratory's test reports.

D. Tests required because of extensive honeycombing, poor consolidation of the concrete or any suspected deficiency in the concrete will be paid for by the Contractor.

E. Dimensional tolerances:

1. Dimensional tolerances for allowable variations from dimensions or locations of concrete work, including the locations of embedded items shall be as given in ACI 301.
2. Where anchor bolts or other embedded items are required for equipment installation, comply with the manufacturer's tolerances if more stringent than those stated in ACI 301.

F. Watertight concrete:

1. All liquid containing structures, basements or pits below grade shall be watertight.
2. Any visible leakage or seepage shall be repaired as instructed by the Engineer at no expense to the Owner.

3. Where physical evidence of honeycombing, cold joints or other deficiencies which may impair the watertightness of a structure exists, the Engineer may at his discretion call for leak testing of the structure.
   a. Fill the structure with water and allow to stand for not less than 48 hours.
   b. Make repairs on the structure until all visible leaks are sealed and the leakage rate of the water in the structure is less than 0.1% of the volume held in the structure per day.
   c. The cost of testing and repairs shall be performed at no expense to the Owner.

G. Concrete which fails to meet strength requirements, dimensional tolerances, watertightness criteria, or is otherwise deficient due to insufficient curing, improper consolidation or physical damage shall be replaced or repaired as instructed by the Engineer at no expense to the Owner.

## 3.12 MEASUREMENT AND PAYMENT

A. No measurement or direct payment will be made for the work under this Section and all costs for same shall be included in the price bid for the item in which the concrete work is an integral part.

END OF SECTION

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to

consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

END OF SECTION

# SECTION 260513

# MEDIUM-VOLTAGE CABLES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

### 1.2 DEFINITIONS

A. Jacket: A continuous nonmetallic outer covering for conductors or cables.

B. NETA ATS: Acceptance Testing Specification.

C. Sheath: A continuous metallic covering for conductors or cables.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Material Certificates: For each type of cable and accessory.

C. Field quality-control reports.

### 1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.6 FIELD CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cables:
   a. Okonite Company (The).

2. Cable Splicing and Terminating Products and Accessories:

   a. Adalet; a Scott Fetzer company.
   b. DSG-Canusa; a Shawcor company.
   c. Engineered Products Company.
   d. G&W Electric Company.
   e. MP Husky.
   f. RTE Components; Cooper Power Systems, Inc.
   g. Thomas & Betts Corporation.
   h. Thomas & Betts Corporation/Elastimold.
   i. 3M; Electrical Markets Division.
   j. Tyco Electronics; Raychem Products.

B. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

## 2.2 SYSTEM DESCRIPTION

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

B. Comply with IEEE C2 and NFPA 70.

## 2.3 CABLES

A. Cable Type: Type MV 105.

B. Comply with UL 1072, AEIC CS8, and ICEA S-93-639/NEMA WC 74.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 15kV.
2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape, helically applied over semiconducting insulation shield.

G. Three-Conductor Cable Assembly: Three insulated, shielded conductors cabled together with ground conductors.

1. Circuit Identification: Color-coded tape (black, red, blue) under the metallic shielding.

## 2.4 CONNECTORS

A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

B. Copper-Conductor Connectors: Aluminum barrel crimped connectors.

## 2.5 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

## 2.6 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Dead-Break Cable Terminators: Elbow-type unit with 600A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

E. Test-Point Fault Indicators: Applicable current-trip ratings and arranged for installation in test points of load-break separable connectors, and complete with self-resetting indicators capable of being installed with shotgun hot stick and tested with test tool.

F. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

## 2.7 SPLICE KITS

A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

## 2.8 MEDIUM-VOLTAGE TAPES

A. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 C operation. Minimum 3/4 inch wide.

## 2.9 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

## 2.10 FAULT INDICATORS

A. Indicators: Manually reset fault indicator with inrush restraint feature, arranged to clamp to cable sheath and provide a display after a fault has occurred in cable. Instrument shall not be affected by heat, moisture, and corrosive conditions and shall be recommended by manufacturer for installation conditions.

B. Resetting Tool: Designed for use with fault indicators, with moisture-resistant storage and carrying case.

## 2.11 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install "buried-cable" warning tape 12 inches above ductbanks.

E. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

F. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

G. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

H. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

I. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

J. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

## 3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.
4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.
5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

## 2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

## 2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

## 2.4 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of

cable or conduit. Include type and number required for material and size of raceway or cable.

2. Pressure Plates: Plastic. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Class 1 Control Circuits: Type THHN-THWN, in raceway.

F. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

## 3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

## 3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

B. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

C. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

D. Cut sleeves to length for mounting flush with both wall surfaces.

E. Extend sleeves installed in floors 2 inches above finished floor level.

F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

H. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

I. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

## 3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with the requirements described in this Section, provide products by one of the listed manufacturers in the Sub-Sections below.

1. Ground Rods:

a) Copperweld Corp.
b) Eritech / Erico International Corporation
c) Galvan Industries, Inc.
d) Harger Lightning and Grounding, Inc.
e) Robbins Lightning, Inc.

2. Grounding electrode connectors:

a) Exothermic type:

1) Cadweld / Erico International Corporation
2) Furseweld
3) Harger Lightning and Grounding, Inc. (Ultraweld)
4) ThermOweld, a division of Continental Industries

b) Copper compression type:

1) Dossert Corp.
2) Framatome Connectors / Burndy
3) Harger Lightning and Grounding, Inc.
4) ILSCO
5) O. Z. Gedney / EGS Electrical Group
6) Panduit Corp.
7) Robbins Lightning, Inc.

## 2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

## 2.3 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

## 2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by10 feet in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

## 3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a) Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
b) Perform tests by fall-of-potential method according to IEEE 81.

B. Report measured ground resistances that exceed the following values:

1. Substations and Pad-Mounted Equipment: 5 ohms.
2. Manhole Grounds: 10 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Section 260548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

## 2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by IBC. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slottedsupport system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

SECTION 260543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct buried concrete-encased ductbanks and duct runs.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for excavation, backfill, and related items for ducts, manholes, and handholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
2. Accessories for handholes, boxes, and other utility structures.
3. Warning tape.
4. Warning planks.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
5. Drawings shall be signed and sealed by a State of South Carolina professional engineer.

C. Qualification Data: For professional engineer and testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Construction Manager no fewer than fourteen days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Engineer.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape.

2.3 NON-METALIC DUCT ENCASEMENT

A. Concrete: Conform to Division 3 for concrete and reinforcing.

1. Strength: 3,000 PSI minimum at 28-day compressive strength.
2. Aggregate for Duct Encasement: 3/8-inch maximum size.

B. Dowel pins: reinforcing steel, epoxy set in drilled holes in concrete walls.

2.4 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

## 2.5 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray or Green to match installed surface.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC."
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. CDR Systems Corporation.
   d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. Christy Concrete Products.
   d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Carson Industries LLC.
   b. Christy Concrete Products.
   c. Nordic Fiberglass, Inc.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicatedDucts for

B. Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths, Walks, and Driveways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
2. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
3. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbfvertical loading.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless

otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psighydrostatic pressure.

E. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

F. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feetof duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inchesbetween tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inchesin nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
7. Set elevation of bottom of duct bank below the frost line.
8. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inchesof concrete.
10. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

## 3.5 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

## 3.6 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

## 3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

## 3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION

SECTION 260548

VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Spring isolators.
   3. Restrained spring isolators.
   4. Channel support systems.
   5. Restraint cables.
   6. Hanger rod stiffeners.
   7. Anchorage bushings and washers.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. See code sheet and IBC for seismic design data.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
   a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
   c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Qualification Data: For professional engineer.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ace Mountings Co., Inc.
   2. Amber/Booth Company, Inc.
   3. California Dynamics Corporation.
   4. Isolation Technology, Inc.
   5. Kinetics Noise Control.
   6. Mason Industries.
   7. Vibration Eliminator Co., Inc.
   8. Vibration Isolation.
   9. Vibration Mountings & Controls, Inc.

B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed

height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

## 3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:
   1. Install restrained isolators on electrical equipment.
   2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

## 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a

different structural element from the one supporting them as they approach equipment.

## 3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Engineer, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.
   6. Measure isolator deflection.
   7. Verify snubber minimum clearances.
   8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

## 3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

## 3.7 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

END OF SECTION 260548

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

## 1.7 CLOSEOUT SUBMITTALS

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

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

## 1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

E. Comply with NFPA 70.

## 1.9 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

## 2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 265600

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge.

C. Luminaire: Complete lighting fixture, including ballast housing if provided.

D. Pole: Luminaire support structure, including tower used for large area illumination.

E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
   a. Photometric data shall be certified by a qualified independent testing agency.
6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For luminaires and **poles** to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide

free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: two years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

a. Color: Match campus standard.

## 2.3 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit

operation without reduction of average lamp life. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F.
3. Normal Ambient Operating Temperature: 104 deg F.

2.4 HID LAMPS

A. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.

2.6 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.

B. Poles: ASTM B 209, 5052-H34 marine sheet alloy with access handhole in pole wall.
   1. Shape: Round, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
   a. Color: Match campus standard.

## PART 3 - EXECUTION

### 3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming.

### 3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

### 3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

### 3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

## 3.5 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

## 3.6 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION