SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arc-Flash Study Software Developer Retain "Product Certificates" Paragraph below to require submittal of product certificates from manufacturers.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

C. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."

F. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

G. Arc-Flash Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance.
6. Incident energy.
7. Hazard risk category.
8. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Flash protection boundary.
4. Hazard risk category.
5. Incident energy.
6. Working distance.
7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies:

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260572 "Overcurrent Protective Device Short-Circuit Study."
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

C. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on the one-line diagram on Drawings[and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article]. Call discrepancies to the attention of Architect.
2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.

4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.4 LABELING

A. Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for each of the following locations:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Control panel.

3.5 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.6 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 260574

SECTION 260923 - LIGHTING CONTROL DEVICES

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 lighting control devices:

1. Time switches.
2. Outdoor and indoor photoelectric switches.
3. Indoor occupancy and vacancy sensors.
4. Digital timer light switch
5. Lighting contactors.
6. Emergency shunt relay

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

a. Refer to specifications 017823 Operation and Maintenance Data for additional O&M requirements

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.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Leviton Mfg. Company Inc.
5. Lightolier Controls; a Genlyte Company.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Paragon Electric Co.; Invensys Climate Controls.
8. Square D; Schneider Electric.
9. TORK.
10. Touch-Plate, Inc.
11. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST, DPST, and DPDT.
2. Contact Rating: 30-A inductive or resistive, 240-V ac, and 20-A ballast load, 120/240-V ac.
3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
4. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
5. Programs: channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule.
6. Programs: channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule with skip-a-day weekly schedule.
7. Programs: channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
8. Programs: channels; each channel shall be individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
9. Programs: channels; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
10. Program: an annual holiday schedule that overrides the weekly operation on holidays.
11. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
12. Astronomic Time: All channels.
13. Battery Backup: For schedules and time clock.

C. Electromechanical-Dial Time Switches: Type complying with UL 917.

1. Contact Configuration: SPST, DPST, SPDT, and DPDT.
2. Contact Rating: 30-A inductive or resistive, 240-V ac, 20-A ballast load, 120/240-V ac.
3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
4. Astronomic time dial.
5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
6. Skip-a-day mode.
7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Novitas, Inc.
6. Paragon Electric Co.; Invensys Climate Controls.
7. Square D; Schneider Electric.
8. TORK.
9. Touch-Plate, Inc.
10. Watt Stopper (The).

B. Description: Solid state, with SPST and DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with SPST and DPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 30-second minimum, to prevent false operation.
3. Lightning Arrester: Air-gap type.
4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.3 INDOOR OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:

1. Hubbell Lighting.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. RAB Lighting, Inc.
6. Sensor Switch, Inc.
7. TORK.
8. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. operation of the sensor.

2.4 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Separate power pack.
4. Hardwired connection to switch BAS; and BAS and lighting control system.
5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
6. Operation:

    a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20 A LED load at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
10. Mounting:

a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

B. PIR Type: Wall or Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch.
2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft.when mounted on a 10 ft. high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 3000 sq. ft. when mounted 48 inch above finished floor.

C. Ultrasonic Type: [Wall] [Ceiling] mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96 inch high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96 inch high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 ft. when mounted on a 10 ft.high ceiling in a corridor not wider than 14 ft..
6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 3000 sq. ft. when mounted 84 inch above finished floor.

D. Dual-Technology Type: [Wall] [Ceiling] mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft.when mounted on a 96 inch high ceiling.

4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of [3000 sq. ft.] when mounted 48 inch above finished floor.

2.5 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS, and using hardwired connection.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time, delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800 VA LED load at 120 V.

B. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Match the circuit voltage 120 V Dual voltage – 120V.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: White.
11. Faceplate: Color matched to switch.

C. Wall-Switch Sensor:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: PIR.
3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Match the circuit voltage 120 V, Dual voltage, 120 and 277 V.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: White.
11. Faceplate: Color matched to switch.

2.6 LIGHTING CONTACTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE Industrial Systems; Total Lighting Control.
5. Grasslin Controls Corporation; a GE Industrial Systems Company.
6. Hubbell Lighting.
7. Lithonia Lighting; Acuity Lighting Group, Inc.
8. MicroLite Lighting Control Systems.
9. Square D; Schneider Electric.
10. TORK.
11. Touch-Plate, Inc.
12. Watt Stopper (The).

B. Description: Electrically operated and electrically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings and schedule, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation.

2.7 EMERGENCY SHUNT RELAY

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. LVS, Inc.
2. Sensor Switch
3. Watt Stopper

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts (dual-contact where required); complying with UL 924.

1. Coil Rating: 120-277 V or as indicated on drawings.

2.8 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

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

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

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.

E. 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.

F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 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 panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards 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 NEMA PB 1.

F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

C. 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 Architect and Construction Manager Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's and Construction Manager's written permission.
3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250
b. Outdoor Locations: NEMA 250, Type 3R.
c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5 or Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual vertical sections.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product 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.

C. Panelboards: NEMA PB 1, power and feeder distribution type.

D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

E. Mains: Circuit breaker, Fused switch, and Lugs only.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-inBolt-on circuit breakers.

G. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

H. Branch Overcurrent Protective Devices: Fused switches.

I. Contactors in Main Bus: NEMA ICS 2, Class A, electrically and/or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 120-V branch circuit.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product 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.

C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

D. Mains: Circuit breaker or lugs only.

E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

F. Contactors in Main Bus: NEMA ICS 2, Class A, electrically and/or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 120-V branch circuit.

G. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

H. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product 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.

C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. 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.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Compression and Mechanical style, suitable for number, size, trip ratings, and conductor materials.
c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
f. Shunt Trip: 120 and/or 24 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and/or NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and/or NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim [90 inches (2286 mm) above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. The CxA must be provided with a least two weeks notice of any scheduled field quality control testing.

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

D. Perform tests and inspections.

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.

E. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

F. 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. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

G. Panelboards will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports, including a certified report that identifies panelboards included 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 component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

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 equipment for electricity metering by utility company and electricity metering by Owner.

1.3 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

1.4 SUBMITTALS

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

B. Shop Drawings: For electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

C. Field quality-control reports.

D. Operation and Maintenance Data. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.
2. Software licenses.
3. Software service agreement.
4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.5 QUALITY ASSURANCE

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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

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 Architect and Construction Manager no fewer than two (2) days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect's and Construction Manager's written permission.

1.8 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two (2) years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide thirty (30) days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

A. Meters will be furnished by utility company.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets: Comply with requirements of electrical-power utility company.

D. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only and/or disconnect device, wireways, tenant meter socket modules, and tenant feeder circuit breakers arranged in adjacent vertical sections. Assembly shall be complete with interconnecting buses and other features as specified below.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric

2. Comply with requirements of utility company for meter center.
3. Housing: NEMA 250, Type 3R enclosure.
4. 100,000 A symmetrical at rated voltage.
5. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers.
6. Main Disconnect Device: Fusible switch, series-combination rated by circuit-breaker manufacturer to protect downstream feeder and branch circuit breakers.
7. Tenant Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect circuit breakers in downstream tenant and to house loadcenters and panelboards that have 22,000-A interrupting capacity.

   a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems" with legend identifying tenant's address.
   b. Physical Protection: Tamper resistant, with hasp for padlock.

8. Meter Socket: Rating coordinated with indicated tenant feeder circuit rating.
9. Surge Protection: For main disconnect device, comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to NECA 400 switchboard installation requirements.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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. Tests and Inspections:

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for 8 hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

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. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Wall-box motion sensors.
4. Snap switches and wall-box dimmers.
5. Wall switch sensor light switches with dual technology sensors.
6. Digital timer light switches

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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 NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; GF20.
b. Pass & Seymour; 2084.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; L520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.

3. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221L.
b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.

3. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995.
b. Hubbell; HBL1557.
c. Leviton; 1257.
d. Pass & Seymour; 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 1995L.
b. Hubbell; HBL1557L.
c. Leviton; 1257L.
d. Pass & Seymour; 1251L.

2.6 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.7 OCCUPANCY SENSORS

A. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Cooper; 6111 for 120 V, 6117 for 277 V.
    b. Hubbell; WS1277.
    c. Leviton; ODS 10-ID.
    d. Pass & Seymour; WS3000.
    e. Watt Stopper (The); WS-200.

3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

B. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Hubbell; AT120 for 120 V, AT277 for 277 V.
    b. Leviton; ODS 15-ID.

3. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

C. Long-Range Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Hubbell; ATP1600WRP.
    b. Leviton; ODWWV-IRW.
    c. Pass & Seymour; WA1001.
    d. Watt Stopper (The); CX-100.

3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).

D. Long-Range Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; ATD1600WRP.
b. Leviton; ODW12-MRW.
c. Watt Stopper (The); DT-200.

3. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft. (111 sq. m).

E. Wide-Range Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; ATP120HBRP.
b. Leviton; ODWHB-IRW.
c. Pass & Seymour; HS1001.
d. Watt Stopper (The); CX-100-3.

3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft. (111 sq. m).

2.8 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Stainless, tamper resistant with trident pan head matching current building standard.
2. Material for Finished Spaces: Brushed stainless.
3. Material for Unfinished Spaces: Brushed stainless for flush box installations, raised galvanized for surface box installations.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet locations while in use.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with lockable cover.

2.9 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable.

2.10 EPO MUSHROOM SWITCHES

A. Pushbuttons: NEMA ICS 2; Heavy duty, Oil-tight and dust-tight without boot, Chrome plated bezel, EMERG. STOP in front cover, Red mushroom style actuator.

B. Contact Blocks: Stacked mounting with single screw installation, color coded with clear window for contact status. Furnish with two N.O. and two N.C. contacts.

C. Activation: Two-position, push to activate, key to return to normal state.

2.11 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory and/or as selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. TVSS Devices: Blue.
4. Isolated-Ground Receptacles: Orange and/or as specified above, with orange triangle on face.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.

c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Install GFCI devices in all wet locations.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served. Use self-adhesive labels with black lettering on white field mounted on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Test straight blade convenience outlets in patient-care areas and hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

END OF SECTION 262726

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. 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 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. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. 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. Submit on translucent log-log graph paper.

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.

C. Qualification Data: For qualified testing agency.

D. 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.

E. 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.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "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. Submit on translucent log-log graph paper.

1.6 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.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

B. 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 Architect and Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Architect and Construction Manager written permission.
4. Comply with NFPA 70E.

1.8 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.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.
3.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product 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.

C. Type HD, Heavy Duty, Single Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac and 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 600-V ac and 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. 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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical and/or Compression type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product 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.

C. Type HD, Heavy Duty, Single Throw, 600-V ac and 240-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.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac and 240-V ac, 200 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.

E. Type HD, Heavy Duty, Double Throw, 600-V ac and 240-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.

F. 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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical and/or Compression type, suitable for number, size, and conductor material.

2.3 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.
3. Kitchen and/or Wash-Down Areas: NEMA 250, Type 4X.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250,[Type 9.

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 Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "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. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

C. Perform tests and inspections.

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.

D. 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.

E. 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. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. 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.

B. Set field-adjustable circuit-breaker trip ranges as specified

END OF SECTION 262816

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. LED: Light-emitting diode.

H. MCP: Motor-circuit protector.

I. NC: Normally closed.

J. NO: Normally open.

K. OCPD: Overcurrent protective device.

L. PCC: Point of common coupling.

M. PID: Control action, proportional plus integral plus derivative.

N. PWM: Pulse-width modulated.

O. RFI: Radio-frequency interference.

P. TDD: Total demand (harmonic current) distortion.

Q. THD(V): Total harmonic voltage demand.

R. VFC: Variable-frequency motor controller.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs 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 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of enclosed unit.
f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

D. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.

E. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

F. Seismic Qualification Certificates: For VFCs, 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.

G. Product Certificates: For each VFC, from manufacturer.

H. Source quality-control reports.

I. Field quality-control reports.

J. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

K. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

L. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 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. 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.

C. Comply with NFPA 70.

D. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.7 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: Not exceeding 3300 feet (1005 m).

1.9 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Refer to sections 2.5 through 2.9 of specification section 262419 “Motor-Control Centers” for general VFC requirements.

2.2 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Kitchen Areas: Type 4X, stainless steel.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.3 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted

to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Division 07 Section "Roof Accessories."
2. Structural-steel channels are specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 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.

B. Perform tests and inspections.

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.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect and Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFCs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect and Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 263213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, materials, services, equipment, and transportation necessary for complete and operational factory tested, paralleled electrical generation systems as indicated on Contract Drawings and specified herein, including, but not limited to the following:

1. Battery charger.
2. Engine-generator set.
3. Paralleling capability.
4. Enclosed muffler.
5. Exhaust piping external to set.
6. System controller.
7. Outdoor enclosure.
8. Remote annunciator.
9. Remote stop switch.
10. Starting battery.
11. System commissioning.

B. Related Sections include the following:

1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.3 SUBMITTALS

A. Product Data: Include the following:

1. Data on features, components, accessories ratings and performance.
2. Thermal damage curve for generators.
3. Time-current characteristic curves for generator protective device.
4. Certified generator sets fuel consumption curve.
5. Evidence of UL2200 Listing.
6. Evidence of EPA emissions certification for diesel gas configurations.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Welding certificates.

D. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. 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."

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.

E. Submit Qualification Data for testing agency, including a sample of a representative Field Quality Control Test Report.

F. Certified summary of prototype-unit test report.

G. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

H. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet performance criteria for sensitive loads.

I. Test Reports:

1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements. Systems not tested in parallel at the factory will not be accepted.
2. Report of sound generation.
3. Report of exhaust emissions showing compliance with EPA and other applicable regulations.
4. Report of UL2200 Listing.
5. Field quality-control test reports.

J. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.

K. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 and Division 26, include the following:

1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

L. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than 4 hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer that has produced and commissioned a minimum of one thousand (1000) integrated paralleled systems. Maintain, within fifty (50) miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one (1) source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to Section 016000 "Product Requirements."

E. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX for welding exhaust and cooling system piping.

F. 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.

G. Comply with NFPA 37.

H. Comply with NFPA 70.

I. Comply with NFPA 99.

J. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver engine generator system and auxiliary system components to their final locations in protective wrappings, containers and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period. Alternate Bi-Fuel Bid must also include single source warranty responsibility for all components including bi fuel accessories. Third party warranties will not be accepted.

1. Warranty Period: Five (5) years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide twelve (12) months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, paralleling, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One (1) for every ten (10) of each type and rating, but not less than one (1) of each.
2. Indicator Lamps: Two (2) for every six (6) of each type used, but not less than two (2) of each.
3. Filters: One (1) set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cummins

2. Kohler Generators

3. Generac

2.2 ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.

C. Output Connections: Three-phase, four-wire.

D. Safety Standard: Comply with ASME B15.1.

E. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, and model and serial number of component.

F. Fabricate engine-generator-set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.

G. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

2.3 GENERATOR-SET PERFORMANCE

A. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

1. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

B. Steady-State Voltage Operational Bandwidth: Two percent (2%) of rated output voltage from no load to full load.

C. Steady-State Voltage Modulation Frequency: Less than 1 Hz.

D. Transient Voltage Performance: Not more than ten percent (10%) variation for fifty percent (50%) step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.

E. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

F. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

G. Transient Frequency Performance: Less than 2-Hz variation for a fifty percent (50%) step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

H. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed two percent (2%) total with no slot ripple. The telephone influence factor, determined according to NEMA MG 1, shall not exceed fifty percent (50%).

I. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of three hundred percent (300%) of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

J. Excitation System: Permanent Magnet Generator. Performance shall be unaffected by voltage distortion caused by nonlinear load.

K. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 SERVICE CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.
2. Relative Humidity: Zero to ninety-five percent (0-95%).
3. Altitude: Sea level to 1000 feet.

2.5 ENGINE

A. Fuel: Deisel.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for V-10 Cylinder Arrangement: 1677 fpm.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove ninety percent (90%) of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Designed to operate on Diesel.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Pipe crankcase ventilation fumes directly into engine intake to burn them and reduce unwanted emissions.

I. Engine must meet EPA emissions standards for diesel engines. Evidence of EPA certification must be submitted prior to engineering acceptance.

2.6 ENGINE COOLING SYSTEM

A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

B. Radiator: Rated for specified coolant.

C. Coolant: Solution of fifty percent (50%) ethylene-glycol-based antifreeze and fifty percent (50%) water, with anticorrosion additives as recommended by engine manufacturer.

D. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

E. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

F. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

1. Rating: 50-psig maximum working pressure with coolant at 180 deg F (82 deg C), and non-collapsible under vacuum.
2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

G. Coolant piping external to engine-generator set. Use ASTM B 88, Type L copper tubing with brazed joints, sized as recommended by engine manufacturer. Refer to Plumbing Drawings for basic piping installation and joint construction.

2.7 FUEL SUPPLY SYSTEM

A. Deisel.

2.8 ENGINE EXHAUST SYSTEM

A. Muffler: Critical type, sized as recommended by engine manufacturer. Muffler must be installed inside the generator enclosure.

1. Provide muffler with drain outlet through a petcock.

B. Connection from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe, minimum 18-inch length from exhaust outlet to muffler with flanged pipe connections.

C. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liner.

D. Exhaust Piping External to Engine: ASTM A 53, Schedule 40, welded, black steel, with welded joints and fittings.

2.9 COMBUSTION-AIR INTAKE

A. Description: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

2.10 STARTING SYSTEM

A. Description: 24-V electric, with negative ground and including the following items:

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph in "Service Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified
4. Battery: Adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article to provide specified cranking cycle at least three (3) times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus ten percent (+/- 10%).
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.11 CONTROL AND MONITORING

A. Functional Description: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one (1) or more separate automatic transfer switches initiate starting and stopping of the generator set. When mode-selector switch is switched to the on position, the generator set starts. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

B. Functional Description: Switching on-off switch on the generator control panel to the on position starts the generator set. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and protective devices and controls shall include those required by NFPA 110 for a Level 1 system, and the following:

1. Digital Indicating and Protective Devices and Controls:

a. AC voltmeter.
b. AC ammeter.
c. AC frequency meter: dial type.
d. DC voltmeter (alternator battery charging).
e. Engine-coolant temperature gage.
f. Engine lubricating-oil pressure gage.
g. Engine lube oil temperature.
h. Running-time meter.
i. Ammeter-voltmeter, phase-selector switch(es).
j. Generator-voltage adjusting rheostat.
k. Upper and lower meter scale indicator lights.
l. Start-stop switch.
m. Overspeed shutdown device.
n. Coolant high-temperature shutdown device.
o. Coolant low-level shutdown device.
p. Oil low-pressure shutdown device.
q. Auto/Off/Test switch. Test mode shall automatically start unit without interrupting normal electrical supply.
r. Overspeed shutdown device with LED status indicator which lights when overspeed condition has occurred as cause of shutdown.
s. Coolant high-temperature shutdown device with LED status indicator which lights when pre-alarm operating temperature has been reached and stays lit when shutdown occurs.
t. Coolant low-level shutdown device with LED status indicator which lights when low coolant level causes shutdown.
u. Oil low-pressure shutdown device with LED status indicator which lights when pre-alarm oil pressure condition has been reached and stays lit when shutdown occurs.
v. Overcrank shutdown device with LED status indicator which indicates engine has failed to start after 60 second cranking period.
w. Lamp test switch and audible alarm with silencer switch.
x. Low coolant temperature alarm with LED status indicator which indicates failure of block heater.
y. LED status indicator for “switch off”, which indicates when control switch has been placed in “off” position.
z. LED status indicator for “system ready”, indicating no malfunctions detected.
aa. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

H. 12/24 Volt Remote Annunciator Panel: With lights, audible alarm, alarm switch and lamp test switch, in accordance with NFPA 110, Level 1, to monitor the following conditions:

1. Line power.
2. Generator power.
3. System ready (in auto position).
4. Alarm switch off.
5. Generator switch off.
6. Emergency stop.
7. Engine high-temperature shutdown.
8. Lube-oil low-pressure shutdown.
9. Overspeed shutdown.
10. Remote emergency-stop shutdown.
11. Engine high-temperature pre-alarm.
12. Lube-oil low-pressure pre-alarm.
13. Low coolant level.
14. Overcrank shutdown.
15. Coolant low-temperature alarm.
16. Control switch not in auto position.
17. Battery-charger malfunction alarm.
18. Battery low-voltage alarm.
19. Battery high voltage alarm.

I. Remote Alarm Annunciator: Comply with NFPA 99. Labeled LED shall identify each alarm event. Common audible signal shall sound for alarm conditions. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.12 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type, one hundred percent (100%) rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Circuit breaker must be mounted inside generator enclosure. External circuit breakers or power breakers are not acceptable.

B. Generator Protector: Microprocessor-based unit that continuously monitors current level in each phase of generator output, integrates generator heating effect over time, and predicts when thermal damage of the alternator will occur. When signaled by the protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from the load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when the generator has operated at an overload equivalent to one hundred ten percent (110%) of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates the generator to three hundred percent (300%) of rated full-load current for up to 10 seconds.
3. As the overcurrent heating effect on the generator approaches the thermal damage point of the unit, the protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Comply with NFPA 70, Article 700.7(D). Integrate ground-fault alarm indication with other generator-set alarm indications.

D. Provide generator output breaker with one N.C. and one N.O. contact indicating breaker status. This status indication shall signal an alarm to the remote annunciator panel to indicate a “Generator Output Breaker Open” alarm. The remote annunciator panel shall be equipped with a single summary alarm wired to the building BMS system indicating a “Generator Trouble” alarm.

2.13 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1 and specified performance requirements.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to one hundred twenty-five percent (125%) of rating, and heat during operation at one hundred ten percent (110%) of rated capacity.

F. Excitation shall use no slip or collector rings, or brushes, and shall be arranged to sustain generator output under short-circuit conditions as specified.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus five percent (+/-5%) adjustment of output-voltage operating band.
2. Provide with under-frequency protection and moisture-resistive protection.
3. Regulation shall be within plus or minus two percent (+/-2%) of rated voltage from no load to full load.
4. On application of rated load at rated power factor, instantaneous voltage dip shall NOT exceed twenty percent (20%), with recovery within 1 second.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: Twelve percent (12%), maximum.

M. Provide Permanent Magnet Generator (PMG) system.

N. Alternator shall be self-ventilated, one-piece cast aluminum alloy, uni-directional internal fan shall provide high volume, low noise air delivery with broad range, 12-load reconnectable, four-pole rotating field unit.

O. Temperature rise shall be within NEMA MG1-22.40, IEEE and ANSI Standards for standby duty at rated output.

P. Provide front-end mounted junction box for load connections. Junction box shall have space to mount regulator and voltage adjust rheostat inside box and to relocate same to opposite side without unit modification.

Q. Locked Rotor kVA: Total available skVA shall be minimum 6,600 at thirty-five percent (35%) voltage dip (1,650 skVA for each unit). Ninety percent (90%) sustained voltage ratings will not be accepted.

2.14 SYSTEM CONTROLLER (PM-SC)

A. The power manager system controller shall be an integrated microprocessor-based solution providing full digital integration with the generator controllers. The system controller shall utilize standard hardware and firmware manufactured by the generator supplier. The use of PLC based solutions will be considered less desirable due to reliability and support concerns posed by custom hardware/custom software solutions. A preference will be shown for designs that use the same control board hardware for both the generator(s) and system controller.

B. To ensure reliability and serviceability, the system controller shall be required to meet the same requirements as listed for the generator controller.

C. The control panel will provide a touch screen display to provide intuitive access to all user pertinent system status information.

D. The power for the system controller shall utilize redundant DC sources - an internal DC source inclusive of charging system and an external DC source from one of the generator's cranking batteries.

E. The system controller shall interface with the generators using digital communications. Any of the generator(s) status, operation conditions, or configuration parameters shall be accessible with a single point communication via the system controller.

F. The system controller shall provide sequence of facility load through three (3) priority loading (permissive) load steps and three (3) load shedding steps. These output parameters function based on the number of generators on the generator bus. The priority loading function provides sequential permissive contact closures enabling load to be transferred onto the generator in response to generators coming on-line. The load shedding function provides contact closures that disconnects load from the generator bus in response to a reduction in available generator capacity.

G. In addition to the communication requirements identified in Article 2.3.3, the system controller shall provide modem communications as standard.

H. The system controller and digital communications shall enhance system operation; neither shall be required to synchronize or operate the generators in parallel. Systems that require external control hardware or digital communications to synchronize and operate the generators in parallel are not acceptable.

I. The design of the system shall allow continued generator paralleled operation with failures to the system controller and/or communication. Control systems that have any systemic single point failure modes are not acceptable. This is inclusive of the reactive cross current and isochronous load sharing control loops.

J. The design of the system shall also provide generator start and paralleled operation with failures to the system controller and/or communication.

2.15 SOUND ATTENUATED OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, sound attenuated weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance including rear-hinged control panel door. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Provide locking hasps (keyed alike) on engine side panels and control door.

B. Description: Prefabricated or pre-engineered enclosure with the following features:

1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
2. Structural Design and Anchorage: Wind resistant up to 100 mph.
3. Space Heater: Thermostatically controlled and sized to prevent condensation.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
5. Hinged Doors: With padlocking provisions.
6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
8. Muffler Location: Within enclosure.
9. Enclosure Panelboard: Within enclosure, serving lights, receptacles, heaters, controls, batter charger and devices within enclosure. All electrical components and devices served by the enclosure panelboard shall be factory prewired to this panelboard.
10. Sound attenuation to reduce emitted sound to 76dBA at 23 feet.

C. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at one hundred ten percent (110%) of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

D. Interior Lights with Switch: Factory-wired, vapor-proof type fixtures within housing; arranged to illuminate controls and accessible interior.

E. Convenience Outlets: Factory wired. Arrange for external electrical connection. Exterior Lighting: Contractor to supply and field install external lighting for generator enclosures.

2.16 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.17 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
2. Generator Tests: Comply with IEEE 115.
3. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype shall have been factory tested to demonstrate compatibility and reliability.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Full load run as a complete paralleled system for minimum 4 hours for base and alternate bids. Systems not factory paralleled and tested prior to shipment will not be accepted.
2. Parallel operation.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Observation of Factory Tests: Provide fourteen (14) days' advance notice of tests and opportunity for observation of tests by Owner's representative.

C. Report factory test results within ten (10) days of completion of test.

D. Provide evidence of UL2200 listing for specified engine generators.

E. Provide evidence of EPA certification.

F. Provide factory warranty documentation for all equipment

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases.

3.3 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generators level on concrete base.

1. Seismic Restraint: Mount packaged engine generator on restrained spring isolators to provide seismic restraint and vibration isolation. Seismic restraint and vibration isolation requirements. Seismic installation shall provide “withstand” requirement.

C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

1. Verify that electrical wiring is installed according to manufacturer’s submittal and installation requirements in Division 26 Sections. Proceed with equipment start up only after wiring installation is satisfactory.
2. Provide interconnecting wiring between generator and automatic transfer switch(es).
3. Provide interconnecting wiring between generator and remote annunciator panel.
4. Provide interconnecting wiring between the SCR control system operating components, sensors, generator set, troubles and alarms.

3.4 CONNECTIONS

A. Piping installation requirements are specified on the Plumbing Drawings. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
2. Connect cooling-system water supply and drain piping to gas engine heat exchangers. Install flexible connectors at connections to engine generator and remote radiator.
3. Connect fuel piping to engines with a gate valve and union.

a. Natural- and LP-gas piping, valves, and specialties for gas distribution outside and inside the building are specified on the Plumbing Drawings.

4. Connect exhaust-system piping to engines.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical System".

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. 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.

3.5 IDENTIFICATION

A. Identify system components according to Section 260553 “Identification for Electrical Systems” and Plumbing Drawings.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.15.2.1 and 7.22.1 (except for vibration baseline test). Certify compliance with test parameters. Tests shall be conducted by applying load (via load bank) to load side of automatic transfer switch or to other load point acceptable to Engineer.
2. Perform tests recommended by manufacturer.
3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:

    a. Single-step full-load pickup test.

4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
7. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
8. Exhaust Emissions Test: Comply with applicable government test criteria.
9. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for fifty and one hundred percent (50 and 100%) step-load increases and decreases, and verify that performance is as specified.
10. Harmonic-Content Tests: Measure harmonic content of output voltage under twenty-five percent (25%) and at one hundred percent (100%) of rated linear load. Verify that harmonic content is within specified limits.
11. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four (4) locations on the property line less than 23 feet from the enclosure, and compare measured levels with required values.

B. Coordinate tests with tests for transfer switches and run them concurrently.

C. Test instruments shall have been calibrated within the last twelve (12) months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Remove and replace malfunctioning units and retest, reinspect as specified above.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Section 017900 “Demonstration and Training”.

1. Coordinate this training with that for transfer switches.

END OF SECTION 263213

SECTION 263323.11 - INVERTER/BATTERY EQUIPMENT FOR EMERGENCY 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. Section includes the following central battery and power conversion equipment rated 600 V and less for emergency lighting:

1. Interruptible (slow-transfer) inverter/battery equipment.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. IBC: International Building Code.

C. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time can be "slow" (up to approximately 1.5 second or depending on manufacturer).

D. LED: Light-emitting diode.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

F. OCPD: Overcurrent protective device.

G. PWM: Pulse-width modulated.

H. TDD: Total demand (harmonic current) distortion (also listed as "THD" in catalog data by manufacturers).

I. THD(V): Total harmonic voltage demand.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of inverter/battery equipment unit.

1. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.

B. Shop Drawings: For each type and rating inverter/battery equipment unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection.
3. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring.
4. Include elevation, details, and legends of control and indication displays.
5. Include -circuit current (withstand) rating of unit.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around central battery equipment. Show central battery equipment layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Qualification Data: For Installer and testing agency.

C. Seismic Qualification Certificates: For inverter/battery equipment, accessories, and components, from manufacturer.

1. Certificate of compliance.
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.

D. Product Certificates: For each type of Inverter/battery equipment.

E. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for input filtering of inverter / battery equipment to limit TDD and THD(V) to specified levels.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inverter/battery equipment to include in emergency, operation, and maintenance manuals.

1. include the following:

a. Manufacturer's written instructions for testing inverter/battery equipment.

b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
c. Manufacturer's written instructions for selecting and setting field-adjustable controls and status and alarm points

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
1. Output Circuit Breakers: One for every 10 of each type and rating of each type.
2. Output Circuit Breaker Open/Tripped Alarm Contacts: One for every 10 supplied of each type.
3. Cabinet Ventilation Filters: One complete set.
4. Circuit Board: One spare circuit board for each critical circuit.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: Member company of NETA or an NRTL acceptable to authorities having jurisdiction.

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

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
3. Humidity: More than 95 percent (condensing).
4. Altitude: Exceeding 3300 feet.

B. Interruption of Existing Electrical Distribution Systems: Do not interrupt electrical distribution systems within 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 Engineer or Owner no fewer than two days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems without Engineer’s or Owner's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for central battery equipment, including clearances between central battery equipment and adjacent surfaces and other items.

1.11 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

a. Battery Equipment (excluding Batteries): One year(s).
b. Standard VRLA Batteries:

1) Full Warranty: 3 year(s).
2) Pro Rata: 6 years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: inverter/battery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated central battery equipment shall be tested and certified by an NRTL as meeting ICC-ES AC 156 test procedure requirements.

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."

2.2 INTERRUPTIBLE (SLOW-TRANSFER) INVERTER / BATTERY EQUIPMENT

A. General Requirements for Interruptible (Slow-Transfer) Inverter / Battery Equipment:

1. 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.
2. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924.

3. Comply with the IBC, NFPA 70, and NFPA 101.
4. Source Limitations: Obtain central battery equipment, including batteries, overcurrent protective devices, components, and accessories, from single source from single manufacturer.

B. Performance Requirements:

1. Slow-Transfer Inverter Battery Equipment: Passive-standby (off-line) system. Automatically sense loss of normal alternating-current (ac) supply and use an electromechanical transfer switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.
2. Automatic Operation:

    a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
    b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
    c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
    d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
    e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
    f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
    g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
    h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

C. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
2. Input Frequency Tolerance: Plus or minus 3 or 5 percent of central battery equipment frequency rating.
3. Synchronizing Slew Rate: 1 Hz per second, maximum.
4. Minimum Off-Line Efficiency: 95 or 99 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 or 98 percent under any load or operating condition.
6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.
7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F and not exceeding 158 deg F
8. Ambient Temperature Rating (Batteries): Not less than 32 deg F and not exceeding 104 deg F.
9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F and not exceeding 104 deg F.

10. Humidity Rating: Less than 95 percent (noncondensing).
11. Altitude Rating: Not exceeding 3300 feet.
12. Off-Line Overload Capability: 1.1 or 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

D. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

E. Controls and Indication:

1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:

a. Normal power available.
b. Status of system.
c. Battery charging status.
d. On battery power.
e. System fault.
f. External fault.

2. Remote Signal Interfaces:

a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:

1) Fault or status indication.
2) On bypass.
3) Low battery.

b. Communications Interface: Factory-installed hardware and software to enable a remote PC to program central battery equipment and monitor and display status and alarms.

1) Communications Ports: RS-232 or RS-485.
2) Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications and shall be able to communicate directly via DDC system for HVAC RS-485 serial networks and Ethernet 10Base-T networks as a native device.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of SPDs to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
3. Battery deep-discharge and self-discharge protection; with alarms.
4. Battery self-test circuitry; with alarms and logging.

G. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.

1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 22kA.

H. Inverter:

1. Description: Solid-state, high-frequency, PWM type, with the following operational features:

    a. Automatically regulate output voltage to within plus or minus 3 or 5 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
    b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
    c. Output Voltage Waveform: Pure Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
    d. Load Power Factor: 0.5 lead to 0.5 lag.
    e. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.

I. Batteries:

1. Description: seal lead batteries.

    a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

2. Battery Disconnect and OCPD: Manufacturer's standard.

J. Maintenance Bypass Systems:

1. Maintenance Bypass Mode: Internal; manual operation only; bypasses inverter/battery equipment power circuits (inverter and transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
2. Maintenance Bypass Mode: External; manual operation only; bypasses central battery equipment completely; requires local operator selection at external switch enclosure remote from central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities. Bypass Overload Capability: 1.5 times the base load current.

K. Integral Output Disconnecting Means and OCPD:

1. Single-Output OCPD: As scheduled on Drawings; manufacturer's standard ratings based on unit output ratings.
2. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.

2.3 ENCLOSURES

A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.4 OPTIONAL AND ACCESSORY FEATURES

A. Factory-Installed Options and Accessories:

1. Multiple-Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
2. Split-Output Configuration: Divides output into normally on and normally off buses.
3. Auto-dialer.
4. Internal fax modem.
5. Audible alarm with silencer switch.
6. Remote Summary Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions; silencing switch in face of panel silences signal without altering visual indication.

    a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
    b. Maximum Distance from Main Unit: 1000 feet.

7. Remote Meter Panel: Match equipment requirements of remote monitoring, controlling, and programming of central battery equipment.

    a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
    b. Maximum Distance from Main Unit: 150 feet.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled central battery equipment, by a qualified testing agency, according to UL 924. Affix standards organization's label. Include the following:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

B. Central battery equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store central battery equipment according to NECA 411.

B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.

D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for central battery equipment input filtering to limit TDD and THD(V) to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and with NETA Acceptance Testing Specification.

3.3 INSTALLATION

A. Coordinate layout and installation of inverter/battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install inverter battery equipment and accessories according to NECA 411.

C. Wall-Mounted Inverter/ Battery Equipment: Install central battery equipment on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Comply with NECA 1.

G. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used for low-voltage control and alarm wiring. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

H. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

I. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.4 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between inverter/battery equipment and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

3.6 IDENTIFICATION

A. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label inverter/battery equipment with engraved nameplates.
3. Label each separate cabinet, for multicabinet units.
4. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for central battery equipment, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of central battery equipment units.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. The CxA must be provided with a least two weeks notice of any scheduled field quality control testing.

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

D. Perform tests and inspections.

E. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

    a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
    b. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
    c. Test continuity of each circuit.

F. Tests and Inspections:

1. Inspect central battery equipment, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
3. Test continuity of each circuit.
4. Verify that input voltages and frequencies at central battery equipment locations are within voltage and frequency limits specified in Part 2. If outside this range, notify Engineer before closing input OCPDs.
5. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.
6. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of central battery equipment. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of central battery equipment 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

G. Inverter battery equipment will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.8 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, and other adjustable parts.

C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.

D. Set the automatic system test parameters.

E. Set field-adjustable, circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

3.10 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace central battery equipment whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION 263323.11

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

B. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. 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."

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 test reports.

1.4 CLOSEOUT SUBMITTALS

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

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than 8 hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches through one (1) source from a single manufacturer.

D. 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.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless the requirements of these Specifications are stricter.

1.6 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:

1. Notify Owner no fewer than two (2) days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner’s written permission.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Contactor Transfer Switches:

a. Cummins
b. Eaton/Cutler Hammer
c. Emerson; ASCO Power Technologies, LP
d. Generac
e. GE Zenith Controls
f. Kohler
g. MTU
h. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding thirty percent (30%) of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008. Coordinate with main service ratings.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus two percent (+/- 2%) or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 400 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

K. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated. Coordinate size, layout, and connection requirements with adjacent switchgear.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

G. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two (2) sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and seventy percent (70%) or more of nominal voltage.

H. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

I. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from eighty-five to one hundred percent (85-100%) of nominal, and dropout voltage is adjustable from seventy-five to ninety-eight percent (75-98%) of pickup value. Factory set for pickup at ninety percent (90%) and dropout at eighty-five percent (85%).
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from 0 to 6 seconds, and factory set for 1 second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from eighty-five to one hundred percent (85-100%) of nominal. Factory set for pickup at ninety percent (90%). Pickup frequency shall be adjustable from ninety to one hundred percent (90-100%) of nominal. Factory set for pickup at ninety-five percent (95%).
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One (1) isolated and normally closed, and one (1) isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from seven (7) to thirty (30) days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Section 260548 "Vibration and Seismic Controls for Electrical Systems."

B. Wall-Mounting Switch.

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one (1) pole deviating by more than fifty percent (50%) from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

E. Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch eleven (11) months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - 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 the following types of LED luminaires:
   1. Downlight.
   2. Recessed linear.
   3. Strip light.
   4. Surface mount, linear.
   5. Surface mount, nonlinear.
   6. Suspended, linear.
   7. Suspended, nonlinear.
   8. Materials.
   9. Finishes.
   10. Luminaire support.

B. Related Requirements:

   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests[, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project] IES LM-79 and IES LM-80.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

D. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

E. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.

1. Include Samples of luminaires and accessories involving color and finish selection.

F. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

G. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings or approved equal.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment or luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Ceiling-mounted projectors.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, 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.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

2. Refer to specifications 014823 Operation and Maintenance Data for additional O&G Requirements

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. 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, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE 7

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified[and the luminaire will be fully operational during and after the seismic event]."

2.2 LUMINAIRE REQUIREMENTS

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

B. Standards:

1. ENERGY STAR certified.
2. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
3. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
4. UL Listing: Listed for damp location.
5. Recessed luminaires shall comply with NEMA LE 4.
6. User Replaceable Lamps:

a. Bulb shape complying with ANSI C78.79.
b. Lamp base complying with ANSI C81.6 or IEC 60061-1.

C. CRI of minimum 80 CCT of 4000 K]

D. Rated lamp life of 50,000 hours to L70.

E. Lamps dimmable from 100 percent to 0 percent of maximum light output.

F. Internal driver.

G. Nominal Operating Voltage: 120 V ac, 24 V dc.

1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

H. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear finish.

2.3 DOWNLIGHT

A. Minimum 1,000 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Universal mounting bracket.

C. Integral junction box with conduit fittings.

D. Optics:

1. Fixed lens.
2. Medium light distribution.

2.4 LINEAR INDUSTRIAL

A. Minimum 5,000 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Housing and heat sink rated to the following:

1. Class 1, Division 2 Group(s) A ,B, C and D.
2. NEMA 4X.
3. IP 54.
4. IP 66.
5. Marine and wet locations.
6. CSA C22.2 No 137.

2.5 RECESSED LINEAR

A. Minimum [1,500] [2,000] [3,000] <Insert number> lumens. Minimum allowable efficacy of [85] <Insert number> lumens per watt.

B. Integral junction box with conduit fittings.

2.6 STRIP LIGHT

A. Minimum [750] <Insert number> lumens. Minimum allowable efficacy of [75] [80] <Insert number> lumens per watt.

B. Integral junction box with conduit fittings.

2.7 SURFACE MOUNT, LINEAR

A. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Integral junction box with conduit fittings.

2.8 SURFACE MOUNT, NONLINEAR

A. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

B. Integral junction box with conduit fittings.

2.9 SUSPENDED, LINEAR

A. Minimum 3,000 lumens. Minimum allowable efficacy of 85 lumens per watt.

2.10 SUSPENDED, NONLINEAR

A. Minimum 3,000 lumens. Minimum allowable efficacy of 85 lumens per watt.

B. Integral junction box with conduit fittings.

2.11 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. 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.

C. Diffusers and Globes:

1. [Tempered Fresnel glass] [prismatic glass] [diffuse glass] [clear glass] [prismatic acrylic] [clear, UV-stabilized acrylic]
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.12 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.13 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.
2. Ceiling mount with [pendant mount] [four-point pendant mount] with 5/32-inch diameter aircraft cable supports adjustable to 120 inches in length.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."

B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT 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. Section Includes:
   1. Exit signs.
   2. Luminaire supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

   1. Include data on features, accessories, and finishes.
   2. Include physical description of the unit and dimensions.
   3. Battery and charger for light units.
   4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
   5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

      a. Testing Agency Certified Data: For all luminaires, photometric data certified by a qualified independent testing agency.

B. Shop Drawings: For nonstandard or custom luminaires.

   1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which equipment will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling including the following:

    a. Other luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Ceiling-mounted projectors.
    e. Sprinklers.
    f. Access panels.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of luminaire.

D. Seismic Qualification Certificates: For luminaires, 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.

E. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.

F. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 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, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

C. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and Connecticut Fire Safety Code with 2009 and 2012 amendments.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Operate one lamp continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
    b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
    c. Humidity: More than 95 percent (condensing).
    d. Altitude: Exceeding 3300 feet (1000 m).

4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

5. Battery: Sealed, maintenance-free, nickel-cadmium or lead-acid type as scheduled.

6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
7. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

I. Refer to section 260923, Lighting Control Devices, fro requirements for UL924 emergency shunt relays.

2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Operating at nominal voltage of 277 V ac.
2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
4. Master/Remote Sign Configurations:

    a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
    b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.
5. Exit Signs wired to emergency lighting power source (AC type): Shall be wired through a UL 924 listed relay providing connection to emergency lighting circuit with an alternate non-emergency circuit (normal lighting) to power the sign on a loss of the emergency circuit.

C. Photoluminescent Signs:
1. Use strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.
2. Unit shall be UL 924 listed for use above the door and for low-level applications for minimum 90 minute durations.
3. Furnish with extruded aluminum frame and concealed mounting hardware.
4. Chevrons shall be self-adhesive type, meeting NFPA requirements.
5. Unit shall carry 10 year warranty.

D. Specified Area of Refuge signs shall meet power and illumination requirements for exit signs. These shall be furnished with appropriate text and the universal symbol of accessibility (wheelchair symbol).

E. Specified Signs for Accessible Exit shall meet power and illumination requirements for exit signs. These shall be furnished with universal symbol of accessibility (wheelchair symbol) having a minimum height of 6 inches and meeting the requirements of IBC 1011.1.2.

2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Prismatic or Clear, UV-stabilized acrylic.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum or polycarbonate housing as scheduled.

E. Conduit: Rigid galvanized steel, minimum 3/4 inch (21 mm) in diameter.

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service:
1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.

a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265219

SECTION 265613 - LIGHTING POLES AND STANDARDS

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. Poles and accessories for support of luminaires.
2. Luminaire-lowering devices.

1.3 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete lighting fixture.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

1.4 ACTION SUBMITTALS

A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

C. Samples: For each exposed lighting pole, standard, and luminaire-supporting device and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Qualification Data: For Installer and testing agency.

C. Seismic Qualification Certificates: For 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.

D. Material Test Reports:

1. For each foundation component, by a qualified testing agency.
2. For each pole, by a qualified testing agency.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: Manufacturer's standard warranty.

H. Soil test reports

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For poles and luminaire-lowering devices to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for foundation testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below finished grade.

D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.

E. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) and luminaire-lowering device(s) 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 a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design pole foundation and pole power system.

B. Seismic Performance: Foundation and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event.
2. Component Importance Factor: 1.5 or 1.0.

C. Structural Characteristics: Comply with AASHTO LTS-6-M.

D. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

E. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.

F. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

G. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles exceeding 50 feet in height is 100 mph, 90 mph.

a. Wind Importance Factor: 1.0.
b. Minimum Design Life: 50 years.
c. Velocity Conversion Factor: 1.0.

2. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph, 90 mph.

a. Wind Importance Factor: 1.0.
b. Minimum Design Life: 25 years.
c. Velocity Conversion Factor: 1.0.

H. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

I. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 STEEL POLES

A. Source Limitations: Obtain poles from single manufacturer or producer.

B. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.

C. Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Square, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

D. Poles: Comply with ASTM A 240/A 240M or ASTM A 666, stainless steel with a minimum yield of 55,000 psig ; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Square, straight.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

E. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as plate.

F. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with galvanized-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

G. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

H. Fasteners: Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

I. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

J. Steps: Fixed steel, with nonslip treads.

1. For climbing positions, install at 15-inch vertical spacing, alternating on opposite sides of pole, oriented 180 degrees from each other; first step shall be at an elevation 10 feet above finished grade.
2. For working positions, install steps on opposite side of pole, oriented 180 degrees from each other at the same elevation.

K. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.

L. Intermediate Handhole and Cable Support: Weatherproof, 3-by-5-inch handhole located at midpoint of pole, with cover for access to internal welded attachment lug for electric cable support grip.

M. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

N. Platform for Lamp and Ballast Servicing: Factory fabricated of steel, with finish matching that of pole.

O. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

P. Galvanized Finish: After fabrication, hot-dip galvanize according to ASTM A 123/A 123M.

Q. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high gloss, high-build polyurethane enamel.

    a. Color: As selected by Architect.

R. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Powder Coat: Comply with AAMA 2604.

    a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils dry film thickness. Coat interior and exterior of pole for equal corrosion protection.
    b. Color: As selected by Architect.

2.3 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

2.4 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C Mechanically deposited galvanization according to ASTM B 695, Class 50.
2. Headed rods
3. Threading: Uniform National Coarse or Uniform National 8, Class 2A.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C Mechanically deposited galvanization according to ASTM B 695, Class 50.

2. Four nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

C. Washers: ASTM F 436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C Mechanically deposited galvanization according to ASTM B 695, Class 50.
2. Two washers provided per anchor bolt.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

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

3.2 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.

1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.

D. Direct-Buried Foundations: Install to depth indicated on Drawings, but not less than as indicated. Add backfill in 6-inch to 9-inch layers, tamping each layer before adding the next, To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height as indicated. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.

1. Make holes 6 inches in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

F. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. Fire Hydrants and Water Piping: 60 inches.
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers unless otherwise indicated.
4. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

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 using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways 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: Comply with requirements in Section 260526 "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.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Inspect poles for nicks, mars, dents, scratches, and other damage.
2. System function tests.

END OF SECTION 265613

SECTION 265619 - LED 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. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 OR IES LM-80.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Structural members to which luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, 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.

D. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency

F. Source quality-control reports.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. 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, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

F. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event.

2.2 LUMINAIRE REQUIREMENTS

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

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. Bulb shape complying with ANSI C79.1.

G. CRI of minimum 65 70 80 CCT of 2700 K,3000 K, 4100 K

H. L70 lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 120 V ac.

L. In-line Fusing: On the primary for each luminaire.

M. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

N. Source Limitations: Obtain luminaires from single source from a single manufacturer.

O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with ANSI C136.10.

2. Adjustable window slide for adjusting on-off set points.

2.4 LUMINAIRE TYPES

A. Area and Site:
1. Luminaire Shape: Round
2. Mounting: See Pole Mounted Luminaire Detail
3. Luminaire-Mounting Height: 20’.
4. Distribution: Type I, Type II, Type III, Type IV, Type V.
5. Diffusers and Globes: See lighting fixture schedule on drawings.
6. Housings:

a. Extruded-aluminum housing and heat sink.
b. powder-coat finish.

2.5 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.

C. 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.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. 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.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter, shape, size, wattage and coating.
    c. CCT and CRI for all luminaires.

2.6 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. 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.

C. 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 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected from manufacturer's standard catalog of colors.

2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached using through bolts and backing plates on either side of wall] <Insert means of attachment.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. 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 Section 033000 "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 Section 260533 "Raceways 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 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

    a. IES LM-5.
    b. IES LM-50.
    c. IES LM-52.
    d. IES LM-64.
    e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

SECTION 271100 - COMMUNICATION EQUIPMENT ROOMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Related Sections:

1. Division 271300 Section Communications Backbone Cabling.
2. Division 271500 Section Communications Horizontal Cabling

1.02 SUMMARY

A. Description

1. The scope of work required as part of this project shall include (1) new I/T Room. This area shall include floor 4-post server racks, ladder racking and wall mounted devices as indicated within the drawing details.

B. Section Includes:

1. Telecommunications Mounting Devices.
2. Telecommunications Pathways.

C. BICSI: Building Industry Consulting Service International

D. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches in width.

E. LAN: Local Area Network.

F. RCDD: Registered Communications Distribution Designer.

G. “Project Manager” shall mean the Owner’s appointed representative.

H. As Necessary” shall mean work which is required for completed construction, but is not necessarily shown or described in the Contract Documents.

I. “As Required” shall mean work which is required for completed construction and is shown on the drawings or described in the project specification.

J. “Install” shall mean to set in place complete with all mounting facilities and connections as required ready for normal use of service.

K. “Substantial Completion” shall mean that the project is sufficiently complete to be utilized for its intended use as stated in the body of this written specification.

L. “Conduit” shall include all fittings, sleeves, connections, hangers and other accessories related to such conduit.

M. “Surface Metal Raceway” shall include all fittings, sleeves, connections, hangers and other accessories related to such raceway.

N. “Concealed” shall mean hidden from sight, as in chases, furred spaces, shafts, fixed ceiling or embedded in construction.

O. “Exposed”, shall mean not “concealed” as defined above.

P. The words “Furnish”, “Supply” and “Provide” shall mean purchase, deliver to the job site, protect and provide interim storage and install in accordance with manufacturer’s specifications.

Q. Words “Approved Equal” shall mean any product which in the opinion of the Technology Consultant is equal in quality, arrangement, appearance, and performance to the product specified.

R. “Cabling” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

S. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.

T. Words in the singular shall also mean and include the plural, wherever the context so indicates, and words in the plural shall mean the singular, wherever the context so indicates.

U. “Contractor” refers to the biding/installation Contractor responsible for furnishing and installation of all work indicated within this specification.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted equipment racks and cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: As-built drawings for communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Seismic Qualification Certificates: For floor-mounted racks, cabinets, 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. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 QUALITY ASSURANCE

A. Installation of products shall be performed in accordance with the Manufacturer's suggested Installation procedures.

B. Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD/NTS and/or Commercial Installer, Level 2.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician and/or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD and/or Commercial Installer, Level 2 to perform the on-site inspection.

C. Telecommunications Pathways and Spaces shall comply with TIA-569-C.

D. Grounding shall comply with ANSI-J-STD-607-A.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment racks, cabinets, frames or cable trays until spaces are enclosed, built-out and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.07 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier/ Service Providers.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of the Voice equipment, LAN equipment, Security Equipment, and all other systems that share space within the Telecommunication Equipment rooms.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.01 PATHWAYS

A. General Requirements: Comply with TIA-569-C.

B. Riser and distribution cables leaving the room to building TRs should be via cable tray, four-inch (4") conduits or sleeved cores.

C. The exact number of conduits required or size of the cable wireway should be determined based upon the amount of fiber and copper cable that must be supported in each closet and each computer or communications room.

D. Additional conduits or sleeved cores must be included in the design to provide for future growth.

E. All conduits/coring should be kept six inches (6") or less from walls whenever construction permits.

F. Cable Support: Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.

G. Conduit and Boxes: are not within part of this section and shall be described within other sections of this bid document.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

B. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.02 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."Comply with TIA-569-C.

B. All conduits etc., passing through fire rated floors, walls and partitions, shall have the space between the raceways, sleeves and all penetrations filled with a reusable fire stopping material such as Firestop Putty, Adhesive Firestop Sealant or Firestop Compound as manufactured by STI or approved equal.

3.03 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2, Class 3, or Class 4 level of administration including optional identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Related Sections:

1. Division 271100 Section "Communications Equipment Room Fittings".

1.02 SUMMARY

A. Section Includes:

1. Pathways.
2. UTP cable.
3. Multi-Mode: OM3, 50/125 micrometer, 24 strand, armored optical fiber cabling.
4. Single mode optical fiber cabling, 24 strand, armored optical fiber cabling.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Cabling identification products.
7. Testing procedures.

1.03 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.04 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between Tele-communications equipment rooms, main terminal spaces and entrance facility rooms for the voice/data cabling systems.

B. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patching or jumpers used for backbone-to-backbone cross-connection to service provider equipment.

C. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.05 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.2 and TIA-568-C.3, when tested according to test procedures of this standard.

1.06 SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
4. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to side of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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. Telecommunications Pathways and Spaces: Comply with TIA-569-C.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PATHWAYS

A. General Requirements: Comply with TIA-569-C.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.02 UTP CABLE

A. Description: Voice Backbone Cabling.

B. Cable shall be 100-ohm, 100 -pair UTP, formed into 25-pair binder groups, plenum rated cable.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA-568-C.2 for performance specifications.
3. Comply with TIA-568-C.2, Category 5E.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include and are limited to the following:

1. Berk-Tek
2. Superior Essex
3. Belden

2.03 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include and are limited to the following:

1. Leviton
2. Hubbell Premise Wiring
3. Belen

B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 5E. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. 100 Pair 110 Style CAT 5E 19” rack mounted patch panels to allow for cross-connection from voice origination (PBX) to workstations via CAT 5E patch cords.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

G. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

2.04 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including Etching, label stocks, laminating adhesives, and inks used by label printers.

B. Labeling of all cable is described within the drawing documents.

2.05 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.2.

C. Factory test UTP cables according to TIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA-568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Each Fiber Optic Termination Panel shall be clearly labeled indicating (1) the destination(s) of the cable(s) and (2) fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS

A. Wiring Method: Install cables in raceways and J-hooks except where cable trays are required in Drawings. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Pre-terminated fiber optic cabling will be accepted. Manufacture shall be approved upon product submission.

3.03 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA-569-C.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA-569-C for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.04 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.2.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."

3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Do not untwist UTP cables more than ½ inch from the point of termination to maintain cable geometry.

3.05 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."Comply with TIA-569-C.

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.06 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.07 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Clearly label all Data Patch Panels via etching, as indicating the Telecommunication Room Number, The Data Patch Panel letter designation and the Data Port Number on the Data Patch Panel Ports 1 through 48. Each Telecommunication Room shall start with Data Patch Panel ‘A’ and continue through the Alphabet.

D. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration including optional identification requirements of this standard.

E. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

F. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

G. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

H. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. All fiber optic backbone and copper (inter-building, riser and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same

cable terminates (e.g. Equipment Room or Telecommunications Room I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.

7. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

I. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA-606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.2.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

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. UTP cabling.
2. Cable connecting hardware, patch panels, and cross-connects.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.
5. Cable management system.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

A. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two (2) telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one (1) transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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

D. Grounding: Comply with J-STD-607-A.

2.3 UTP CABLE HARDWARE

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one (1) of the following:

1. ADC
2. American Technology Systems Industries, Inc.
3. Belden Inc.
4. Dynacom Inc.

5. Hubbell Premise Wiring
6. Leviton Commercial Networks Division
7. Molex Premise Networks; a division of Molex, Inc.
8. Panduit Corp.
9. Siemon Co. (The)
10. Tyco Electronics Corporation; AMP Products

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus twenty-five percent (25%) spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One (1) for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One (1) for each four-pair UTP cable indicated.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.4 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters except in accessible ceiling spaces and partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
b. Locate consolidation points for UTP at least 49 feet from communications equipment room.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot long service loop on each end of cable.

13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than ½ inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with TIA-569-B, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in I/T Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6**,** marking of outlets, cover plates, outlet/connectors, and patch panels
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 271500

SECTION 311000 - SITE CLEARIING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section specifies requirements for site clearance and structure demolition.

B. The Work includes, but is not limited to, the following:

1. Protection of existing improvements and vegetation to remain.
2. Clearing and grubbing.
3. Demolition and the removal of structures, retaining walls, signage, light standards, foundations, curbing, and appurtenances.
4. Demolition and removal of pavements, concrete, asphalt, and pavers.
5. Removal and/or abandonment of utilities.
6. Filling or removal of underground tanks, structures, and piping.
7. Disposal of material from clearing, grubbing, thinning, and demolition in approved off-site disposal areas.
8. Filling of voids and excavations resulting from demolition.
9. Removal and stockpiling of topsoil.
10. Construction fence.
11. Tree protection.

C. This Work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain, as shown on the Drawings, or as directed by the Owner's representative.

D. Related Sections

1. Other specification sections, which directly relate to the work of this Section, include:

a. Section 311500 "Erosion and Sedimentation Control"
b. Section 312000 "Earth Moving"
c. Section 329200 "Turf and Grasses"

1.3 LAWS AND REGULATIONS

A. Conform to applicable codes for the safety of adjacent structures and utilities, dust control, and runoff control.

B. Obtain required permits and licenses from governing authorities. Pay the associated permit fees, including disposal charges.

C. Notify affected utility companies before starting work and comply with their requirements. Notify "Call Before You Dig" by telephone at 1-800-922-4455 at least 48 hours prior to construction.

D. Do not close or obstruct roadways, sidewalks, or hydrants without permits.

E. Conform to applicable state and local regulatory procedures if hazardous or contaminated materials are discovered.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Construct temporary erosion control systems as required or as directed by the Town's representative to protect adjacent properties and street storm drains from sedimentation due to erosion.

1.5 SITE CONDITIONS

A. Site conditions existing during the bidding period will be maintained by the Owner, insofar as practical.

B. The Contractor shall have a clear understanding of existing conditions of the site before submitting his/her bid and shall be fully responsible for carrying out all site work required to fully and properly execute the work of the Contractor, regardless of the conditions encountered in the actual work.

C. Actual site condition variations that differ from those of the bidding period that affect site preparation operations shall be brought to the attention of the Owner's representative prior to the commencement of any site work.

1.6 SUBMITTALS

A. The Contractor shall submit the following information to the Engineer of record for review and approval before commencing any site work:

1. Permits and notices authorizing demolition.
2. Certificates of utility service severances.
3. Permits for transport and disposal of debris.
4. Demolition procedures and operational sequence.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCING

A. Tree protection fencing shall be wire bound, wood-roll snow fence, 4 feet high (minimum) with 3/8-inch by 1½-inch wide pickets, spaced approximately 2 inches apart and bound together with 13-gauge (minimum) galvanized steel wire, or equivalent plastic construction fencing. Stakes shall be a minimum 2-inch x 2-inch x 6-foot wooden stakes or steel posts driven a minimum of 1.5 feet into the ground. Stakes/posts shall be spaced a maximum of 8-feet on center.

2.2 CHAIN LINK CONSTRUCTION FENCE

A. Temporary chain link construction fencing shall conform to Article M.10.05 of Form 816, unless otherwise detailed or authorized by the Owner's representative.

PART 3 - EXECUTION

3.1 PROTECTION

A. The Contractor shall flag the limits of clearing shown on the Drawings by accurate field survey with marked stakes or other means acceptable to the Owner's representative. The Owner's representative shall be notified a minimum of five (5) working days prior to scheduled commencement of clearing operations to review the flagged limits. Adjust the clearing limits as directed by the Owner's representative.

B. Before clearing begins, protect any trees designated to remain with tree protection fencing to the approximate diameter of foliage to prevent damage to the trunk, foliage, and root system by construction equipment and procedures.

C. Place tree protection fencing as required to protect other plants, monuments, existing improvements, and adjacent property areas to remain uncleared from damage.

D. The Contractor shall repair immediately any damage to existing trees or root systems that are to remain. The Contractor shall employ an arborist licensed in the state of Connecticut to determine the repair needs and methods for approval by the Owner's representative. Should the arborist determine repair is not possible, the Contractor will be required to replace the damaged tree with the same size and species tree, as directed.

E. The Contractor shall be responsible for replacing trees with new trees of equivalent total quality and type should existing trees to remain be damaged.

F. The tree protection fencing shall be maintained for the duration of construction operations. The work shall include immediate replacement of any damaged fence.

3.2 TREE PROTECTION FENCING

A. Install fencing completely around all trees to be protected within the project area as shown on the Drawings or as directed by the Owner's representative. Install fencing before any construction activities commence and maintain in place until final grading and seeding is complete and accepted.

B. The Contractor shall not place or stockpile any construction or excavation materials within the drip line of any trees. Vehicle and construction equipment are not to be parked, nor left running (idling), within the drip line of any tree.

C. Any excavation within the drip line of trees to be protected shall be performed by hand, unless otherwise directed by the Owner and or Landscape Architect or Engineer of record.

D. Where construction equipment must pass within the drip line of trees to remain, the Contractor shall install wooden tree protection on the trunk of the tree, as detailed, and as directed by the Owner's representative.

E. Where excavation requires the cutting of tree roots, roots shall be cut with sharp cutting tools and reburied as soon as possible. Until roots can be reburied, the exposed roots are to be covered with wet burlap to prevent roots from drying out. The burlap is to be kept wet until the roots can be reburied.

F. Where cutting of tree root system has occurred, the Contractor shall water the tree root system to the extent of the tree canopy with at least ½-inch of water within 72 hours of when the damage occurred.

G. When less than ½-inch of water has fallen during a 7-day period, the Contractor shall water the tree root system to the extent of the tree canopy with at least ½-inch of water.

H. Trees damaged by construction activities are to be repaired within 72 hours using current arboricultural standards. Those trees determined by the Owner's representative to be damaged beyond repair shall be removed and replaced by the Contractor at no additional cost to the Owner.

3.3 UTILITIES

A. Notify all corporations, companies, individuals, or local authorities owning, or having jurisdiction over, utilities running to, through, or across areas to be affected by clearing and demolition operations.

B. Locate and identify existing utilities that are to remain and protect them from damage.

C. Have all utility services, designated as abandoned or to be removed, disconnected in accordance with the requirements of the utility owner.

3.4 CLEARING AND GRUBBING

A. Clearing shall include cutting, removal, and off-site disposal of trees, bushes, shrubs, stumps, fallen timber, refuse, trash, fencing, and other incidental materials not required for reuse on the site.

B. The Contractor shall grub the area within the clearing limits to completely remove stumps and root systems.

C. Depressions, excavations, and voids resulting from the removal of stumps or roots shall be filled with suitable material and compacted as specified in Section 312000 "Earth Moving".

D. Topsoil shall be stripped to its full depth and stockpiled in the locations shown on the Drawings, or as directed by the Owner's representative. All surplus topsoil shall be removed from the property. Topsoil shall not be mixed with subsoils or other debris.

E. All stockpiles shall be surrounded by a row of hay bales or silt fence and/or completely covered by a tarp and securely anchored. Stockpiles that will not be used within thirty (30) days shall be seeded to vegetate the piles.

3.5 SELECTIVE CLEARING AND THINNING

A. Selective clearing and thinning shall be completed as directed by the Owner's representative. Approximate limits of selective clearing and thinning are shown on the Drawings.

B. The work shall include the removal of dead and diseased tree limbs and plants and pruning and removal of live vegetation that interferes with the growth of other trees and plants. Areas of dense growth shall be thinned to provide room for healthy growth.

3.6 DEMOLITION REQUIREMENTS

A. Conduct demolition operations in a manner that will prevent damage to adjacent structures, utilities, pavements, and other facilities to remain.

B. Cease operations immediately if any damage, settlement, or other adverse effect on adjacent structures occurs. Immediately notify the Owner's representative and regulatory authorities. Do

not resume operations until conditions are corrected, damage repaired, and approval has been received from the Owner.

C. Obtain written permission from adjacent property owners when demolition equipment will traverse, infringe upon, or affect access to their property. Copies of the permission documents shall be submitted to the Owner and the Landscape Architect or Engineer of record.

D. Provide hoses and water connections. Spray water on any demolition debris to minimize dust.

3.7 FILLING VOIDS

A. Completely fill excavation areas and voids resulting from demolition or removal of structures including utilities, underground fuel storage tanks, wells, and cisterns with suitable material as specified in Section 312000 “Earth Moving”.

B. Areas to be filled shall be free of standing water, frost, frozen, and unsuitable material prior to fill placement.

C. Place and compact fill materials in conformance with the requirements as specified in Section 312000 “Earth Moving”. Fill shall be placed in horizontal layers not exceeding 8 inches in loose depth.

D. Grade filled area surface to match adjacent grades and slope to provide surface drainage.

3.8 REMOVAL AND ABANDONMENT OF UTILITIES

A. All existing structures, utilities, and appurtenances of any kind shall be completely removed within the limits of excavation for the new building.

B. All abandoned utilities and utility structures greater than 8 inches in diameter located at least 4 feet below bottom of finished grade shall be sealed with concrete slurry or brick masonry at the limit of excavation. All utilities shall be entirely removed if they are within 4 feet of finished grade.

C. Manholes and catch basins designated to be abandoned shall have all lines plugged with brick and mortar prior to filling with sand or gravel. The top 4 feet of these structures shall be removed, and the bottom slab broken up prior to filling.

D. The Contractor shall remove frames, covers, and grates from manholes, catch basins, and gate valves and satisfactorily store and protect them until they are required for reuse in the work. Existing frames, covers, and grates judged to be unsuitable for reuse shall be removed from the site and disposed of by the Contractor.

3.9 DISPOSAL OF DEBRIS

A. Remove from the site all materials resulting from demolition operations and all debris resulting from clearing and grubbing operations.

B. No burning of any material will be allowed.

END OF SECTION 311000

SECTION 311500 EROSION AND SEDIMENT CONTROL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and other Division 1 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Providing all temporary erosion control measures shown on the Drawings and required by the Owner's representative during the life of the Construction Contract to control soil erosion and water pollution.

B. The installation and maintenance of silt fence, hay bales, temporary diversion swales, temporary sedimentation traps and basins, construction entrances, fiber mats, catch basin filters, straw, netting, gravel, trenches, mulches, grasses, slope drains and other approved erosion control devices or methods.

C. Erosion control shall conform to the 2002 Connecticut Soil Erosion and Sedimentation Control Guidelines.

1.3 RELATED SECTIONS

A. Sections, which directly relate to the work of this Section, include:

1. Section 311000 - Site Clearing
2. Section 312000 – Earthmoving
3. Section 329219 – Seeding

1.4 REFERENCES

A. 2002 Connecticut Guidelines for Soil Erosion and Sediment Control, May 2002.

1.5 COORDINATION WITH PERMANENT EROSION CONTROL PROVISIONS

A. The temporary control provisions shall be coordinated with the permanent site stabilization to the extent practical to ensure economical, effective and continuous erosion control throughout the construction and post-construction period.

1.6 LAWS AND REGULATIONS

A. The DEEP General Permit for Discharge of Stormwater and Dewatering Wastewaters from Construction Activities (General Permit) (if applicable) and all other local, state and federal requirements.

1.7 PRIOR TO CONSTRUCTION

A. Prior to the start of the construction, the Contractor shall submit to the Owner's representative their schedule for the construction of required temporary and permanent erosion and sedimentation control measures, clearing and grubbing, grading, construction, and paving. No work shall be started until erosion control schedules and methods of operations have been accepted by the Owner's representative.

1.8 CONSTRUCTION OPERATIONS

A. When it becomes necessary, the Owner's representative will inform the contractor of construction procedures and operations that jeopardize erosion control provisions. If these construction procedures and operations are not corrected promptly, the Owner's representative may suspend the performance of any or all construction until corrections have been made, and such suspension shall not be the basis of any claim by the Contractor for additional compensation from the Owner for an extension of time to complete the Work.

1.9 CONSTRUCTION REQUIREMENTS—TEMPORARY SEDIMENT CONTROL

A. The Owner's representative has the authority to order immediate, additional, temporary control measures to prevent contamination of adjacent streams or other watercourses, or other areas of water impoundment and damage by erosion. These additional measures may be ordered based upon the visual observation of the Owner's representative .

B. The Contractor shall construct all permanent erosion and sediment control features at the earliest practical time as outlined in the accepted schedule. Temporary erosion and sediment control measures shall be used to correct conditions that develop during construction, which were unforeseen, but are needed prior to installation of permanent control features, or that are needed temporarily to control erosion or sedimentation which develops during construction operations.

C. Where erosion is likely to be a problem, clearing and grubbing operations shall be scheduled and performed so that grading operations and permanent erosion and sediment control features can follow immediately thereafter, if conditions permit; otherwise, temporary control measures will be required between successive construction stages.

D. Failure by the Contractor to control erosion, pollution, and siltation shall be cause for the Owner's representative to employ outside assistance to provide the necessary corrective measures. The cost of such assistance, including engineering costs, will be charged to the Contractor and appropriate deductions made to the Contractor's monthly progress payment request.

E. The Contractor shall periodically remove sediment from erosion control facilities. The accumulated sediment shall not be allowed to rise above the mid height of the erosion control facilities. The Contractor shall modify and improve erosion control facilities and replace deteriorated hay bales and other devices as required by the Owner's representative.

F. Temporary and permanent erosion and sedimentation control measures are shown on the Drawings. The Contractor shall strictly adhere to the proposed measures. Additionally, temporary measures shall be constructed to accommodate field conditions that develop during construction.

1.10 MAINTENANCE OF EROSION CONTROL MEASURES

A. The Contractor shall check the condition of erosion control devices daily and maintain them in good operating condition. Hay bales shall be replaced when deteriorated, and when required by the Owner's representative.

B. The Contractor shall inspect the condition of diversion swales, biofiltration swales, sediment traps, detention basins and other erosion and sedimentation control devices

after each storm event >0.5 inches. Repairs shall be made as necessary and as required by the Owner's representative.

C. Accumulated sediment trapped by erosion and sedimentation control devices shall be removed as required by the SWPCP.

D. Temporary soil erosion and sedimentation control devices shall be removed and adjacent areas outside the limits of grading restored upon completion of the work, or when required by the Owner's representative.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Seed for quick growing grasses, wheat, rye or oats shall be selected based on site and seasonal conditions from Figure TS-2 of the 2002 Connecticut Guidelines for Soil Erosion and Sediment Control, May 2002.

B. Erosion Control Blanket/Fabric Netting shall be:

- Curlex blankets, as manufactured by American Excelsior Company, or
- Polyjute Style 465 GT, as manufactured by Synthetic Industries, or
- Tensar Erosion Mat, as manufactured by the Tensar Corporation, or approved equivalent.

C. Hay bale for sediment traps, consisting of hay bales banded with wire or nylon tape (minimum two bands for bale), shall be approximately two-feet, six-inches in length.

D. Stakes for hay bales shall be standard 1/2-inch x 3-foot reinforcing steel rods, steel pickets, 1 inch x 1 inch x 3-foot wood stakes or approved equivalent.

E. Silt fence fabric shall be Mirafi 100X, Geotex 915SC, Contech C200, or approved equivalent.

F. Filter fabric at a construction entrance shall Mirafi 600X, Geotex 200ST, Contech C-60NW, or approved equal.

G. Catch basin filters shall be Siltsack by ACF Environmental, Dandy Sack by Dandy Products, Silt Mat by Kristar, or approved equal.

PART 3—EXECUTION

3.1 EROSION CONTROL - HAY BALES

A. Hay bales shall be installed in accordance with the details indicated on the drawings and at the following locations, as required by the Owner's representative and as shown on the Drawings:

1. Toe of slope of embankment construction to filter all runoff flowing to off-site discharges.

2. Toe of temporary earthwork stockpile slopes.

3. Across a construction ditch prior to entry into drainage system or waterway.

4. Each side of completed drainage inlets.

5. Dewatering Pumping Settling Basins.

6. Other locations shown on the Contract Drawings or designated by the Owner's representative.

B. Tightly abut hay bales to form a continuous barrier. Secure bales in place with two stakes per bale. The bales shall be trenched 4 inches into the ground. Soil shall be placed on the upside slope side of the bales. Deteriorated, destroyed or rotted bales shall be replaced immediately. Sediment shall be removed and disposed of periodically from behind the hay bales. The accumulated sediment shall not be allowed to rise above the mid height of the bale. All sediment, hay bales and appurtenances shall be removed and disposed of at the completion of the Contract unless directed otherwise by the Owner's representative.

3.2 TEMPORARY EROSION CONTROL MATS

A. Erosion control mats shall be installed in accordance with the manufacturer's recommendations.

B. All areas shall be smooth graded and compacted. Remove all rocks, dirt clods, vegetation and other obstructions that may cause damage to the mats.

C. Unroll mats parallel to the direction of water flow and lay flat against the ground. Overlap roll ends 1-2 feet with upslope mat on the top to prevent uplift of mat end by water flow. Overlay adjacent edges of mat by six inches. Extend mat 2-3 feet above the crest of steep slopes and anchor by excavating a 6-inch deep trench, and secure end of mat in trench, backfill and compact. Secure mat to the ground using staples or pins furnished by manufacturer of mat.

3.3 SILT FENCE

A. Silt fence shall be installed as shown on the Drawings.

B. Supporting posts shall be spaced a maximum of 5 feet on center, and driven at least one foot into the ground. Posts shall be 1-1/2-inch square or heavier wood posts, or standard steel posts.

C. Fabric shall be anchored in a 6-inch deep trench dug on the upslope side of the posts. The trench shall be at least 6 inches wide. The fabric shall be laid in the trench, backfilled and compacted.

D. Fabric rolls shall be spliced at posts. The fabric shall be overlapped 6 inches, folded over and securely fastened to posts.

E. Silt fences shall be inspected immediately after each storm event and at least daily during prolonged rainfall >0.5 inches.

3.4 CATCH BASIN FILTER

A. A catch basin sediment filter shall be installed in each existing catch basin as long as it remains in use. Filters shall be changed/cleaned per the manufacturer's recommendations, or as directed by the Owner's representative, during construction.
B. New catch basins shall have a filter installed immediately upon completion of construction. In addition, a hay bale, or similar, barrier shall be installed around the new basin and maintained in place until binder is placed or disturbed areas draining to it are stabilized.

END OF SECTION 311500

SECTION 312000 - EARTHMOVING

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Excavation and disposal of unsuitable or excess materials.
B. Excavation, fill, backfill and refill, as indicated or required, including compaction.
C. Rock removal, as required.
D. Rough grading, including compaction of existing materials and granular fills, backfills, and refills.
E. Trench excavation, bedding and backfill for all utilities, as directed, including compaction.
F. Riprap and riprap bedding.
G. Installation, maintenance & removal of erosion control measures.

1.2 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements, which affect the Work in this Section. Other specification Sections, which directly relate to the Work of this Section include, but are not limited to, the following:

1. Section 311590 – Erosion Controls
3. Section 334100 - Storm Drainage Systems

1.3 BUILDING AREA

A. The area within limits of a minimum of five (5) feet or to such greater dimensions as indicated on the drawings outside the exterior face of the building is herein defined as the building area. All requirements for structure excavation and for fills and refills within the building area shall extend to these lines.

1.4 PROTECTION

A. Excavation Support: The work is to some extent located in an area near existing construction and new work. Operations will be conducted so as to provide adequate support at all times for these facilities. All excavation shall be sheeted, shored and braced. Excavation shall be sloped, if necessary, to prevent cave-ins, or undermining of these facilities. Sheeting, shoring and bracing shall be removed before backfilling is complete.

B. Dewater when excavations are to some extent below existing groundwater levels and the site is subject to surface water and groundwater flow during the course of construction.

1. Control and pitch the grading to prevent water from running into the excavated areas or to prevent damage to other structures or work already accomplished.

2. The Contractor shall furnish all pumping and other dewatering equipment necessary to keep excavated area dry during construction. The groundwater shall be pumped adequately so that the water table is maintained a minimum of

two (2) feet below the bottom of the excavation at all times. Filters shall be used on the dewatering devices to prevent the removal of fines from the soil. Water shall not be conducted onto adjacent property except in existing water courses.

3. Operations and Performance: Operate the dewatering system continuously, 24 hours per day, 7 days per week, until such time as construction work below existing water levels is complete, unless directed otherwise. Measure and record the performance of the dewatering system at the same time each day by use of suitable observation wells or piezometers installed in conjunction with the dewatering system. After placement of initial slabs and backfill, the water level may be allowed to rise, but at no time allow it to be higher than one foot below the prevailing level of excavation or backfill.

1.5 ENGINEERING AND SURVEY WORK

A. The contractor shall engage the services of a registered Land Surveyor to stake the location and elevation of all parking areas, catch basins, curbing, etc.\

B. Submit two (2) copies of As-Built Drawings upon completion and acceptance of work..As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all grading, drainage structures and new construction. As-Built drawings shall also contain any additional information required by the Owner's representative and shall be stamped by a licensed Land Surveyor.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Except as otherwise specified, all fills, refills and backfills within the building areas and for paved areas, utilities, and appurtenances required in structural or site excavation shall be made with gravel, crushed stone or sand as hereinafter specified.

1. Bank or Crushed Gravel shall be composed of hard, durable stone and coarse to fine sand, not frozen and free form loam and undesirable organic matter, containing no stone having any dimension greater than two-thirds (2/3) of the depth of layer to be compacted. Gravel borrow or bank-run gravel shall conform to article m.02 of the CONNDOT standard specification form 816 and the following gradation requirements:

% PASSING BY WEIGHT	U.S. STANDARD SIEVE SIZE
3 1/2"	100
1 1/2"	55-100
No. 4	25-60
No.40	5-25
No. 200	0-5

2. Processed aggregate shall conform to the applicable requirements of CONNDOT Standard Specifications Form 814 section M.05 and shall have the following gradation:

% PASSING BY WEIGHT	U.S. STANDARD SIEVE SIZE
2 1/4"	100

2"	95-100
3/4"	50-75
1/4"	25-45
No. 40	5-20
No. 100	2-12

3. Material for use as pipe bedding shall conform to the following requirements:

It shall be sand or sandy soil all of which passes a 3/8" sieve and not more than 10% passes a No. 200 sieve.

B. Common borrow and all refills and fills not supporting or influencing structures, pavement, or utilities shall be made with approved granular material containing sound stone, gravel and sand, free of frozen materials, silt, clay, vegetation, roots, peat, muck or other unsuitable matter.

C. The use of on-site materials for fills, refills, or backfills will be permitted provided the material meets the above requirements. Additional material required for structure fill shall be provided from off-site sources and shall meet the above requirements.

D. For lab testing see Div. 1.

3 PART 3 - EXECUTION

3.1 UNSUITABLE OR EXCESS MATERIALS

A. All topsoil and unsuitable or excess materials shall be stripped to their entire depths from areas of new construction or regrading. Materials suitable for use shall be stored in approved locations that will not interfere with building or utility operations. Topsoil shall be stripped and stored before any underlying excavating is begun. Stripped topsoil to be reused shall be free from clay, large stones and debris. Excess topsoil shall remain the property of the Owner and shall be loaded onto Town trucks, by the contractor, at the conclusion of the project. All unsuitable and surplus materials shall be excavated and legally disposed of off-site.

3.2 GRADES AND ELEVATIONS

A. The Drawings indicate, in general, the alignment and invert and finished grade elevations of all structures and utilities; the Owner's Representative, however, may make such adjustments in grades and alignment as are found necessary in order to avoid interference and to adapt the utilities and piping to other special conditions encountered. Grading between indicated final grades shall provide smooth even surfaces, except as otherwise required. Cover over pipes shall, in any case, conform to requirements of local and state agencies having jurisdiction.

3.3 SEQUENCE OF EARTHWORK

A. Within the Contract area operations to conform to a specified sequence of general excavation, structure excavation as required for footings, slabs and foundation units, backfill and completion of the subgrade, will be conducted.

B. The subgrade is herein defined as the top surface of those existing materials, and of fills and refills, not including base materials or surface materials.

C. After clearing and grubbing, and stripping of topsoil and unsuitable or excess materials, excavate and remove all materials above the subgrade level.

D. Excavation shall be performed to elevations and dimensions indicated, plus sufficient space to permit erection of forms and shoring, drains, masonry and the inspection of foundations.

E. Immediately after excavations to the required grades, the exposed surface of the in-site materials shall be cleaned of all loose or disturbed materials. The surface of all structural excavations shall be thoroughly compacted.

F. If suitable bearing for foundations is not encountered at the depth indicated on the Drawings, or in the excavations required in these Specifications, immediately notify the Owner's Representative. Remove any remaining unsuitable material as directed. The Owner's Representative shall be the sole judge of the suitability of all materials. Placing of footings, foundation walls or compacted gravel on unsuitable material will not be permitted.

G. If rock is encountered at the required elevations, the rock shall be over-excavated and replaced with a minimum of twelve (12) inches of compacted gravel to the elevation of the bottom of the footing.

H. Bottoms of excavations shall be protected from frost and from water whatever the source. Foundation units, footings or slabs shall not be placed on frozen ground nor on saturated materials. No excavation shall be made to the full depth indicated when freezing temperatures may be expected, unless the footings or slab can be poured immediately. The bottoms so excavated shall be protected from frost and water if placing or concrete is delayed.

I. The Contractor shall sheet, shore and brace all excavations, if necessary, to prevent cave-ins. Sheeting, shoring and bracing shall be removed before backfilling is completed.

J. Required excavations and excavations below or beyond the indicated or authorized limits shall be refilled with gravel compacted to the indicated percent of the maximum dry density at optimum moisture content as specified herein at no additional expense to the Owner's Representative.

95%	Pavement
85%	General

K. After all required excavations have been made and the footings, foundations units and foundations walls have been constructed the Contractor shall place and compact suitable backfill to the subgrade level in lifts as hereinafter specified.

L. All fills and refills to the subgrade level shall be made with approved materials as specified. Immediately prior to placing the improvements, clean up the subgrade by removing and replacing any unsuitable materials as previously defined.

3.4 SITE EXCAVATION, FILL AND BACKFILL

A. Perform all site excavation, fill, backfill and compaction required for the various utilities, structures, conduits, roads and appurtenances thereto and for all site grading.

B. Trench widths shall be sufficient to permit proper installation of the work and bottoms of trenches shall be evenly graded. The maximum allowable width of trench for pipe shall be as indicated on the Drawing. Excavations below required depths shall be refilled with compacted gravel. Immediately after trench excavations have been carried to the required grades, the exposed surface of the existing bottom materials shall be cleaned of all loose or disturbed materials. Where the trench bottom is below the water level or within saturated earth materials, the bedding shall be crushed stone. Pipe beds shall rounded to accommodate the bottom quadrant of the pipe and bell holes shall be excavated to provide full support and uniform bearing for the entire length of the pipe barrel.

C. After piping and conduits have been installed, tested, inspected and approved by the Owner's Representative, gravel in which stones larger that 2 inches in size have been removed, unless otherwise detailed on the Drawings, shall be carefully hand placed and hand tamped in six (6) inch layers under, around, and to a level one (1) foot above the top of the piping and conduits. The remaining excavation shall be backfilled with approved granular materials from on-site excavations, compacted in one (1) foot layers loose measure.

D. Information shall be obtained from the proper authorities concerning locations of all utilities within the scope of this work, in order that there will be no damage done to such utilities. Neither the Owner nor the Owner's Representative shall be responsible for any such damage and any resultant damage shall be restored to any structure and repaired without additional compensations.

    1. Rules and regulations governing the respective utilities shall be adequately protected from damage, and shall not be removed or relocated except as indicated or directed. Inactive and abandoned utilities encountered in excavation and grading operations shall be removed, plugged or capped, as directed. The locations of such abandoned utilities shall be reported in writing to the Owner's Representative.

E. Excavation of earth beyond indicated or authorized limits shall be refilled, at no additional expense to the Owner, with gravel compacted to 85 percent of the maximum dry density as required by the Owner's Representative.

F. Excavations shall be adequately sheeted, shored and braced, as necessary, to permit proper excavation of the work and to protect all slopes and earth banks. Sheeting shall be installed as required to prevent cave-ins or settlement and to protect workmen, adjacent structures and utilities. Shoring and sheeting may be removed as the backfilling progresses, but only when banks are safe against caving. The Owner's Representative may direct that sheeting, shoring and bracing, be left in place at any time during the progress of the work, and direct that timber be used for sheeting and bracing, authorized to be left in place, be cut-off at a specified elevations. In removing sheeting or bracing, care shall be taken to prevent voids. Voids, if formed, shall immediately be filled with sand. Dewatering shall be performed, as required, for all excavations below ground water level.

G. Dig test pits at the locations selected and to the dimensions directed by the Owner's Representative for compaction testing or to establish locations of existing pipelines or any other buried item for which the exact location is to be determined. The excavation, protection and backfilling of test pits shall be in accordance with the provisions of this Section. The maximum depth of test pits shall generally be ten (10) feet, measured from the average ground surfacing existing at the test pit location immediately prior to digging each pit. Test pits shall be backfilled with approved materials and compacted to the densities specified.

3.5 ROCK EXCAVATION

A. All rock encountered within the limits of excavation shall be removed as may be required to complete the work of this contract, as shown on the Drawings and as specified herein.

B. Rock excavation shall include only excavation of boulders of more than 1 cubic yard in volume and ledge rock which is determined by the Engineer to be so hard that it is necessary to loosen and handle with special rock breaking equipment or blasting.

C. Where boulders are exposed on the sides of, or in the bottom of the trenches or excavations for structures, they shall be wholly or partially removed, as directed; boulders shall be removed to limits not less than twelve (12) inches below and to the trench width lines indicated, and shall be removed to limits not less than twelve (12) inches outside below the structure walls or the underside of structure foundation slabs. Depressions resulting from the removal of boulders shall be refilled with approved compacted gravel.

D. The Contractor may excavate the rock by any method which is satisfactory to the Engineer and which will prevent damage to existing surfaces and structures adjacent to the work. The approval of the method of excavation shall not be construed as relieving the Contractor of any of his responsibilities or liabilities for damages.

E. The Contractor shall exercise great care in the use of explosives to prevent damage to adjacent property and shall comply with all Federal, State and City ordinances governing the handling, storage and use of explosives and shall obtain the necessary permits at his own expense.

F. The Contractor shall employ only experienced supervisors and workmen in the handling, loading and firing of dynamite. All employees engaged in this work shall be properly licensed by the State of Connecticut for the handling of explosive. Where explosives are used, work shall be done by experienced powdermen, using properly sized charges and in strict accordance with all regulations governing this work. The Contractor shall take every precaution to protect persons, property and the work.

3.6 PLACING FILL

A. Foundations for fills, refills and backfills shall be prepared in an approved manner by removing all excess and unsuitable materials. The base or other surface of fills, refills or excavations which have been allowed to weather and which in the option of the Owner Representative, are unsuitable, shall be removed and replaced with crushed stone or gravel or shall be dried, roughened or scarified, and then compacted before any additional fills or refills are placed on them.

B. Materials placed shall, unless permitted or required, be specially compacted by depositing in approximately horizontal layers not exceeding six (6) inches in thickness before compaction and, unless sufficiently moist as spread, shall be wetted to near the optimum moisture content. Each layer shall be compacted by suitable vibratory compactors or tampers, as previously approved by the Owner Representative, which will secure the required minimum degree of compaction. No other type of equipment shall be used for compaction.

C. Materials used in refills and backfills shall be deposited carefully to avoid injury to structures, conduits or pipes.

D. The areas to be fine graded for loaming and seeding shall be raked to remove all stones and other unsatisfactory material and shall then be rolled as directed under this Section. Any depressions which may occur during the rolling shall then be filled with additional suitable material and the surface then regraded and rolled until true to the lines and grades required. Care shall be taken not to affect the line or grade of walls and footings during grading and rolling operations.

3.7 COMPACTION

A. Fills placed under pavements, utilities and storm drainage systems shall be compacted to not less than 90 percent of the ASTM maximum dry density, except that the top six (6) inches below subgrade shall be compacted to 95 percent of maximum dry density. Fills in playing fields and planting areas shall consist of approved on-site material and shall be compacted to not less than 85 percent of the ASTM maximum dry density.

B. Where vibratory compaction equipment is specified herein or is directed to be used by the Owner's Representative all such equipment whether plate-type or roller shall be furnished with a vibrating surface at least 24 inches in width, and capable of operating at a minimum of 2,000 blows per minute. Equipment not specifically designed as vibrating compaction equipment shall not be permitted for compaction of either existing in-place materials or of fills, refills and backfills. Jack hammers, rubber-tired vehicles and similar equipment not specifically designed and manufactured for compaction of granular materials will not be approved for use.

C. Surfaces to be compacted shall, unless otherwise specified, be compacted by not less than six (6) complete passes of approved vibratory compactors, in order to obtain the required percentage of compaction. A complete pass shall consist of the entire coverage of the surface area to be compacted with one trip of the equipment. Each trip of equipment shall overlap the previous trip by at least one (1) foot.

D. Dumping, spreading preparing and compacting of several layers of fill materials across the site may be performed simultaneously, providing there is sufficient total area to permit these operations to proceed in a systematic manner.

E. No rolling equipment shall be used to compact fill, refill or backfill materials within five (5) feet of the vertical faces of any concrete walls or utility pipes. Plate vibratory tampers shall be used in these restricted areas, and in other areas too confined to satisfactorily use rolling equipment.

F. It is the intent of these compaction requirements that the minimum in-place dry density of the compacted materials resulting will be equal to or greater than the

minimum percentage specified herein. Additional compaction shall be required if the minimum percentages of ASTM in-place dry densities as specified are not obtained.

END OF SECTION

SECTION 312319 - DEWATERING

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 RELATED SECTIONS

A. Other specification Sections, which directly relate to the work of this Section, include:

1. Section 312000 “Earth Moving”

1.3 DESCRIPTION OF THE WORK

A. The Contractor shall prevent surface water and subsurface or groundwater from flowing into excavations or earthwork areas which would cause flooding of the Project site and surrounding area or softening or loosening of the soil at excavation or earthwork subgrade.

B. The Contractor shall provide adequate and satisfactory dewatering and drainage of excavations and furnish all materials and equipment and do all incidental work required in conjunction with the furnishing, installing, and maintaining of same to permit proper and timely completion of all work required. The Contractor may choose any satisfactory method he/she wishes subject to the approval of the Owner’s representative for handling groundwater or surface water encountered in the work, provided they perform the dewatering required. The Contractor shall assume all responsibility for the adequacy of the methods, materials, and equipment employed. The Contractor shall take all precautions necessary to prevent loosening or softening of the subgrade. In this regard, the Contractor shall at all times be prepared to alter his construction method or sequence. Dewatering and control of water shall be conducted as necessary to prevent seepage, groundwater flow, or surface infiltration and runoff from it in any way undermining or otherwise damaging adjacent structures and utilities.

C. Pumping equipment and devices to properly remove and dispose of all water entering the trenches and excavation for structures shall be provided. The grade shall be maintained dry until the structures (building slabs and footings, paved area, pipe, drainage structure, embankments, etc.) to be built thereon are completed. All dewatering required by pumping and drainage shall be performed without damage to the excavation, pipe trench, pavements, pipes, electrical conduits, other utilities, and any other work or property. Existing or new sanitary sewers shall not be used to dispose of drainage.

D. The Contractor’s method of dewatering shall maintain the bottom of excavations dry at all times.

E. The Contractor shall prevent pollution from storm water discharges in compliance with the DEEP General Permit for Discharge of Storm Water and Dewatering Wastewaters from Construction Activities (General Permit) and all other local, state, and federal requirements.

1.4 DESIGN CRITERIA

A. The Contractor is responsible for the adequacy of the dewatering systems and shall design the dewatering systems so they will:

1. Effectively reduce the hydrostatic pressure and lower the groundwater levels to a minimum of 2 feet below the bottom of excavation.
2. Develop a substantially dry and stable subgrade for the prosecution of subsequent operations.
3. Not result in damage to adjacent properties, buildings, structures, utilities, and other work.
4. Assure that, after 12 hours of initial pumping, no soil particles will be present in the discharge.

B. Methods may include sump pumping, single or multiple stage well point systems, educator and ejector-type systems, deep wells, and combinations thereof.

C. Locate dewatering facilities where they will not interfere with utilities and construction work to be done by others.

D. Modify dewatering procedures, which threaten to cause damage to new or existing facilities, so as to prevent damage. The Contractor is responsible for determining the modifications to be made, which shall be at no additional expense to the Owner.

1.5 SUBMITTALS

A. Prior to installation of the dewatering system, submit design data showing the following, for review by the Owner's representative:

1. The proposed type of dewatering system.
2. Arrangement, location, and depths of system components.
3. Complete description of equipment and instrumentation to be used, with installation, operation, and maintenance procedures.
4. Types, sizes, and location for the dewatering wastewater filtration system.
5. Design calculations demonstrating adequacy of the proposed system and equipment.
6. Methods of disposal of filtered dewatering wastewater.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 JOB CONDITIONS

A. Surface Drainage: Intercept and divert precipitation and surface water, away from excavations through the use of temporary diversion swales, temporary sediment traps, pipes, sumps, or other approved means.

B. Drainage of Excavated Areas: Provide and maintain ditches of adequate size to collect surface and seepage water, which may enter the excavations. Divert the water into the temporary sediment trap(s), sumps, and storm drains or pump into drainage channels or storm drains. When water is to be diverted into a storm drain, provide dewatering settling basins, or other accepted apparatus, such as fractionation tanks, as required to reduce the amount of fine particles, which may be carried into the drain. If a storm drain becomes blocked due to dewatering operation, it shall be cleaned by the Contractor at their own expense.

3.2 DEWATERING

A. Accomplish dewatering in accordance with accepted design data and applicable dewatering permits. Keep the Owner's representative advised of any changes made to accommodate field conditions and, on completion of the dewatering system installation, revise and resubmit design data as necessary to show the installed configuration.

B. Organize dewatering operations to lower the groundwater level in excavations as required for prosecution of the work, and to provide a stable, dry subgrade for the prosecution of subsequent operations.

C. Maintain the water level at such lowered elevations that no danger to structures can occur because of the buildup of excessive hydrostatic pressure on the subgrade, or bottom of trench, unless otherwise permitted by the Owner's representative.

D. Do not allow water to accumulate in excavations. The Contractor shall, at all times during construction, provide ample means and devices with which to remove promptly and dispose properly of all water entering roadway, trench, and structure excavations and keep them dry until the structures to be built thereon are completed.

E. No pipe/culvert/structure shall be laid in water. No masonry shall be laid in water, and no water shall be allowed to rise over masonry (either concrete or brick) in 24 hours after being placed. Nor shall moving water be allowed to rise over masonry for four (4) days. In no event shall water be allowed to rise so as to set up unequal pressures in the structures until the concrete or mortar has set at least 24 hours. The Contractor shall constantly guard against the possibility of flotation of pipe or structures after installation. He/She shall place adequate backfill promptly in accordance with Section 312000 "Earth Moving", to prevent this occurrence, and his/her method of handling drainage and carrying on these operations shall always be adequate to prevent flotation.

3.3 RECORDS FOR WELL SYSTEMS (IF USED)

A. Observe and record the average flow rate and time of operation of each pump used in the dewatering system. Where necessary, provide appropriate devices, such as flow meters, for observing the flow rates. Submit the data, in tabular form during the period that the dewatering system is in operation.

B. Observe and record the elevation of the groundwater on a form during the period that the dewatering system is in operation. Submit observation records within 24 hours of reading, on a regular basis.

C. During the initial period of the dewatering, make required observations on a daily basis. If, after a period, dewatering operations have stabilized, reduce observations to longer intervals as accepted by the Owner's representative.

END OF SECTION 312319

SECTION 315000 - SHEETING AND STAYBRACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF THE WORK

A. The Contractor shall install sheeting or staybracing as necessary in order to comply with the applicable Safety Code; to accommodate traffic; to permit access to existing utilities; to provide an opening of proper depth and width in which to install the proposed pipes and other underground structures; and to protect his workmen, employees of the Owner, and the public, from death or injury from bank failure, earth collapse, or earth movement of any nature whatsoever. In general, all trenches and excavations over 4 feet in depth, any other unstable excavations, or excavations in unstable material, shall be protected against the hazard of collapse.

1.3 SHEETING/STAYBRACING DESIGN

A. The Contractor shall be entirely and solely responsible for the adequacy and sufficiency of all supports and for all sheeting, bracing, shoring, underpinning, cofferdamming, etc. The Contractor shall assume the entire and sole responsibility for damages on account of injury to persons or damage to adjacent pavements and public and private property (including but not limited to, the Work under construction, existing buildings, facilities, etc. which injury or damage results directly from said Contractor's failure to install, or to leave in place, adequate and sufficient supports, sheeting, bracing, underpinning, cofferdamming, etc.

B. The Contractor shall submit, in triplicate, a detailed written description of the equipment and sheeting methods he proposes to use to the Owner’s representative prior to the installation of any sheeting and/or shoring. These plans should include, but not be limited to, the type of sheeting or shoring, sizes and dimensions, bracing, spacing, methods of installation and removal, etc.

C. All sheeting shall be designed and sealed by a Professional Engineer licensed to practice in the State of Connecticut. He/She shall be known as the Contractor's Engineer. Sheeting computations and sketches shall be submitted for the Owner’s representative's review.

1.4 SHEETING LEFT-IN-PLACE

A. Sheeting, shoring, or other timbering may be left-in-place at the option of the Contractor when needed to protect other existing facilities or the Work built or to be built under this Contract. However, steel sheeting left-in-place will be paid for only where specifically shown as "Steel Sheeting Left-in-Place" on the Contract Drawings or where ordered by the Owner’s representative.

B. It is expressly understood and agreed that removing or leaving-in-place any sheeting or shoring, etc., as noted above, shall not relieve the Contractor from any responsibility for any loss damage whatever due to omission of, or failure of, the sheeting, etc., failure to leave it in place, or the settling of the backfill, or any movement of the ground or any structure or object adjacent to any trench or excavation made by the Contractor. The Owner’s representative will not order any sheeting, etc.

left-in-place at the expense of the Owner in order to accommodate the convenience of the Contractor or to save him/her the cost of its removal.

1.5 OPTIONAL METHOD OF TRENCHING

A. The Contractor may, with the approval of the Owner's representative, lay back slopes in accordance with the provisions of the applicable local, State, or Federal Safety Code in order to avoid the necessity of sheeting or limiting the quantity thereof. However, in the case of trenches, the toe of this slope will not be lower than 1 foot above the top of the pipe to be installed. A level bench of at least 2 feet in width shall be maintained between the toe of the sloped section and vertical trench excavation for pipes with an outside diameter of 6 feet or less; for pipes with an outside diameter over 6 feet, a minimum 4-foot bench shall be provided. Where sloping is used as a substitute for sheeting or staybracing, or used in combination therewith, it shall be sloped a minimum of one (1) horizontal to one (1) vertical except where instability of the material requires a slope flatter than one to one. If the Contractor elects and is allowed to lay back the slopes, there will be no additional payment made for the extra excavation outside of the normal trench or structure excavation payment limits.

1.6 RESPONSIBILITY OF THE OWNER'S REPRESENTATIVE

A. There shall be no obligation on the part of the Owner's representative to issue orders for sheeting, staybracing, or sheeting left-in-place and/or to pass upon sufficiency and adequacy of sheeting; nor shall the failure on the part of the Owner's representative to give such orders relieve the Contractor from liability for damages occasioned by negligence, or otherwise growing out of the Contractor's failure to either install sufficient and adequate sheeting and/or staybracing or to leave in place in the excavation sufficient and adequate support to prevent the caving in or moving of the ground adjacent to the sides of the excavation during and after the backfilling operation.

PART 2 - MATERIALS

2.1 MATERIALS

A. Wooden staybracing, shoring, and sheeting shall be in conformance with the requirements of Connecticut DOT Form 816, Subarticle M.09.01-1.

B. All steel sheeting shall be continuous and interlocking with materials conforming to the provisions of ASTM A 328 or equal.

2.2 TRENCH BOXES

A. Trench boxes shall not be used unless requested by the Contractor and authorized by the Owner's representative. If authorized, they shall be used only when the protection of workmen is involved, not for support of existing adjacent utilities, structures, embankments, etc. A trench protected by the use of a trench box shall not be considered a sheeted trench.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unless expressly authorized by the Owner's representative, sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting to facilitate driving, care shall be taken to avoid trimming behind the face

along which the sheeting will be driven. Care shall be taken to prevent voids outside of the sheeting.

B. All sheeting and staybracing shall be securely installed and properly braced in accordance with the applicable local, State, or Federal Safety Code. The Owner's representative may direct the Contractor at any time in writing to have sheeting, bracing, etc. in place to be embedded in backfill or concrete for the purpose of preventing subsequent injury to structures and property.

C. The depth of pilot cuts for trenches/structures shall not exceed 5 feet in depth at any time. The Owner's representative may reduce the depth of the pilot cut should the soil and subsurface conditions warrant such action. Sheeting must be driven by drop hammer or other methods approved in writing by the Owner's representative below the area of the pilot cut. Driving of sheeting above the pilot cut is subject to the directions of the Owner's representative. The Owner's representative may direct the Contractor to use other types of equipment, and to revise the procedure during the excavation of the pilot cut and the driving of the sheeting should it be found necessary to do so.

D. Vibratory driving hammers shall not be used unless specifically authorized by the Owner's representative.

E. Where sheeting is specified to be left-in-place, it shall be wood sheeting unless otherwise specifically noted on the Contract Drawings. Where wooden sheeting cannot be driven due to the nature of the material, then steel sheeting may be driven and removed in lieu of the wooden sheeting providing the following procedures are followed:

1. Simultaneously with the withdrawal of sheeting and as each layer is compacted in accordance with Section 312000 "Earth Moving"; or
2. The trench/area will be backfilled to the surface. If the sheeting is to be withdrawn, backfilling will proceed up to each set of rangers and braces; the rangers and braces will be removed; the backfilling will proceed up to the next set of rangers and braces, etc. up to the top of the excavation. The backfill material shall be compacted to ninety-eight percent (98%) of the maximum dry density as determined by AASHTO T 99, Method C. Alternate sections of sheeting from the left side and right side of the trench/area shall be removed and the cavity remaining there from shall be jetted thoroughly by high-pressure water, starting at the toe of the sheeting and being drawn to the surface. Sand shall be inserted with the jetting process.

F. Where the bottom of the excavation is not free draining material (some areas of organic material or miscellaneous fill) or where granular backfill is not available or ordered by the Owner's representative, the jetting shall be very carefully done with a minimum amount of water being expended. In such locations, the Contractor may request the approval of the Owner's representative for other compaction methods in the sheeting cavity.

G. The Contractor shall remove the sheeting and/or staybracing from the excavation, except where it is specifically indicated on the Contract Drawings "To be Left- in-Place", or the Contractor may elect to leave in place the sheeting and/or staybracing for his/her own convenience, or to serve his/her own interest to protect existing facilities, the Work built or to be built under this Contract, or for the safety of the public, etc., at no cost to the Owner. No sheeting or bracing which is within 3 feet of the existing or proposed finished grade may be left-in-place without the prior permission of the Owner's representative. This may require the Contractor cut off sheeting at this elevation and at no additional cost to the Owner.

H. Where sheeting, regardless of the type of sheeting used, is left in place, as specified, ordered, or at the Contractor's convenience/option, unless otherwise specifically permitted in writing by the Owner's representative, all elements such as rangers, braces, wales, etc. shall be left in place except as specified hereinbefore; and, except such temporary braces required to be

removed to make way for the structure/utility. Where it is necessary to remove such temporary braces, the sheeting shall be rebraced, but in no case shall the sheeting be braced against the sides of the structure/utility to be constructed unless approved in writing by the Owner of the structure/utility. Where lagging and "soldier" beams are used, the "soldier" beams and all the braces shall also be left in place.

I. Where wood sheeting has been driven below the excavation bottom to provide for a "toe-in", no wood sheeting below the top of pipe or structure shall be removed, but it shall be cut off at this elevation and the remaining sheeting above this line removed as described herein. There will be no payment made for this work, nor for the wood sheeting left-in-place.

J. Sheeting shall be cut away and removed from in front of capped outlets or other braces or inlets set in the pipe for future connections.

K. All sheeting, shoring, and bracing removed shall be carefully removed from the excavation in such a manner as not to endanger the completed work or any adjacent pavements, buildings, structures, utilities, property, etc. The sheeting shall be withdrawn to such an extent that it is just above the backfill material being compacted, and all voids left or caused by the withdrawal of such sheeting, shall be immediately refilled with approved material and compacted at no additional cost to the Owner.

L. Where the excavation is to be left open during non-working hours, the sheeting shall extend 42 inches above existing grade to protect pedestrian and vehicular traffic from the open excavation. If barricades are not used, such sheeting shall be suitably lighted, conforming to the Section 317000 “Maintenance and Protection of Traffic”.

END OF SECTION 315000

SECTION 317000 - MAINTENANCE AND PROTECTION OF TRAFFIC

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 DESCRIPTION OF THE WORK

A. The Work under this Section shall consist of maintaining and protecting traffic in and adjacent to the project area to the satisfaction of the applicable local Police, Fire, and Traffic Departments and the Owner's representative. Unless otherwise specified within the Contract Documents, the Contractor must maintain pedestrian and vehicular traffic and permit access to parking lots, parking garages, buildings, and intersecting streets.

1.3 WORK BY OTHERS

A. The Contractor is advised that he shall coordinate the maintenance and protection of traffic, both vehicular and pedestrian for the entire job. The Contractor shall insure that the provisions provided herein shall be complied with by all parties involved in work on this Contract.

1.4 MAINTENANCE AND PROTECTION OF TRAFFIC EQUIPMENT

A. The equipment used under this Item shall comply with all requirements herein and the requirements of the 1988 Manual on Uniform Traffic Control Devices for Streets and Highways, as amended. Traffic drums shall be used to separate moving lanes of traffic from the Work area. Each drum shall be affixed with high intensity flashers for nighttime operation.

B. Type I barricades shall be used to barricade off work zones from operating travel lanes and parking lanes. Each barricade shall be affixed with suitable construction signs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TRAFFIC CONTROL

A. The Contractor shall furnish, light, and maintain such signs as may be directed, or may be necessary, for the safe regulation, and convenience of traffic. Said signs will be as specified on the Contract Drawings or elsewhere herein, or if not specified, they shall be adequate for the regulation, safety, and convenience of traffic and in conformance with the applicable requirements of the State/Federal Manual on Uniform Traffic Control Devices. All signs shall be subject to the approval of the Owner's representative. The Contractor shall provide, erect, and maintain suitably lighted barricades, warning lights, etc. as needed, or as directed in order to keep people, animals, and vehicles from excavations, obstacles, etc. The Contractor may be required to employ traffic men and take other such reasonable means or precautions as the Owner's representative may direct, or as may be needed to prevent damage or injury to persons, vehicles, or other property and to minimize the inconvenience and danger to the public by his construction operations. He shall arrange his operations to provide access to properties

along the street, including temporary bridges to driveways, and provide access to fire hydrants, manholes, gate boxes, or other utilities. Whenever any trench obstructs traffic in, or to, any public street, private driveway, or property entrance, the Contractor shall take such steps as required to maintain necessary traffic and access, including temporary bridging if required. The Contractor shall confine his occupancy of public or traveled ways to the smallest space compatible with the efficient and safe performance of the Work contemplated by the Contract.

B. The Contractor shall observe and obey all local and state laws, ordinances, regulations, and permits in relation to the obstruction of streets and highways, keeping passageways open, and protecting traffic where there may be danger from blasting or other construction activities.

C. Suitable lighted barriers or barricades shall be furnished by the Contractor and put up and maintained at all times during the night or daytime, around all open ditches, trenches, excavations, or other work potentially dangerous to traffic. Such barricades shall be as shown on the Contract Drawings, or if not shown, will be constructed of 2-inch by 8-inch rough lumber, securely supported and braced at least 3 feet high above the ground. Barricades shall be placed on all sides and throughout the entire length and breadth of all open ditches, trenches, excavations, or other work, which must be barred to the general public. Barricades shall be properly painted to the satisfaction of the Owner’s representative in order to retain a high degree of visibility to vehicular and pedestrian traffic.

D. Suitable lighted barricades shall be defined as barricades lit by flashers in accordance with this paragraph or other lighting methods approved by the Owner’s representative in lieu thereof. Flashers shall be placed along the entire length of the barricades at an interval no greater than 8 feet, center to center. Flashers shall be power operated, lens directed, enclosed light units which shall provide intermittent light from seventy to one hundred twenty (70-120) flashes per minute, with the period of light emittance occurring not less than twenty-five percent (25%) of each on-off cycle, regardless of temperature. The emitted light shall be yellow in color and the area of light on at least one (1) face of the unit shall be not less than 12 square inches. The discernible light shall be bright enough to be conspicuously visible during the hours of darkness at a minimum distance of 800 feet from the unit under normal atmospheric conditions. For units, which beam light in one (1) or more directions, the foregoing specifications shall apply 10 degrees or more to the side and 5 degrees or more above and below the photometric axis.

E. The Contractor shall furnish and securely fasten flashing units to signs, barricades, and other objects in such numbers and for such lengths of time as are required for the maintenance and protection of traffic, or as the Owner’s representative may order. The flasher shall be in operation during all hours between sunset and sunrise, and during periods of low visibility. The Contractor shall maintain, relocate, and operate barricades and flashers throughout the life of the Contract. No special payment will be made for barricades or flashers.

F. Should the Contractor or his employees neglect to set out and maintain barricades or lights, as required in these Specifications, the Owner’s representative immediately, and without notice, may furnish, install, and maintain barricades or lights. The cost thereof shall be borne by the Contractor and may be deducted from any amount due, or to become due, to the Contractor under this Contract.

G. The Contractor will be held responsible for any damages that the Owner, Owner’s representative, Governmental units, or their heirs or assigns may have to pay as a consequence of the Contractor's failure to protect the public from injury, and the same may be deducted from any payments that are due or may become due to the Contractor under this Contract. The Contractor shall allow for bridging for trenches at all street and driveway crossings in such manner as the Owner’s representative may direct in order that the traffic on intersecting streets may not be blocked, and in order that entrance may be made to properties along the line of work.

3.2 MAINTENANCE OF TRAVEL LANES

A. During non-construction hours, weekends, and holidays, a minimum of two (2) 12-foot-wide travel lanes shall be open to traffic. Trenches shall be either temporarily paved or covered with skid resistant steel plates, unless otherwise directed by the Owner's representative. Steel plates to be designed to withstand the normal traffic loads. Also, during the above mentioned times, all driveways shall be accessible to vehicular traffic.

B. During construction hours, the Contractor will be allowed to close the streets to through traffic, provided alternate detour arrangements are made which are acceptable to the Police, Fire, and the Owner's representative. The Contractor shall notify the local Police, Fire, and Ambulance Services 72 hours in advance of any/or all street closures, or partial closures.

3.3 SNOW REMOVAL

A. If the Contractor's operations or occupancy of any public street or highway, or the uneven surfaces over any trenches being maintained by the Contractor shall interfere with the removal or sanding of snow or ice by the public authorities or adjoining landowners, in an ordinary manner with regular highway equipment, the Contractor shall be required to perform such services for the public authorities or adjoining Owners without charge. If the Contractor fails to do so, he shall reimburse the said authorities or adjoining Owners or the Owner for any additional cost to them for doing such work occasioned by conditions arising from the Contractor's operations, occupancy, or trench surfaces, together with any damage to the equipment of said parties by those conditions or claims of any parties for damage or injury or loss by reason of failure to remove snow or ice or to sand icy spots under these conditions.

3.4 STREET DETOURS

A. Where detours will be required, the Owner's representative shall require the Contractor submit a proposed detour plan for all portions of the Work to the Owner's representative and to the applicable Local Regulatory Agencies. This submittal shall be made at least seven (7) days prior to commencing construction. It shall be the sole responsibility of the Contractor to keep the Local Regulatory Agencies (including, but not limited to, the Police and Fire Departments) forewarned at least 72 hours in advance of changes in traffic patterns due to reduction of pavement widths or closing of streets. The Contractor shall supply, install, maintain, replace as necessary, adjust, move, relocate, and store all signs, suitably lighted barricades, traffic cones, and traffic delineators, as necessary to carry out the traffic routing plan and maintain vehicular and pedestrian traffic. All this work shall meet with the requirements of the Local Regulatory Agencies and the Owner's representative. If additional signs and traffic protection is necessary beyond that shown in the Contract Documents, or if not shown, beyond that initially estimated by the Contractor, the total cost shall still be borne by the Contractor.

3.5 TEMPORARY DETOURS

A. Temporary detours shall be constructed on the site as directed by the Owner's representative, required by the Contract Drawings, or specified elsewhere herein. Said detours shall not have grades in excess of ten percent (10%) anywhere along their lanes unless otherwise shown on the Contract Drawings. Detours shall be smooth riding as determined by the Owner's representative.

B. Suitable barricades shall be installed continuously along both sides of a detour where (1) the adjacent side slope is steeper than 6:1; (2) the Contractor's operations or equipment may operate within 20 feet of the detour, or (3) other unsafe conditions require them for the protection of traffic along the line of detour.

3.6 TRAFFIC CONTROL PROCEDURES

A. The proper and adequate signing of the construction zone, and any approved detours, is considered of utmost importance. Prior to the start of construction, the Contractor shall submit a signing plan for review by the Owner's representative, Police, and Fire Departments.

B. The Contractor shall provide a minimum of at least one (1) flagman for each work crew within signed areas for the control and direction of vehicular and pedestrian traffic on as needed, or as directed, basis and at no cost to the Owner. This flagman shall be dedicated to traffic control only and shall not be utilized as part of the Work crew.

C. The Contractor shall provide uniformed policemen at major intersections and at other locations where the applicable Local Regulatory Agencies may determine their need for the control and direction of vehicular traffic and pedestrians.

END OF SECTION 317000

SECTION 320000 - CURBING

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 DESCRIPTION OF THE WORK

A. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

B. The Work of this Section includes, but is not limited to, the furnishing and installing of cast-in-place concrete curb and bituminous concrete lip curbs. Work shall also include all associated items and operations necessary and required to complete the installations, including, but not limited to, surface preparation, finishing and cleanup.

1.3 RELATED SECTIONS

A. Carefully examine all the Contract Documents for requirements that affect the Work in this Section. Other specification Sections that directly relate to the Work of this Section include, but are not limited to, the following:

1. Section 312000 “Earth Moving”
2. Section 321216 “Asphalt Paving”
3. Section 321314 “Site Cast-in-Place Concrete”

PART 2 - PRODUCTS

2.1 CAST-IN-PLACE CONCRETE CURB

A. Concrete and reinforcement for cast-in-place concrete curbs shall be as specified in Section 321314 “Site-Cast-in-Place Concrete”.

2.2 BITUMINOUS CONCRETE LIP CURBING

A. Bituminous concrete for curbing shall conform to the applicable requirements for Class 3 bituminous concrete as specified in Connecticut DOT Form 816, Article M.04.

PART 3 - EXECUTION

3.1 GENERAL

A. Trenching, excavation, backfilling, and compaction shall be completed in accordance with Section 312000 “Earth Moving”, except as modified within this Section.

3.2 BITUMINOUS CONCRETE LIP CURB

A. General Requirements

1. Bituminous curbing shall be constructed by the use of an approved self-propelled extruding curb machine equipped with a material hopper, distributing screw, and curb forming device capable of placing the bituminous mixture to the required lines, grades, and proper curb cross-section. Prior to the placement of any curb, the Contractor shall submit a detail of the cross-section of the curb mold that he proposes to use to the Owner's representative for approval.

B. Surface Preparation

1. When curbing is to be placed on existing bituminous pavements, concrete pavements, or newly laid bituminous pavements which have been in place more than 24 hours, the surface on which the curb is to be placed shall be swept and cleaned, thoroughly dried, and immediately prior to placement of the curb, the surface to be occupied by the curb shall be given an application of tack coat material. Particular care shall be exercised to prevent spread of tack coat material beyond the area to be occupied by the curb. Recently placed bituminous concrete pavement, which have been placed less than 24 hours prior to placement of the curb need only be thoroughly swept and cleaned.

C. Placing and Compaction

1. The hot bituminous mixture shall be placed in the hopper of the curb paver without segregation and extruded through the mold form to provide the proper compaction and surface texture.
2. The curb paver shall be properly supported and weighted during operation along the edge of the pavement and shall be guided along string or chalk lines to maintain the proper alignment and level of the completed curb.
3. Any portions of the completed curb, which are not satisfactorily compacted, or show signs of sagging, cracking, or distortion, or do not conform to the required lines, grades, or cross-section for any reason, and which cannot be satisfactorily repaired during construction, shall be removed and replaced at no additional cost to the Owner.

D. Joints: Bituminous curb construction shall be a continuous operation in one (1) direction only, to eliminate frequent joints. When the placing of the curb is discontinued for a length of time that permits the mixture to become chilled, the curb shall be cut in a true vertical plane and the exposed end painted with a thin uniform coat of hot asphalt cement just prior to placing the fresh curb mixture against the previously constructed curb to insure a continuous bond.

3.3 CONCRETE CURB (CAST-IN-PLACE)

A. General Requirements: Concrete curb shall be constructed of concrete and shall be cast-in-place to proper size and shape and to the line and grade shown on the Drawings. The curbing shall be constructed using conventional forms and in segments separated by construction joints and expansion joints as specified herein.

B. Forms: Forms shall be metal or acceptable planed and matched lumber, straight and free from warp or other irregularities that will adversely affect the installation. Forms shall conform to the curb cross-section shown on the Drawings and shall be carefully set to line and grade and thoroughly braced and secured in place so that there will be no displacement during placement of the concrete. All forms shall be thoroughly cleaned prior to reuse.

C. Placing of Concrete: Prior to placement of the concrete, the subgrade shall be moistened and the contact surfaces of the forms shall be given a light coating of oil that will not discolor the concrete. Concrete shall then be placed in the form as near to its final position as practicable, struck off with a template, spaded to prevent “rock-pockets” or “honey combing” adjacent to the forms, and finished to a smooth even surface. The concrete may be compacted by mechanical vibrators if approved by the Owner’s representative. Placing by slip form methods shall be approved by the Owner’s representative.

D. Expansion Joints: Vertical expansion joints shall be located approximately every 75 feet and shall be so arranged that they shall match expansion joints in any adjacent concrete pavements and sidewalks. Unless directed otherwise, expansion joints shall also be installed at the PC and PT of all radius curb. Expansion joints shall be constructed vertical, plumb, and at right angles to the face of the curb. They shall be ½-inch in width and formed with premolded bituminous joint filler cut to conform to the cross-section of the curb/curb gutter.

E. Construction Joints: Vertical construction joints shall be located approximately every 15 feet being equally spaced between expansion joints. The length of these curb/curb gutter segments may be varied slightly for closures but in no case shall they be less than 8 feet. Construction joints shall be vertical, plumb, and at right angles to the face of the curb and shall be formed by approved method that will provide complete separation of the curb segments during the placing of the concrete. If curb is formed by slip form methods, the joints shall be sawed as soon as practicable after the concrete has set to preclude raveling during the sawing and before any shrinkage cracking occurs in the concrete.

F. Finishing: Forms shall be left in place for 24 hours or until the concrete has sufficiently hardened as determined by the Owner’s representative, so that they can be removed without injury to the curb. Upon removal of the forms, the exposed faces of the curb/curb gutter shall be immediately rubbed to a uniform surface. Rubbing shall be performed by experienced and competent concrete finishers. No plastering will be permitted.

END OF SECTION 320000

SECTION 321200 - PREPARATION OF SUBGRADE/FINE GRADE

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. This work shall consist of the preparation of the top surface of the roadbed, after all grading has been substantially completed and all pipes/conduits laid, to accommodate the placement of the pavement structure and gutters in accordance with these specifications and in conformity with the lines, grades, and typical cross-sections as shown on the Contract Drawings.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION OF SUBGRADE

A. All soft and yielding material and other portions of the subgrade which will not compact readily when rolled, vibrated, or tamped, shall be removed and replaced with suitable material. The surface shall be compacted uniformly with a minimum of four (4) complete coverages using an approved power roller having a minimum compression of 300 pounds per inch of width of tread on the rear wheel, and weighing not less than 10 tons, or with an equivalent vibratory roller or compactor.

B. When more than one (1) compacting unit is used, the unit exerting the greatest compactive effort shall be used to make the initial compaction. Any portion of the subgrade, which is not accessible to a roller or other compacting unit, shall be compacted thoroughly with hand tampers or with approved mechanical vibrators.

C. The Contractor shall notify the local authority for inspection of the subbase in public streets prior to placement of the base course.

3.2 FINE GRADING

A. After compaction, the top surface of the subgrade shall be fine graded so that it shall not extend above, nor more than ½-inch below, true grade and surface at any location. The subgrade shall not be muddy or otherwise unsatisfactory when pavement/base/subbase is placed upon it. If the surface of the subgrade becomes rutted or displaced due to any cause whatsoever, the Contractor shall regrade same at their own expense.

3.3 PROTECTION OF SUBGRADE

A. The Contractor shall protect the subgrade from damage by exercising such precautions, as the Owner’s representative may deem necessary. At all times, the subgrade surface shall be kept in such condition that it will drain readily and correctly. The subgrade shall be checked and approved before any pavement structure is placed thereon.

END OF SECTION 321200

SECTION 321216 - ASPHALT PAVING

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. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.

B. The Work of this Section includes, but is not necessarily limited to:

1. Asphaltic (bituminous) concrete paving for new or repaired street, driveway, and parking area pavements.
2. Installation of bituminous concrete overlays over existing pavement, including surface preparation, truing and leveling pavement, tack coating, and all other associated items and operations necessary and required to complete the installation.
3. Adjust existing castings to finished grade.
4. Saw cut existing edge of pavements for the construction of a proper butt joint.

C. Related Sections

1. Carefully examine all the Contract Documents for requirements, which affect the Work in this Section. Other specification Sections, which directly relate to the Work of this Section include, but are not limited to, the following:

a. Section 312000 “Earth Moving”
b. Section 320000 “Curbing”
c. Section 321200 “Preparation of Subgrade/Fine Grade”

1.3 JOB CONDITIONS

A. Weather Limitations

1. Apply tack coat where indicated on the Drawings and when ambient temperature is above 40°F, and when temperature has been above 35°F for 12 hours immediately prior to application. Do not apply when base is wet, contains excess moisture, or during rain.
2. Construct bituminous concrete paving when atmospheric temperature is above 40°F and when base is dry.
3. The temperature of the mixture, within a tolerance of plus or minus 15°F, when delivered at the site will be governed by its temperature of the base upon which the mix is placed and the following table:

Air Temperature in Degrees F	Base Material Temperature in Degrees F For Course Thickness in Inches			
	1	1½	2	3 and Greater
35-40	--	305	295	280
41-50	--	300	285	275
51-60	300	295	280	270
61-70	290	285	275	265
71-80	285	280	270	265
81-90	275	270	265	260
91 & Over	270	265	260	255

1.4 SUBMITTALS

A. Design Mix: Before any bituminous concrete paving is constructed, submit actual design mix to the Owner's representative for review and/or approval. Design mix submittal shall follow the format as indicated in the Asphalt Institute Manual MS-2, Marshall Stability Method; and shall include the type/name of the mix, gradation analysis, grade of asphalt cement used, Marshall Stability (lbs.), flow, and effective asphalt content (percent).

B. Material Certificates: Submit Material Certificate to the Owner's representative, which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

1.5 COORDINATION

A. The Site Contractor shall coordinate with all other trades, especially underground Utility Contractors, in order to prevent covering up unfinished or uninspected work and loss of time or labor by improper scheduling. Any rework shall be done at no cost to the Owner.

1.6 PAVEMENT WITHIN PUBLIC RIGHT-OF-WAY

A. The installation of all pavements within the Public Rights-of-Way shall be in accordance with the rules, regulations, and requirements of the Public Agency having control and ownership of such Rights-of-Way. Work shall include all items and operations necessary and required to complete the pavement installation to the satisfaction of the authorities having jurisdiction.

1.7 SUBGRADE TESTING

A. Subgrade bearing capacity shall be determined by testing. The minimum CBR (California Bearing Ratio) shall be 10. The Contractor shall perform CBR tests as necessary, but in no case less than one (1) test for each 1,000 square yards of paved area.

B. The Contractor shall remove any subgrade areas not meeting the minimum CBR during subgrade preparation. Areas of subgrade removal shall be filled and compacted with suitable material at no extra cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Mineral Aggregate

1. Coarse Aggregate shall be clean, crushed rock free from dirt or other objectionable material and shall have a percentage of wear, as determined by the Los Angeles Abrasion test (AASHTO-T96-02), of not more than 30.
2. Fine Aggregate shall consist of natural sand, stone sand, or a blend of natural sand and stone sand. The fine aggregate as delivered to the mixer shall meet the following requirements:

Sieve	Percent Passing Grading No. 1
3/8-inch	100
No. 4	95 to 100
No. 8	70 to 100
No. 30	20 to 65
No. 50	7 to 40
No. 200	0 to 10

3. The use of reclaimed asphalt pavement in new bituminous pavement will not be permitted.

B. Asphalt Cement: Comply with AASHTO M-226/ASTM D 3381-92; Table 2 for grades AC-10, AC-20, or AC-30, AR-8000, viscosity grade, depending on local mean annual air temperature. (See chart below):

Temperature Condition	Asphalt Grades
Cold, mean annual air temperature $\leq$7 degrees C) 45 degrees F)	AC-10 85/100 pen.
Warm, mean annual air temperature between 7 degrees C (45 degrees F) and 24 degrees C (75 degrees F)	AC-20 60/70 pen.
Hot, mean annual air temperature $\geq$24 degree C (75 degrees F)	AC-30

Final acceptance of the proper grade of AC shall be made by the Owner's representative.

C. Tack Coat: Emulsfied asphalt; AASHTO M140-70 or AASHTO M 208/ASTM D 2397-98, Grades RS-1, SS-1, SS-1H, CRS-1, CSS-1, or CSS-1H, diluted with one (1) part water to one (1) part emulsified asphalt.

D. Mineral Filler: Rock or slag dust, Portland cement, or other inert material complying with ASTM D 242-04.

E. Asphalt-Aggregate Mixture: Unless otherwise noted on the Drawings, the Design Mix shall have a minimum stability based on a 75-blow Marshall Method, complying with AASHTO T245, of 1200 lb. with a flow between 8 and 16. The Design Mix shall be within sieve analysis and binder ranges below:

SIEVE ANALYSIS OF MIX
PERCENT BY WEIGHT PASSING

Sieve	Class 1	Class 2	Class 3	Class 4	Class 12
2-inch	--	--	--	100	--
1-inch	100	--	--	--	--
¾-inch	90-100	--	--	60-80	--
½-inch	70-100	100	100	--	100
3/8-inch	60-82	90-100	95-100	42-66	98-100
¼-inch	--	--	--	--	--
No. 4	40-65	55-80	65-87	30-55	80-95
No. 8	28-50	40-64	40-70	20-40	60-95
No. 30	10-32	16-36	20-40	--	20-60
No. 50	6-26	8-26	10-30	5-18	10-40
No. 200	3-8	3-8	3-8	0-5	3-10
Grade of PG Binder	PG 64-28	PG 64-28	PG 64-28	PG 64-28	PG 64-28
Content Percent (%)	5.0-6.5	5.0-8.0	6.5-9.0	4.0-6.0	7.5-10.1
Voids	3.0-6.0	2.0-5.0	0-4.0	--	0-5.0

F. Geotextile Fabric: Geotextile fabric shall be Exxon Geotextile Fabric **GTF-300**, Geotex **315ST**, Contech Fabric **C300**, or approved equivalent.

2.2 BITUMINOUS CONCRETE

A. Bituminous concrete for sidewalks and driveways shall conform to Connecticut DOT Form 816, Section M.04 Class 2.

B. Bituminous concrete for roadways shall conform to Connecticut DOT Form 816, Section M.04 Class 1.

2.3 EQUIPMENT

A. Maintain equipment in satisfactory operating condition and correct breakdowns in a manner that will not delay or be detrimental to progress of paving operations.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install all on-site and off-site pavements as specified in the location and to the grades as shown on the Drawings and/or approved by the Owner's representative. Materials, methods of construction, and type and thickness of pavement courses shall be as shown on the Details of the Drawings and as specified herein.

B. The Owner and its representatives shall have access to all parts of the Work under construction at all times.

C. The Owner's representative shall permit the laying of bituminous concrete only between April 15th and November 15th, when the air temperature is 40 degrees Fahrenheit or warmer, and the temperature of the surface to be paved is 45 degrees or higher. Paving outside these limits requires written permission of the Owner's representative.

D. The pavement types and thicknesses as shown on the pavement details shall conform to the Connecticut DOT Form 816, Section M.04.02.

3.2 PREPARATION FOR PAVEMENT INSTALLATION

A. Remove loose material from compacted base material surface immediately before proof rolling.

B. Proof roll prepared base material surface to check for areas requiring additional compaction and areas requiring removal and recompaction.

C. Do not begin paving work until deficient base material areas have been corrected and are ready to receive paving.

D. Check all frames, covers, grates, water valve boxes and other miscellaneous castings that are located in the proposed pavement areas to ensure that all such items have been correctly positioned and set to the proper slope and elevation. All covers and grates are to be set flush with the required finished surface. No depressions or mounds will be permitted in the pavement to accommodate inaccuracies in the setting of these appurtenances. All correctional work that may be necessary, as determined by the Owner's representative, shall be performed at the Contractor's own expense.

E. All vertical surfaces of structures and existing concrete surfaces in contact with new bituminous pavement shall be painted with a uniform coating of an approved bituminous emulsion material. Extreme care shall be exercised in the application of this material to prevent splattering or staining of surfaces that are to be exposed after the Work is completed. Surfaces that are stained as a result of the Contractor's operation shall be repaired and/or replaced to the satisfaction of the Owner's representative at the Contractor's own expense.

F. Bituminous paving shall not be applied until the Owner's representative inspects and approves the finished base.

G. All existing paved surfaces to be overlaid must be thoroughly cleaned by a self-propelled sweeper. Areas inaccessible by power sweeper shall be broom swept until all non-pavement surface matter is removed.

3.3 APPLICATION

A. Tack Coat

1. Apply to contact surfaces of all Portland cement concrete surfaces and surfaces abutting or projecting into bituminous concrete pavement.
2. Apply tack coat to existing bituminous concrete surfaces at match points and where indicated on the drawings.
3. Apply at a minimum rate of 0.05 gallons per square yard of surface.
4. Allow tack coat to dry until at proper condition to receive paving.

3.4 BITUMINOUS CONCRETE PAVEMENT

A. Place bituminous concrete mixture on completed, compacted base surface, spread, and strike off.

B. Whenever possible, all pavements shall be spread by a self-propelled finishing machine. At inaccessible or irregular areas, pavement may be placed by hand methods. The hot mixture shall be spread uniformly to the required depth with hot shovels and rakes. After spreading, the hot mixture shall be carefully smoothed to remove all segregated course aggregate and rake marks. Rakes and lutes used for hand spreading shall be of the type designed for use on asphalt mixtures. Loads shall not be dumped faster than they can be properly spread. Workers shall not stand on the loose mixture while spreading.

C. Paving Machine Placement: Apply successive lifts of bituminous concrete in transverse directions with the surface course placed in the direction of surface-water flow. Place in typical strips not less than 10'-0" wide.

D. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construction joints shall have the same texture, density, and smoothness as other sections of bituminous concrete courses. Clean contact surfaces and apply tack coat.

3.5 ROLLING AND COMPACTION

A. The mixture, after being spread, shall be thoroughly compacted by rollers having a minimum weight of 240 pounds per inch of wheel width as soon as it will bear the weight of the rollers without undue displacement. The number, weight, and types of rollers and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in a workable condition.

B. Compact mixture with hot hand tampers or hand rollers in areas inaccessible by self-propelled rollers.

C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas and fill with fresh, hot bituminous concrete. Compact by rolling to maximum surface density and smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to be marked.

3.6 BITUMINOUS CONCRETE SIDEWALKS

A. Forms: Where walls, curbing, or other suitable permanent supports are not present, satisfactory forms shall be installed to assist in securing alignment and adequate compaction of the base and surface courses. All forms shall be removed and backfilled with proper material.

B. Placing Bituminous Concrete: The bituminous concrete walk surface shall be laid in a single course to a depth after compaction of 2 inches, unless otherwise detailed or directed. Unless otherwise directed, the walk shall have a maximum cross slope of two percent (2%) to provide for proper drainage.

1. Spreading Mixture. The mixture shall be dumped, as needed, in wheelbarrows or an approved steel dump sheet outside the areas on which it is to be placed. It shall then be immediately distributed into place by means of shovels and raked into a uniformly loose layer to the full width required and of such depth that, when the Work is completed, it shall conform to the grade and surface contour required.

2. Rolling. The surface shall be rolled with a self-propelled, tandem roller weighing not less than 1½ tons and not more than 5 tons. In places inaccessible to a power roller, compaction shall be obtained by means of mechanical rammers or by hand tampers weighing not less than 50 pounds and having a tamping face not exceeding 100 square inches.
3. Testing Surface. When tested with a 10-foot straightedge placed parallel to the centerline of the courses, there shall be no deviation from a true surface in excess of ¼ of an inch.

3.7 FIELD QUALITY CONTROL

A. Independent Testing Laboratory: If elected by the Owner, an independent testing laboratory shall be retained to perform construction testing of in-place bituminous concrete courses for compliance with requirements for thickness and surface smoothness. The Owner shall pay for costs of the testing. Bituminous surface and base courses shall be randomly cored at a minimum rate of one (1) core for every 20,000 square feet of paving. However, no less than three (3) cores in light duty areas and three cores in heavy duty areas shall be obtained. Coring holes shall be immediately filled with full-depth asphalt or with concrete. Bituminous concrete pavement samples shall be tested for conformance with the mix design.

B. Grade Control: Establish and maintain required lines and elevations.

C. Thickness: In-place compacted thickness shall not be less than the thickness specified on the drawings. Areas of deficient paving thickness shall receive a tack coat and a minimum 1-inch thickness, at the discretion of the Owner's representative, until specified thickness of the course is met or exceeded at no additional expense to the Owner.

D. Surface Smoothness: Testing shall be performed on the finished surface of each bituminous concrete course for smoothness, using 10-foot straightedge applied parallel with, and at right angles to centerline of paved area. The results of these tests shall be made available to the Owner's representative upon request. Surfaces will not be acceptable if exceeding following tolerances for smoothness:

1. Base Course Surface: ¼-inch.
2. Wearing Course Surface: 3/16-inch.

E. Check surfaces areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by the Owner's representative.

F. Compaction: Field density tests for in-place materials shall be performed by examination of field cores and shall have a minimum compacted density of ninety-five percent (95%) of laboratory Marshall Density in accordance with one (1) of the following standards:

1. Bulk Specific Gravity and Density of Compacted Bituminous Mixture Using Paraffin-Coated Specimens: ASTM D 1188-96.
2. Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens: ASTM D 2726-04.
3. Rate of testing shall be one core per 20,000 square feet of pavement, with a minimum of three (3) cores from heavy-duty areas and three (3) cores from standard-duty areas. Cores shall be cut from areas representative of the project.
4. Areas of insufficient compaction shall be delineated, removed, and replaced in compliance with the specifications at no expense to the Owner.

3.8 MEETING EXISTING PAVEMENTS

A. Where new pavements are to meeting existing pavements, the Contractor shall saw cut the existing pavements so that there will be a vertical butting surface between the old and new pavements. Sawcutting of existing pavements shall be along neat, straight, and even lines, and shall be done in such a manner so as not to damage the adjacent pavement, which is to remain.

B. Full-Depth Pavement: The existing pavement shall be sawcut by an approved method for the full depth of the pavement prior to placement of any new pavement. The existing bituminous surface shall be trimmed to a neat true line with straight vertical edges free from irregularities, and the trimmed edges shall be treated with a light coating of asphaltic emulsion immediately prior to the installation of the new abutting bituminous concrete surface course to provide a bond between the old and new pavement. The new compacted pavement surface shall be finished flush with the adjacent pavement.

C. Bituminous Concrete Overlays: A line shall be cut by an approved method where the new pavement is to meet the existing pavement. The existing bituminous surface shall be trimmed to a neat true line with straight vertical edges free of irregularities for a minimum depth of 1½ inches. Sufficient pavement shall then be ground by machine method leaving a tapered Section of pavement ground 1½ inches thick at the pavement butt and feathered back to meet the existing pavement surfaces. The ground, tapered transition section width shall be 2 feet at driveways and 6 feet in roadways and parking areas. Immediately prior to the placement of the bituminous concrete overlay the trimmed edges of the existing pavement shall be treated with a coating of asphaltic emulsion to bond the new pavement to the old pavement. The new pavement surface shall be finished flush with the adjacent pavement. Surface seam of pavement joint shall be painted with emulsion and covered with sand or proper material to absorb excess emulsion.

END OF SECTION 321216

SECTION 321214 - SITE CAST-IN-PLACE CONCRETE

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 DESCRIPTION OF THE WORK

A. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this section, and as shown on the Drawings.

B. The Work of this section includes site cast-in-place concrete, including but not necessarily limited to, concrete sidewalks, concrete driveway and pedestrian walkways, utility bases, concrete curbing, light pole bases, retaining walls, and thrust blocks.

1.3 RELATED SECTIONS

A. Carefully examine all the Contract Documents for requirements, which affect the Work in this section. Other specification sections, which directly relate to the Work of this section include, but are not limited to, the following:

1. Section 312000 “Earth Moving”

1.4 QUALITY ASSURANCE

A. Unless otherwise specified, work and materials for construction of concrete walks shall conform to ACI 316R. Other cast-in-place concrete shall conform to ACI 301.

B. Work, materials, and color of the handicap ramp paving shall conform to applicable sections of ADA and State Standards whichever is more restrictive. The maximum cross slope for sidewalks shall be two percent (2%) unless otherwise noted.

C. Paving work, base course, etc., shall be done only after excavation and construction work, which might injure them, has been completed. Damage caused during construction shall be repaired before acceptance.

D. Existing paving areas shall, if damaged or removed during course of this project, be replaced under this section of the specification. Workmanship and materials for such repair and replacement, except as otherwise noted, shall match as closely as possible those employed in existing work.

E. Pavement, base, or subbase shall not be placed on a muddy or frozen subgrade.

F. Dimensions, locations, and details of equipment pads, anchors, supports, and similar features indicated on the Drawings are approximate. Manufacturer’s approved shop drawings of equipment to be supported, anchored, or contained thereby shall be consulted for exact location, size, and details.

1.5 SUBMITTALS

A. For each type of specially furnished concrete provide a description of methods and the sequence of placement.

B. Submit manufacturer's product data for the following:

1. Form release agent.
2. CIP and surface mounted ADA approved detectable surface.
3. Preformed joint filler.

C. Submit samples of the following:

1. Preformed joint filler.

1.6 TESTING

A. The Owner will retain and pay for the services of a State approved laboratory to perform all concrete testing and inspections in accordance with applicable ASTM standards.

B. Tests will be required to determine whether the concrete being produced complies with the standard of quality and strength as specified.

C. Additional Tests: The Contractor may have the testing service make additional tests of in-place concrete when test results indicate that specified concrete strengths and other characteristics have not been attained. The testing inspection agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42-04 or such non-destructive testing methods that may be approved by the Owner's representative. Contractor shall pay for all such tests conducted. Any holes made shall be patched by the Contractor at their own expense.

D. Concrete Replacement: Failure of any test or to follow proper installation procedures will require that the concrete be removed and properly replaced by the Contractor at their own expense.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE COURSE

A. Material for aggregate base course shall be well-graded, granular, free-draining gravel compacted to ninety-five percent (95%) of optimum density. Material shall have at least ninety-five percent (95%) passing a 1½-inch sieve and not more than eight percent (8%) passing a number 200 sieve.

2.2 STEEL REINFORCEMENT

A. Steel reinforcing bars shall conform to ASTM A 615.

1. Bars employed as reinforcement shall be the deformed type.
2. Bars employed as dowels shall be hot-rolled plain rounds.
3. Unless otherwise indicated on the Drawings, reinforcing bars shall be Grade 60.

B. Welded wire fabric reinforcement shall conform to the applicable requirements of ASTM A 185-02. Fabric reinforcement shall be furnished in flat sheets. Fabric reinforcement in rolls will not be permitted.

2.3 PORTLAND CEMENT CONCRETE

A. Portland cement concrete for pavements, walks, and slabs shall be the air-entrained type with a maximum water/cement ratio of 5.0 conforming to ACI 316R. Minimum compressive strength at twenty-eight (28) days shall be 4,000 psi. Other cast-in-place concrete shall have a minimum compressive strength of 3,000 psi at twenty-eight (28) days.

1. Concrete shall be the air-entrained type conforming to ASTM C 94. Air content by volume shall be six percent (6%) and shall be tested in accordance with ASTM C 231-04. No antifreeze or other admixtures are permitted.
2. Concrete slump shall be no less than 2 inches nor greater than 4 inches, determined in accordance with ASTM C 143.
3. Cement shall be Portland cement, conforming to ASTM C 150-04, Type I or II. Only one (1) color of cement, all the same manufacturer, shall be used for the Work. Type III cement shall be used only with the prior approval of the Owner's representative.
4. Fine and coarse aggregates shall conform to ASTM C 33-03.
5. Concrete shall contain a water reducing agent to minimize cement and water content of the concrete mix at the specified slump. Water reducing agent shall conform to ASTM C 494.
6. No calcium chloride or admixtures containing calcium chloride shall be added to the concrete. No admixtures other than those specified shall be used in the concrete without the specific written permission of the Owner's representative in each case.
7. The concrete mix shall be designed by a licensed Professional Engineer to meet project design conditions.
8. Retempering of concrete will not be allowed.
9. Use latex or acrylic bonding agents when placing new concrete against existing concrete.

2.4 CURING MATERIALS FOR UNCOLORED CONCRETE

A. Curing shall be by moist curing (preferred) or by use of curing compound.

B. Curing paper shall be non-staining, fiber reinforced laminated Kraft bituminous product conforming to ASTM C 171-03. 4-mil polyethylene sheeting may be substituted for curing paper.

C. Curing compound shall be a resin-base, white pigmented compound conforming to ASTM C 309-03, Type 2.

D. Sodium Silicate curing compounds shall be used where required by the weather, approved construction schedules and construction that is not adaptable to damp curing.

E. Curing compounds shall contain a fugitive dye or when hot weather conditions dictate, a fugitive heat reflecting pigment.

2.5 EXPANSION JOINTS

A. Expansion joint filler shall be preformed, non-bituminous type joint filler conforming to ASTM D 1752-04a, or preformed, bituminous type joint filler conforming to D 1751-04.

1. Premolded filler shall be one (1) piece for the full depth and width of the joint leaving a sealant recess as indicated.
2. Use of multiple pieces of lesser dimensions to make up required depth and width of joint will not be permitted.
3. Except as otherwise noted on the Drawings, joint filler shall be ½-inch-thick.

B. Expansion joints shall receive joint backer rod and shall be sealed with joint sealant.

2.6 BOND BREAKER

A. Bond breaker shall be asphalt felt conforming to ASTM D 2626-04, Type I or 6-mil polyethylene sheeting.

2.7 FORMS

A. Cylindrical Forms: Sonotube **Fibre Forms**, wax-impregnated strippable forms or ABS or PVC plastic reusable forms.

B. Forms for Exposed Finish: Plywood, metal, metal-framed plywood faced, or other acceptable panel materials. Plywood shall be APA Ref. 1 B-B (Concrete Form), Class I Exterior Grade plywood or B-B or A-C Class I high density overlay concrete form plywood. Form work materials shall produce smooth, continuous, straight, and level surfaces.

C. Forms for Unexposed Finish: Plywood, lumber, or metal, with lumber dressed on at least two (2) edges and one (1) side.

D. Form Ties: Provide prefabricated, adjustable length galvanized steel snap-off ties, with brackets, cones, cornerlocks, and other accessories, as necessary.

E. Form Release Agent: Commercial formulation compounds that will not bond with, stain, or adversely affect concrete.

F. Forms shall be true to line and free from warp, and shall be of sufficient strength, when staked, to resist the pressure of the concrete without springing. Form work shall be designed so that sections may be fastened together to prevent vertical or horizontal movement of ends.

PART 3 - EXECUTION

3.1 GENERAL

A. All permanent sidewalks shall be poured concrete. If temporary walks are required, bituminous concrete may be used.

B. No concrete walks shall be poured after 12 noon unless a guard is visibly stationed nearby to prevent graffiti. The Contractor shall be responsible for replacing any sidewalk with graffiti if he/she fails to provide adequate protection from graffiti.

C. The Owner’s standard for sidewalk is 5 feet wide, unless otherwise shown or noted on the drawings, constructed of 4000 psi air entrained concrete reinforced with 6 x 6 – #6 welded, plain, cold-drawn steel wire fabric. Walk surface shall have a fine broom or float finish. The thickness of the walk shall be a minimum of 4-inches, on an 8-inch-thick compacted gravel base.

D. Where sidewalks intersect, the Contractor shall provide a 3’-6” radius at the intersection corners.

3.2 PREPARATION OF SUBGRADE

A. Areas to be paved will be compacted and brought to subgrade elevation under Section 312000 “Earth Moving”, before work of this section is performed. Final fine grading, and compaction of areas to receive paving, as required to form a firm, uniform, accurate and unyielding subgrade at required elevations and to required lines, shall be done under this Section.

B. Existing subgrade material, which will not readily compact as required, shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material conforming to this Section.

C. Subgrade of areas to be paved shall be recompacted as required to bring the top 8 inches of material, immediately below the gravel base course, to a compaction at optimum moisture of at least ninety-five percent (95%) of maximum density, as determined by ASTM D 1557-02. Subgrade compaction shall extend for a distance of at least 1-foot beyond pavement edge.

D. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, subbase, base, or pavement, subsequent backfill and compaction shall be performed as directed by the Owner's representative and as specified in Section 312000 "Earth Moving". Completed subgrade, after filling such areas, shall be uniformly and properly graded.

E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than, or equal to, 2 inches deep in subgrade, shall be graded out, reshaped as required, and recompacted before placing pavement.

F. Materials shall not be stored or stockpiled on subgrade.

G. Disposal of debris and other material excavated under this section, and material unsuitable for, or in excess of requirements for, completing work of this section shall be disposed of off-site.

H. Prepared subgrade shall be inspected and approved by the Owner's representative before installation of the gravel base course. Disturbance to subgrade caused by inspection procedures shall be repaired under this Section of the Specification.

3.3 AGGREGATE BASE COURSE

A. Aggregate base course for concrete paving and the spreading, grading, and compaction methods employed shall conform to the standard requirements for usual base course of this type for first class roadwork.

B. Width of base course shall be greater than or equal to the width of pavement surface, if continuous lateral support is provided during rolling. The width of base course shall extend at least two (2) times base thickness beyond the edge of the course above, if it is not so supported.

C. Aggregate shall be applied in lifts less than or equal to 6 inches thick, compacted measure. Each lift shall be separately compacted to specified density.

1. Material shall be placed adjacent to wall, manhole, catch basin, and other structures only after they have been set to required grade and level.
2. Rolling shall begin at the sides and progress to the center of crowned areas and shall begin on the low side and progress toward the high side of sloped areas. Rolling shall continue until material does not creep or wave ahead of roller wheels.
3. Surface irregularities, which exceed ½-inch, as measured by means of a 10-foot-long straightedge, shall be replaced and properly recompacted.

D. Base course shall be compacted at optimum moisture content to not less than ninety-five percent (95%) of maximum density as determined by ASTM D 1557-02.

E. Subgrade and base course shall be kept clean and uncontaminated. Less select materials shall not be permitted to become mixed with gravel. Materials spilled outside pavement lines shall be removed and the area repaired.

F. Portions of subgrade, or of construction above, which become contaminated, softened, or dislodged by the passing of traffic, or otherwise injured, shall be cleaned, replaced, or otherwise repaired to conform to the requirements of this specification before proceeding with the next operation.

3.4 STEEL REINFORCEMENT

A. Before being placed in position, reinforcing for reinforced concrete shall be thoroughly cleaned of loose mill and rust scale, dirt, ice, and other foreign material, which may reduce the bond between the concrete and reinforcing. Where there is a delay in placing concrete after reinforcement is in place, bars shall be reinspected and cleaned when necessary.

B. Any bar showing cracks after bending shall be discarded.

C. Unless otherwise indicated on the Drawings, reinforcing shall extend within 2 inches of formwork and expansion joints. Reinforcing shall continue through control joints. Adjacent sheets of fabric reinforcing shall lap 6 inches.

D. After forms have been coated with form release agents, but before concrete is placed, reinforcing steel anchors shall be securely wired in the exact position called for, and shall be maintained in that position until concrete is placed and compacted. Chair bars and supports shall be provided in a number and arrangement satisfactory to the Owner’s representative.

E. Welded wire fabric and reinforcing bars shall be elevated off gravel base by use of metal chair supports or approved equal.

3.5 CONCRETE PAVING

A. Paving mix, equipment, methods of mixing and placing, and precautions to be observed as to weather, condition of base etc., shall meet the requirements of ACI 316R. Pavement shall be constructed in accordance with the Drawings.

B. The Owner’s representative shall be notified of concrete placement sufficiently in advance of start of operation to allow their representative to complete preliminary inspection of the Work, including subgrade, forms, and reinforcing steel, if used.

C. Normal concrete placement procedures shall be followed. Concrete shall arrive at the job site in a timely manner so that no additional water will be required to produce the desired slump. When conditions develop that require the addition of water to produce the desired slump, permission of the Owner’s representative must be obtained. The concrete shall be transported from the mixer to its place of deposit by a method that will prevent segregation or loss of material.

D. Work shall not be performed during rainy weather or when temperature is less than 40°F (4.4°C).

E. Adjacent work, etc., shall be protected from stain and damage during entire operation. Damaged and stained areas shall be replaced or repaired to equal their original conditions.

F. Existing concrete, earth, and other water-permeable material against which new concrete is to be placed shall be thoroughly damp when concrete is placed. There shall be no free water on surface.

G. Concrete, which has set, or partially set before placement shall not be employed. Retempering of concrete will not be permitted.

H. Concrete shall be thoroughly spaded and tamped to secure a solid and homogeneous mass, thoroughly worked around reinforcement and into corners of forms.

3.6 PLACING CAST-IN-PLACE CONCRETE

A. Before placing concrete, forms and the space to be occupied by the concrete shall be thoroughly cleaned and reinforcing steel and embedded metal shall be free from dirt, oil, mill scale, loose rust, paint, and other material which might tend to reduce bond.

B. Existing concrete, earth, and other water-permeable material against which new concrete is to be placed and shall be thoroughly damp when concrete is placed. There shall be no free water on the surface.

C. Concrete, which has set, or partially set, before placement shall not be employed.

D. Concrete shall be thoroughly spaded and tamped to secure a solid and homogeneous mass, thoroughly worked around reinforcement and into corners of forms.

E. When joining fresh concrete to concrete which has attained full set, the latter shall be cleaned of foreign matter, and mortar scum and laitance shall be removed by chipping and washing. Clean, roughened base surface shall be saturated with water, but shall have no free water on surface. A coat of 1:1 cement-sand grout, approximately 1/8-inch-thick shall be well scrubbed into thoroughly dampened concrete base. New concrete shall be placed immediately, before grout has dried or set.

3.7 FINISHING

A. Concrete flatwork surfaces shall be screened off and finished true to line and grade, and free of hollows and bumps. Surface shall be dense, smooth, and at exact level and slope required.

1. Finished concrete surface for concrete subbase shall be woodfloated to a slightly rough surface. Surface shall not deviate more than ¼-inch in 10 feet.
2. Finished concrete surface for concrete pavement, walks, and pads shall be wood-floated and steel troweled to a smooth surface. Surface shall not deviate more than 1/8-inch in 10 feet.

B. Unless otherwise indicated, horizontal surfaces of concrete surfaces, which will be exposed, shall be given a light broomed finish, with direction of grooves in concrete surface perpendicular to length of concrete band, slab, or pad. After concrete has set sufficiently to prevent coarse aggregate from being torn from the surface, but before it has completely set, brooms shall be drawn across it to produce a pattern of small parallel grooves. Broomed surface shall be uniform, with no smooth, unduly rough or porous spots, or other irregularities. Coarse aggregate shall not be dislodged by the brooming operation.

C. Immediately following finishing operations, arises at edges and both sides of expansion joints shall be rounded to a ¼-inch radius. Control joints to be tooled shall be scored into slab surface with scoring tool. Adjacent edges of control joint shall be same time be finished to a ¼-inch radius.

D. Where finishing is performed before the end of the curing period, concrete shall not be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.

3.8 CURING

A. It is essential that concrete be kept continuously damp from time of placement until the end of the specified curing period. It is equally essential that water not be added to the surface during floating and troweling operations, and not earlier than 24 hours after concrete placement. Between finishing operations, the surface shall be protected from rapid drying by a covering of waterproofing paper. Surface shall be damp when the covering is placed over it and shall be kept damp by means of a good spray of water, applied as often as necessary to prevent drying, but not sooner than 24 hours after placing concrete. None of the water so applied shall be troweled or floated into the surface.

B. Concrete surfaces shall be cured by completely covering them with curing paper or an application of a curing compound.

1. Concrete cured using waterproof paper shall be completely covered with paper with seams lapped and sealed with tape. Concrete surface shall not be allowed to become moistened between 24 and 36 hours after placing concrete. During curing period surface shall be checked frequently and sprayed with water as often as necessary to prevent drying, but not earlier than 24 hours after placing concrete.
2. If concrete is cured with a curing compound, the compound shall be applied at a rate of 200 square feet per gallon, in two (2) applications perpendicular to each other.
3. Curing period shall be seven (7) days minimum.

C. Only if additional protection is absolutely required, the surface should remain uncovered for at least four (4) days, after which time new and unwrinkled non-staining reinforced waterproof Kraft curing paper may be used.

3.9 HANDICAP RAMPS

A. Paving mix, equipment, methods of mixing and placing, and precautions to be observed as to weather, condition of base etc., shall meet the requirements of ACI 316R for any concrete paving in similar conditions. Handicap ramps shall be constructed in accordance with the Drawings, and ADA Guidelines 4.7.10 and 4.29.2, as amended. The maximum cross slope for sidewalks shall be two percent (2%) unless otherwise noted.

B. Normal concrete placement procedures shall be followed. Concrete shall arrive at the job site in a timely manner so that no additional water will be required to produce the desired slump. When conditions develop that require the addition of water to produce the desired slump, permission of the Owner’s representative must be obtained. The concrete shall be transported from the mixer to its place of deposit by a method that will prevent segregation or loss of material.

3.10 EXPANSION JOINTS

A. Expansion joints shall be ½-inch-wide and shall be as located on the Drawings. Expansion joint shall be troweled in the concrete to required width with preformed joint filler in place. Joint filler shall extend the full depth of the slab. Joint filler shall extend the full length of the expansion joint.

1. For concrete walks, pavements, and pads, depth of joint filler shall be as required to form a 1¼-inch-deep sealant and back rod recess below finished concrete surface.

3.11 CONTROL JOINTS

A. Unless otherwise indicated, control joints shall be tooled into the concrete slab, with 3-inch-wide border and toweled edges, in the pattern indicated on the Drawings, or every 10-foot o.c. maximum. Joint shall be made after concrete is finished and when the surface is stiff enough to support the weight of workmen without damage to the slab, but before the slab has achieved its final set.

B. Scoring shall cut into slab surfaces at least 1-inch, but in no case not less than twenty-five percent (25%) of slab depth.

3.12 COLD WEATHER CONCRETING

A. Materials for concrete shall be heated for concrete, which is mixed, placed, or cured when the mean daily temperature is below 40°F or is expected to fall below 40°F within 72 hours. The concrete, after placement, shall be protected by covering, heat, or both.

B. Details of handling and protecting concrete during freezing weather shall be subject to the approval and direction of the Owner's representative. Procedures shall be in accordance with provisions of ACI 306R.

3.13 HOT WEATHER CONCRETING

A. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placement shall be sprinkled with cold water. Every effort shall be made to minimize delays that will result in excessive mixing of the concrete after arrival on the job.

B. During periods of excessively hot weather (95°F, or above), ingredients in the concrete shall be cooled insofar as possible and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of ACI 305R-99. Any concrete with a temperature below 95°F, when ready for placement, will not be acceptable, and will be rejected.

C. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, etc.) and relative humidity. Records shall include checks on temperature of concrete as delivered and after placing in forms. Data should be correlated with the progress of the Work so that conditions surrounding the construction of any part of the structure can be ascertained.

3.14 PROTECTION OF CONCRETE SURFACES

A. Concrete surface shall be protected from traffic or damage until surfaces have hardened sufficiently. If necessary, ½-inch-thick plywood sheets shall be used to protect the exposed surface.

END OF SECTION 321314

SECTION 321723 - PAVEMENT MARKINGS

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. Description of The Work

1. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this section, and as shown on the Drawings.
2. The Work under this section includes the application of pavement markings as indicated on the Drawings and as specified herein.

B. Related Sections

1. Carefully examine all the Contract Documents for requirements that affect the Work in this section. Other specification sections, which directly relate to the Work of this section include, but are not limited to, the following:

a. Section 320000 “Curbing”
b. Section 321216 “Asphalt Paving”

1.3 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs, and warning lights as required.

1.4 SUBMITTALS

A. Submit material certificate to the Owner’s representative signed by the material producer and Contractor, certifying that materials comply with these specifications and have been approved for use by the State of Connecticut Department of Transportation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pavement markings shall conform to Connecticut DOT Form 816, Section 12.09 and Articles M.07.20, M.07.21, and M.07.30 and the Manual of Uniform Traffic Control Devices, current edition.

B. Traffic markings shall be white, yellow, and blue traffic paint, as indicated on the Drawings.

PART 3 - EXECUTION

3.1 APPLICATION

A. The material shall be applied to the pavement by equipment used specifically for the application of pavement markings and shall be of a standard commercial manufacturer.

B. The Contractor shall provide survey control for layout of pavement markings by utilizing his own surveyor or hiring a registered land surveyor. The cost of this survey control shall be included in the cost of the work.

C. Markings shall be applied at a minimum thickness of 15 ±1 mil.

D. Pavement striping and marking shall be applied in accordance with this Specification and the Drawings. See Drawings for layout and additional notes. No paint shall be applied to new pavement until the top pavement course has cured at least one (1) week minimum and allow two (2) weeks curing period on newly installed bituminous concrete lip curbing.

E. Stripe all stalls on new pavement as shown on the Drawings accurately, and paint all parking stall striping in white 4-inch-wide strips. All lines shall be straight with sharp corners and clean edges. Where they occur, directional arrows, cross hatching, lane divider strips, stop lines, and lettering shall be painted white to the size, length, and spacing as specified and indicated on the Drawings.

F. All stripes shall be applied one (1) coat with brush, spray, or marking machine over dry clean pavement surfaces, when the atmospheric temperature is at or above 40°F and when the weather is otherwise favorable in the opinion of the Owner's representative.

G. Furnish only skilled workmen who are experienced and normally employed in the Work of installing traffic lines. Supply all the necessary equipment and materials for the installation of the traffic lines.

H. The Contractor shall be responsible for cleaning the pavement of dust, dirt, old pavement markings, concrete curing compounds, and other foreign material, which may be detrimental to the adhesion of the paint film.

I. All stalls shown on the plan are to be striped in accordance with the details. The line between rows of stalls shall be a single line.

J. Where entire areas are to be crosshatched, the striping shall conform to the cross-hatching described in the Drawings.

K. The Contractor shall clean and sweep all areas to be striped or restriped of all sand, dirt, grease, oil, etc., as required so as to produce a first-class job. By proceeding, the striping subcontractor agrees the surface is satisfactory to produce the required first-class job and warrant the one (1) year guarantee described.

L. The Contractor shall protect the buildings, walks, pavement, curbing, trees, shrubs, mulch, etc. from over-spray of paint and damage by his operations.

M. Traffic shall not be permitted on the pavement until the paint is thoroughly dry.

3.2 PAVEMENT MARKING REMOVAL

A. Pavement Markings shall be removed to the fullest extent possible by an approved method. Pavement markings shall be removed before any change is made in the traffic pattern. Any damage to the pavement or surfacing caused by pavement marking removal shall be repaired by the Contractor at their expense by methods acceptable to the Owner's representative.

B. Approved methods include, but are not limited to:

1. Sand blasting using air or water.
2. High pressure water.
3. Steam or superheated water.
4. Mechanical devices such as grinders, sanders, scrapers, scarifiers, and wire brushers.

C. Painting over a pavement marking line by use of asphaltic liquids or paints will not be permitted, unless otherwise approved by the Owner's representative.

D. Material deposited on the pavement as a result of removing markings shall be removed as the Work progresses. Accumulations of sand or other material which might interfere with drainage or could constitute a hazard to traffic will not be permitted.

E. Where blast cleaning is used for the removal of pavement markings and such removal operation is being performed within 10 feet of a lane occupied by traffic, the residue including dust shall be removed immediately after contact between the sand and the surface being treated. Such removal shall be by a vacuum attachment operating concurrently with the blast cleaning operation, or by other methods approved by the Owner's representative.

END OF SECTION 321723

SECTION 321726 - TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.

B. Related Requirements:

1. Section 321314 "Site Cast-in-Place Concrete" for concrete walkways serving as substrates for tactile warning surfacing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of exposed finish requiring color selection.

C. Samples for Verification: For each type of tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For tactile warning surfacing, to include in maintenance manuals.

1.5 PROJECT CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Mortar and Grout:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks, and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set unit pavers within 1 minute of spreading setting-bed mortar.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of tactile warning surfaces that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering and wear.
b. Separation or delamination of materials and components.

2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

B. Source Limitations: Obtain each type of tactile warning surfacing from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

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

a. Armor-Tile; **Cast-in-Place** (Basis of Design)
b. ADA Solutions, Inc.; **Cast-in-Place**
c. Detectable Warning Systems; **EZ Set Tile Cast-in-Place**

2. Material: Cast-fiber-reinforced polymer concrete tile.
3. Color: As selected by Architect and Owner from manufacturer's full line.
4. Shapes and Sizes:

a. Rectangular panel: 24 inches by 48 inches

5. Dome Spacing and Configuration: Manufacturer's standard compliant spacing, in rectangular pattern.
6. Mounting:

a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish Type 316 stainless-steel fasteners for exterior use.
2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is in suitable condition to begin installation according to manufacturer's written instructions. Verify that installation of tactile warning surfacing will comply with accessibility requirements upon completion.

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

3.2 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

3.3 INSTALLATION OF DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles:

1. Concrete Paving Installation: Comply with installation requirements in Section 321314 "Site Cast-in-Place Concrete." Mix, place, and finish concrete to conditions complying with detectable warning tile manufacturer's written requirements for satisfactory embedment of tile.
2. Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. If necessary, temporarily apply weight to tiles to ensure full contact with concrete.
3. Set surface of tile flush with surrounding concrete and adjacent tiles, with variations between tiles and between concrete and tiles not exceeding plus or minus 1/8-inch from flush.
4. Protect exposed surfaces of installed tiles from contact with wet concrete. Complete finishing of concrete paving surrounding tiles. Remove concrete from tile surfaces.
5. Clean tiles using methods recommended in writing by manufacturer.

3.4 CLEANING AND PROTECTION

A. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless

otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

B. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION 321726

SECTION 323110 - CHAIN LINK FENCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF THE WORK

A. Furnishing and installing woven wire fencing of the type and height specified and supported by metal posts erected where indicated on the Drawings and as specified herein.

B. Contractor shall coordinate work between all subcontractors, sections, and trades required for the proper completion of the work.

C. Contractor shall be responsible for the health and safety of all Contractor and Subcontractor workers during progress of the work.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM), latest revision.

1. ASTM A 90 – Standard Test Method for Weight (Mass) of Coating on Iron or Steel Articles with Zinc or Zinc Alloy.
2. ASTM A 123 – Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A 153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
4. ASTM A 392 – Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
5. ASTM A 428 – Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles.
6. ASTM A 491 – Standard Specification for Aluminum Coated Steel Chain Link Fence Fabric.
7. ASTM A 817 – Standard Specification for Metallic-Coated Steel Wire for Chain Link Fence Fabric and Marcelled Tension Wire.
8. ASTM A 824 – Standard Specification Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
9. ASTM B 211 – Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
10. ASTM C 94 – Standard Specification for Ready-Mixed Concrete.
11. ASTM F 567 – Standard Practice for Installation of Chain Link Fence.
12. ASTM F 626 – Standard Specification for Fence Fittings.
13. ASTM F 900 – Standard Specification for Industrial and Commercial Swing Gates.
14. ASTM F 1043 – Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
15. ASTM F 1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
16. ASTM F 1183 – Standard Specification for Aluminum Alloy Chain Link Fence Fabric.

B. Chain Link Fence Manufacturer’s Institute

1. Chain Link Fence Manufacturer’s Institute Product Manual, latest revision.

1.4 SUBMITTALS

A. Shop drawings showing the plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and a schedule of components.

B. Material certificates or other data indicating compliance with these specifications for fabric, posts, fittings, hardware, and accessories.

C. Fence sample complete with all typical hardware and components. The samples shall be representative of the type of construction for the project and color of all components.

1.5 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. Supply material in accordance with Chain Link Fence Manufacturer's Institute Product Manual and this Specification.

C. Perform installation in accordance with ASTM F 567.

D. Maintain all facilities installed under this Section in proper and safe condition throughout the progress of the work.

1.6 PRODUCT HANDLING

A. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.

B. Packages shall be labeled with the manufacturer's name.

C. Store fence fabric and accessories in a secure and dry place.

PART 2 - PRODUCTS

2.1 GENERAL

A. Material furnished shall be in good condition and shall not have been painted.

B. All posts and rails shall be straight, true to section and of sufficient length for proper installation.

C. Unless otherwise specified, hardware and accessories shall conform to the requirements of ASTM F 626 and ASTM A 123 or ASTM A 153 as applicable for zinc-coating.

2.2 LINE POSTS

A. Type I: 2-inch nominal (2.375 O.D.) steel pipe, 3.65 lb./lf, hot dipped galvanized, ASTM F 1083, with average zinc coating of 1.8 oz./ft^2 interior/exterior conforming to ASTM F 1043.

B. Type II: 2-inch nominal (2.375 O.D.) steel pipe, 3.12 lb./lf, cold formed and welded per ASTM F 1043, Group IC, minimal yield Strength 50,000 psi. External zinc coating shall be Type B, zinc with polymer film, 0.90 oz./ft^2. Internal coating shall be Type B, zinc 0.90 oz./ft^2 minimum, or type D, zinc pigmented, eighty-one percent (81%) nominal coating with 0.30 mils minimum thickness.

2.3 CORNER, END, AND PULL POSTS

A. Type I: 2.5-inch nominal (2.875 O.D.) steel pipe, 5.79 lb./lf, hot dipped galvanized, ASTM F 1083, with average zinc coating of 1.8 oz./ft^2 interior/exterior conforming to ASTM F 1043.

B. Type II: 2.5-inch nominal (2.875 O.D.) steel pipe, 4.64 lb./lf. External zinc coating shall be Type B, zinc with polymer film, 0.90 oz./ft^2. Internal coating shall be Type B, zinc 0.90 oz./ft^2 minimum, or type D, zinc pigmented, eighty-one percent (81%) nominal coating with 0.30 mils minim thickness.

2.4 BRACE ASSEMBLY

A. Rails

1. Type I: 1.25-inch nominal (1.660 O.D.) steel pipe, 2.27 lb./lf, hot dipped galvanized, ASTM F 1083, with average zinc coating of 1.8 oz./ft^2 interior/exterior conforming to ASTM F 1043.
2. Type II: 1.25-inch nominal (1.660 O.D.) steel pipe, 1.83 lb./lf. External zinc coating shall be Type B, zinc with polymer film, 0.90 oz./ft^2. Internal coating shall be Type B, zinc 0.90 oz./ft^2 minimum, or type D, zinc pigmented, eighty-one percent (81%) nominal coating with 0.30 mils minim thickness.

B. Truss rod shall be 3/8-inch zinc-coated steel with adjustable turnbuckles or truss tightener.

2.5 FABRIC

A. Wire fencing fabric shall be No. 9 gauge wire woven into a 1-12-inch diamond wire mesh, 6-foot height. Fabric shall be knuckled at bottom selvage, twisted at top selvage.

1. Zinc-Coated Steel Fabric: ASTM A 392, Class I, zinc-coated steel wire with minimum coating weight of 1.2 oz./ft^2 uncoated wire surface.
2. Aluminum-Coated Steel Fabric: ASTM A 491, coated by the hot-dip process before weaving. Minimum aluminum coating shall not be less than 0.40 oz./ft^2 of uncoated wire surface.
3. Aluminum Alloy Fabric: ASTM F 1183.

2.6 STRETCHER BARS

A. Bars shall be one-piece lengths of zinc-coated steel, not less than 2 inches shorter than the full height of the fencing fabric with a minimum cross section of 3/16-inch by ¾-inch in accordance with ASTM F 626.

2.7 TENSION WIRE

A. Marcelled (spiraled or crimped) No. 7 gauge, (0.177-inches) diameter, ASTM A 824. Tension wire coating shall conform to ASTM A 824 Type I, aluminum coated, 0.40 oz./ft^2 or Type II zinc-coated Class 2, 1.2 oz./ft^2.

2.8 HARDWARE AND TIES

A. Miscellaneous hardware, including but not limited to nuts, bolts, washers, clips, bands, rail ends, brackets, and straps shall be provided as required, hot-dip galvanized steel or aluminum alloy, ASTM F 626.

B. Tension bands shall be formed from flat or beveled steel and shall have a minimum thickness after galvanizing of 0.078 inches and a minimum width of ¾-inch.

C. Brace bands shall be formed from flat or beveled steel and shall have a minimum thickness after galvanizing of 0.108 inches and a minimum width of ¾-inch.

D. Wire ties shall be minimum 16-gauge galvanized steel wire or minimum 9-gauge aluminum alloy wire.

2.9 GATES

A. Gate Construction: ASTM F 900. Corners welded or assembled with special malleable or pressed-steel fittings and rivets or bolts to provide rigid connections.

B. Gate Posts:

1. Type I: 2.5-inch nominal (2.875 O.D.) steel pipe, 5.79 lb./lf, hot dipped galvanized, ASTM F 1083, with average zinc coating of 1.8 oz./ft^2 interior/exterior conforming to ASTM F 1043.
2. Type II: 2.5-inch nominal (2.875 O.D.) steel pipe, 4.64 lb./lf. External zinc coating shall be Type B, zinc with polymer film, 0.90 oz./ft^2. Internal coating shall be Type B, zinc 0.90 oz./ft^2 minimum, or type D, zinc pigmented, eighty-one percent (81%) nominal coating with 0.30 mils minim thickness.

C. Gate Frame: Constructed of minimum 1.25-inch nominal (1.660 O.D.) steel pipe, 1.83 lb./lf.

D. Wire Fencing Fabric: Fabric shall match that of fence, attached securely to frame at intervals not exceeding 15-inches.

E. Gate Leaves: Configured with intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction, free from sag or twist.

F. Hinges: Malleable iron, forged steel, or pressed steel to suit gate size, no-lift-off type, offset to permit 180-degree opening.

G. Provide minimum ½-inch-diameter drop rod on each gate pair. Drop rod assembly and related latches shall be configured to secure gate in a closed position and accept padlock as an integral part of the latch system.

H. Hinges, Stops, Keepers, and other hardware items shall be furnished as required for proper operation.

I. Locks:
1. Basis-of-Design Product: Locinox, LUKY J5.
2. Adaptor Plate for Lock: Locinox 3019LA.
3. Surface Mounted Strike: Locinox SAKL, requires a latch gap of 1-1/4-inches.
4. Adaptor Plate for Lock: Locinox 3018LA.
5. Tension Bar to Hold Chain Link around Mounted Lock: Locinox CLH-LA.
6. Hinge and Closer Assembly: Locinox TIGER (for gates up to 4-feet wide, 165 pounds. Hinge gap adjustable from 7/16-inchs to 1-inch.
7. Chain Link Bracket: Locinox CLB-TIGER.

2.12 CONCRETE

A. Concrete shall conform to ASTM C 94; or pre-packaged concrete mix, ASTM C 387. Minimum 28-day compressive strength of 3000 psi.

PART 3 - EXECUTION

3.1 GENERAL

A. Install fence with properly trained crew as shown on the drawings in accordance with ASTM F 567.

B. Install all nuts for tension bands and hardware bolts on the side of the fence opposite the fabric.

3.2 POSTS

A. Posts shall be spaced in line not further than 10 feet on centers.

B. Intermediate or line posts, except where indicated on the Drawings, may be driven by mechanical means. A suitable driving cap shall be used to ensure that no damage is caused to the post. Posts not driven, and all other type posts, shall be set in concrete conforming to the requirements herein and as shown on the Drawings.

C. Concrete post footings shall have a plan diameter 12-inches greater than the post diameter. Holes shall be clean and free of loose soil and debris. Concrete shall be placed continuously in one (1) operation and tamped or vibrated for consolidation. Lower limit of concrete footing shall be at least 4 inches below the bottom of the post. Tops of the concrete footings shall be crowned to shed water.

1. Line posts or line-post footings shall be installed a minimum of 36 inches below grade.
2. Corner, gate, and terminal post footings shall be installed a minimum of 42 inches below grade.

D. All corner, end posts, and gate posts shall be braced.

1. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one (1) bay from end and gate posts.
2. Corner and terminal posts are to be braced horizontally and diagonally. The braces are to extend over one (1) adjacent panel. Changes in line of 30 degrees or more shall be considered as corners.
3. Braces and truss rods shall be securely fastened to posts with appropriate hardware.
4. Pull posts with two (2) braces shall be provided for all heights where changes in horizontal or vertical alignment of 10 degrees or more occur.

3.3 FABRIC

A. Do not install fabric until concrete post footings have cured seven (7) days. Provide fabric of the height specified. Install fabric on the public side of the fence, with bottom no greater than 2 inches above the ground surface. Fasten fabric to line posts at intervals not exceeding 15 inches with ties as specified.

B. Install tension wire in one (1) continuous length between pull posts, weaved through fence fabric at top and bottom. Tension wires shall be applied to provide a wire without visible sag

between posts. Fasten fabric to tension wires at intervals not exceeding 24 inches with ties or hog rings as specified.

C. Where it is not practicable to conform the fence to general contour of the ground, the opening beneath the fence shall be enclosed with chain link fabric and sufficiently braced to preclude access, but not to restrict the flow of water.

3.4 GATES

A. Provide swing gates at the locations and dimensions shown on the Drawings. Do not install gates until concrete post footings have cured seven (7) days.

B. Do not install gates until concrete post footings have cured seven (7) days.

C. Gates shall be installed plumb, level, and secure, with full opening without interference. Hardware shall be installed and adjusted for smooth operation and lubricated where necessary.

D. Provide concrete center drop to footing depth and suitable drop rod sleeve at center of double gate openings.

END OF SECTION 323110

SECTION 323120 - TRAFFIC CONTROL DEVICES

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 DESCRIPTION OF THE WORK

A. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this section, and as shown on the Drawings.

B. The Work of this section includes the installation of new signs and sign supports and the removal of existing signs as indicated on the Drawings and specified herein. New signs and sign supports in public roadways, which will be within the jurisdiction of the State of Connecticut or the local municipality, shall conform to the requirements of Connecticut DOT Form 817, Sections 12.06, 12.07, 12.08, and 12.20 and the local Traffic Authority, as applicable.

1.3 SUBMITTALS

A. Shop Drawings

1. Submit shop drawings of all work of this Section. Do not order material or begin fabrication until the approval of the Owner's representative has been obtained.
2. Show the size and thickness of all members, types of materials, methods of construction, assembly method, type of surface treatment, complete dimensions, hangers, brackets, anchorage, relationship to surrounding work by other trades, shop finishes, sign designs, layouts, lettering, and other pertinent details of fabrication and installation.

1.4 QUALITY ASSURANCE

A. The approved manufacturer shall have experience in the type of work required; shall have a reputation for doing satisfactory work on time; and shall have recently successfully completed similar work.

B. Deliver and store work under these Sections in a manner to prevent cracking, chipping, or stress of the components, and to prevent mechanical damage or damage by the elements.

PART 2 - PRODUCTS

2.1 ALUMINUM SIGN PANELS

A. Aluminum sign panel shall be fabricated from flat aluminum sheeting, ASTM B 209-04, Alloy 6061-T6 or Alloy 5052-H38, of the following thickness and mounting, unless otherwise specified:

Area of Sign (square feet)	Mounting	Municipal Thickness (Inches)

< 10	Single Post	.080
Between 10 and 20	Two Posts	.080
Between 6 and 25	Single Post (Top Mounted)	.080

B. Sign supporting hardware shall be aluminum or stainless-steel.

2.2 REFLECTIVE SHEETING

A. Reflective sheeting shall meet the requirements of AASHTO M268.

1. Panel sheeting shall be Type II (Engineering Grade).
2. Legend sheeting shall be Type III (High Intensity).

2.3 LEGENDS

A. Permanently Applied Legends:

1. Permanently applied legends shall be reflective or opaque sheeting applied directly to clean, dust-free background in a manner specified by the sheeting manufacturer.
2. Heat activated adhesive-coated material shall be applied only by mechanical means.
3. Pressure sensitive, adhesive-coated materials shall be applied only by hand means.
4. Finishes shall be as recommended by and in a manner as specified by the sheeting manufacturer.
5. Legends shall be neatly cut.

2.4 SILK SCREEN PROCESSED

A. The legends shall be of the series and size specified in the AASHTO Manual for “Signing and Pavement Markings” (Current Edition), and the dimension and details of the letters with respect to each series shall be as specified in the FHWA publication “Standard Alphabet for Highway Signs” (Current Edition), or as shown on the Drawings.

2.5 FASTENERS AND ANCHORS

A. The sign fabricator shall design a complete system of fastenings and anchorage devices for the various signs, as required for attachment to the various supporting structures. These may include, but are not limited to, concealed clip systems, face screws, epoxy adhesives, etc. Wherever reasonably possible, fastenings and anchorage devices shall be fully concealed and shall be vandal proof. The Contractor is responsible to provide safe and secure installations in strict conformance to the governing laws and building code.

B. Fully describe proposed fastenings and anchorage devices for each sign type on the shop drawings.

2.6 SIGN SUPPORTS

A. Sign supports shall be of the breakaway type. Material for breakaway signposts shall be as specified in these Specifications and as required by the Owner’s representative.

B. Owner’s signs shall be mounted on Telspar posts within the concrete sidewalk. The posts shall be 1/8-inch-thick, 2-inch posts anchored in a 2-7/8-inch sleeve with a depth of 9-inches. All materials for public street signs shall conform to the local Traffic Authority standards.

PART 3 - EXECUTION

3.1 PROTECTION AND TEMPORARY COVERS

A. Completed sign panels shall be properly protected and maintained in good condition, free from dirt, scratches, hand marks, or other blemishes. The panels shall be shipped in such a manner as to insure their arrival on the job site in an undamaged condition.

B. Subsequent to erection, if directed by the Owner's representative, exterior signs may be required to be covered until the actual use thereof is desired. Material used to temporarily cover any sign panel shall effectively conceal the message and be non-injurious to the panel, its finish, or its structural integrity.

3.2 INSTALLATION

A. Erection of all work under this Section shall be performed by experienced sign erectors. Signs shall be installed true, plumb, and level, located as shown on the Drawings. No field cutting of any sign work will be allowed. Exercise extreme care in all handling and stacking of signs to avoid chipping. Exact location of signs will be determined by the Owner's representative in the field.

B. All work shall be rigidly anchored to the supporting construction, as indicated on the approved shop drawings.

3.3 ALUMINUM SIGN PANEL

A. Sign panels shall show careful workmanship and present a reasonably plane surface with the message and outlines clear and sharp.

1. Finished sign panels shall be shipped in such manner as to ensure arrival on the Project in undamaged condition, where they shall be properly protected from dirt, scratches, hand-marks, and other blemishes until erected and accepted.

B. Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified for the manufacture of traffic control signs by the sheeting manufacturer. Heat activated adhesive coating sheeting shall be pre-perforated.

1. No splices shall be allowed on sign panels.

C. When pressure sensitive adhesive coating reflective sheeting is used, all sheeting splices and sign edges shall be sealed with materials recommended by and in a manner specified by the sheeting manufacturer.

1. Dry heat activated adhesive coated reflective sheeting when applied to aluminum shall be edge sealed as specified by the sheeting manufacturer.

3.4 REFLECTIVE SHEETING

A. The reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

B. The numerals shall be black-die-cut, pre-spaced, conforming to the details on the Drawings and/or Owner's standards. Numerals shall have a pre-coated, pressure-activated adhesive applied as recommended by the manufacturer of the reflective sheeting or be opaque black permanent inks applied on approved high intensity sheeting.

C. Treatment of aluminum sign panels prior to application of reflective sheeting.

1. Vapor Degreasing: By total immersion of the panel in a saturated vapor or trichloroethylene. Trademark printing shall be removed with lacquer thinner or controlled alkaline cleaning system.
2. Alkaline Degreasing: By total immersion of the panel in a tank containing alkaline solutions, controlled and titrated to the solution manufacturer's specification.
3. Rinsing: After satisfactory degreasing, the panels shall be thoroughly washed with running water.
4. Drying: The panel shall be thoroughly dried by use of a forced hot air dryer.
5. Metal shall not be handled between cleaning and etching operation and the application of reflective sheeting, except with devices or clean canvas gloves.
6. Metal shall not come in contact with greases, oils, or other contaminants prior to the application of reflective sheeting.

3.5 CLEAN-UP

A. Surfaces of sign work shall be cleaned as recommended by the sign manufacturer after installation and left in a condition satisfactory to the Owner's representative.

B. All defective work, including that exhibiting cracked, chipped, scratched, abraded, or otherwise damaged finishes, shall be removed and replaced with work conforming to the specified requirements.

3.6 ERECTION OF POSTS

A. Posts shall be installed in conformance with details shown on the Drawings or as required by the local Traffic Authority.

B. Posts shall be driven a minimum of 3 feet into firm ground or shall be anchored in concrete in accordance with Owner's requirements.

C. Bottom of all signs shall be the minimum height above existing ground in accordance with MUTCD, latest edition, the local Authority or Connecticut DOT Form 816, whichever is more stringent.

END OF SECTION 323120

SECTION 329115 - SOIL PREPARATION

PART 1 – GENERAL

1.1 SECTION NCLUDES

A. The work shall include, but not be limited to the following:

1. Final grading of topsoil for finish landscaping.

2. Providing, leveling and compacting topsoil where sodding, seeding and planting is scheduled.

1.2 RELATED SECTIONS

A. Section 329200 - Turfs and Grasses

B. Section 329300 - Plants

1.3 SAMPLES

A. Submit 10 lb sample of topsoil to testing laboratory in air-tight containers. Provide laboratory results for soil properties, pH, organic content, and nutrient status for turf and horticulture with recommendations for amending to correct any deficiencies. Soil samples shall be certified as to their origin and there shall be multiple samples if they come from more than one source. The nearest qualified testing lab is the Ct. Agricultural Experiment Station, 123 Huntington St. New Haven, CT 06504.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: friable, screened loam; free of subsoil, roots, grass, excessive amounts of weeds stone, and foreign matter; acidity range (pH) of 5.5 to 7.5; containing a minimum of 4 % and maximum of 25 % organic matter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify site conditions and note irregularities affecting work of the section.

B. Beginning work of this Section means acceptance of existing conditions.

C. Examine grade stakes and reset, as needed to control placing and leveling of topsoil, maintaining grade stakes on 20 foot centers.

3.2 SUBSOIL PREPARATION

A. Eliminate uneven areas and low spots.

B. Remove debris, roots, branches, stones, in excess of 2 inches in size

C. Scarify subgrade to depth of 3 inches where topsoil is scheduled and equipment used for hauling and spreading topsoil and has compacted subsoil.

3.3 PLACING TOPSOIL

A. Place topsoil where seeding, sodding, or landscaping is scheduled to a nominal depth of 6 inches. Use topsoil in a relatively dry state, but moist enough so that soil structure is not destroyed when worked. Place topsoil during dry weather.

B. Fine grade topsoil eliminating rough or low areas. Maintain contour of subgrade.

C. Remove roots, weeds, rocks and foreign material after spreading, using mechanical stone picking machines, making passes over the entire area in two directions.

D. Manually spread topsoil close to trees, plants, and to prevent damage.

E. Lightly compact placed topsoil.

F. Remove surplus subsoil and topsoil from site.

G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.4 TOLERANCES

A. Top of Topsoil: Plus or minus 1/2 inch.

3.5 PROTECTION

A. Protect landscaping and other features remaining as final

work. B. Protect existing walls, walks, utilities and paving.

3.6 SCHEDULES

A. Compacted topsoil thickness: Seeded Grass: 6 inches.

B. Compacted topsoil thickness: Shrub beds: 12 inches.

END OF SECTION

SECTION 329200 - TURFS AND GRASSES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Seeding, mulching, and fertilizing.

B. Maintenance.

1.2 RELATED SECTIONS

A. Section 329115 - Soil Preparation: Preparation of subsoil and placement of topsoil in preparation for the work of this Section.

1.3 REFERENCES

A. The words "Topsoil and Seed" as called for on the contract drawings shall mean the work included in Section 329115 and this section.

1.4 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging. Data to include percentages of purity, germination, and weed seed for each grass species.

B. Review topsoil test results obtained by contractor under Section 32915.

1.5 REGULATORY REQUIREMENTS

A. Comply with applicable regulatory agencies for fertilizer and herbicide composition.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1.

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

C. Deliver fertilized in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.7 MAINTENANCE

A. Furnish maintenance of seeded areas immediately after seeding until grass is well established, usually after three cuttings.

PART 2- PRODUCTS

2.1 SEED MIXTURE

A. Seed Mixtures: See Drawings

2.2 SOIL MATERIALS

A. Topsoil: As specified in Section 329115.

2.3 ACCESSORIES

A. Fertilizer: Granular, non-burning, complete, guaranteed analysis fertilizer. Not less than 50% of the nitrogen shall be from organic sources. The fertilizer shall contain formulations of total nitrogen, available phosphoric acid and soluble potash in a 1:1:1: ration with an analysis of 10:10:10 in spring and a 1:2:1 ratio of
5:10:5 in the fall.

B. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth.

C. Herbicide: Tupersan; or approved equal, if spring or summer seeding..

D. Limestone: Ground limestone to contain not less than 85% of total carbonates and ground to a gradation such that 50% will pass a 100 mesh screen and 90% will pass through a 20 mesh screen.

E. Slope seeding protection: Curlex I Blanket by American Excelsior or approved equal.

2.5 TESTS

A. Provide topsoil analysis per Section 329115

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this Section. Seed bed shall have been thoroughly tilled and lightly rolled to insure finished lawns meet new grades called for on the grading plans. Incorporate lime when tilling.

3.2 PREPARATION

A. Apply fertilizer to supply one (1) pound of actual nitrogen per 1000 square feet.

B. Apply after smooth raking of topsoil. Refer to Section 329115.

C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

3.3 SEEDING

A. Apply seed at a rate of 5 lbs. per 1000 sq. ft. evenly in two (2) intersecting directions. Rake in lightly. Or use a mechanical seeding machine.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Planting Season: Spring: March 15 to June 15; Fall: August 15 to Sept. 30

D. Do not sow immediately following rain, when ground is too dry, or during windy periods.

E. Roll seeded area with light roller if seeding machine is not used.

F. Immediately following seeding and compacting, apply mulch at 100 lbs. to 1000 s.f.

G.. Apply water with a fine spray immediately after each area has been mulched. Saturate to 6 inches.

3.4 SEED PROTECTION

A. Identify seeded areas with stakes and string around area periphery. Set string height to 30 inches. Space stakes at 15 feet.

B. Cover seeded slopes where grade is 4 inches per foot or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.

C. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

D. Secure outside edges and overlaps at 36 inch intervals with stakes.

E. Lightly dress slopes with topsoil to ensure close contact between fabric and soil. F.

At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.5 MAINTENANCE

A. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.

B. Neatly trim edges and hand clip where necessary.

C. Immediately remove clippings after mowing.

D. Water to prevent grass and soil from drying out.

E. Roll surface to remove minor depressions or irregularities.

F. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

G. Immediately reseed areas which show bare spots.

H. Protect seeded areas with warning signs during maintenance period.

I. Maintenance period shall extend until the grass is formally accepted by the Engineer.

END OF SECTION

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The work shall include, but not be limited to, the following:

1. New trees, plants, and ground cover including trees and shrubs.
2. Mulch and fertilizer.
3. Maintenance.

1.2 RELATED SECTIONS

A. Section 329115 - Soil Preparation: Preparation of subsoil and placement of topsoil in preparation for the work of this Section.

1.3 REFERENCES

A. ANSI Z60.1 - Nursery Stock.
B. "American Standards for Nursery Stock", latest edition.

1.4 DEFINITIONS

A. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Silverlace, and Crab Grass, Japanese Knotweed.

B. Plants: Living trees, plants, and ground cover specified in this Section.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit instructions for continuing Owner maintenance under provisions of Division

1. Include cutting and trimming methods; types, application frequency, and

recommended coverage of fertilizer.

1.6 QUALITY ASSURANCE

A Supply plants in compliance with "Standardized Plant Names: as adapted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Provide stock true to botanical name and legibly tagged.

B. Comply with sizing and grading standards of the latest edition of "American Standards for Nursery Stock."

C. All plants to be grown in nurseries with climatic conditions similar to the locality of the project.

D. Stock furnished shall be at least the minimum size indicated. Larger stock is

acceptable, at no additional cost, providing that the larger plants will not be cut back to the size indicated.

E. Plants may be inspected and approved at the place of growth for compliance with specification requirements for quality, size, and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.

1.7 QUALIFICATIONS

A. Nursery: Company specializing in growing and cultivating the plants with three years documented experience.

B. Installer: Company specializing in installing and planting the plants with three years documented experience approved by nursery.

1.8 REGULATORY REQUIREMENTS

A. Comply with regulatory requirements for fertilizer and herbicide composition.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 1. Cover plants transported in open vehicles to prevent windburn.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

C. Protect plants until planted.

D. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install plant life when ambient temperatures may drop below 35 degrees F or above 80 degrees F.

B. Do not install plants when wind velocity exceeds 30 MPH.

1.11 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Division 1. Notify Landscape Architect at least seven (7) working days prior to installation of plant material.

1.12 WARRANTY

A. Provide a warranty on work of this Section for a minimum of one year including one continuous growing season.

B. Warranty: Include coverage of plants from death or unhealthy conditions. Replace dead, unvigorous, or unhealthy plants.

C. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

1.13 MAINTENANCE SERVICE

A. Maintenance Services: Performed by installer.

B. Maintain plant life immediately after placement until plants are well established and exhibit a vigorous growing condition. Continue maintenance until termination of warranty period.

C. Maintenance to include:
1. Cultivation and weeding plant beds and tree pits.
2. Application of herbicides for weed control in accordance with manufacturer's instructions. Remedy damage resulting from use of herbicides.
3. Application of pesticides in accordance with manufacturer's instructions. Remedy damage from use of pesticides.
4. Irrigating sufficient to saturate root system.
5. Trimming and pruning, including removal of clippings and dead or broken branches, and treatment of pruned areas or other wounds.
6. Disease control.
7. Maintaining wrapping, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

PART 2 - PRODUCTS

2.1 TREES, PLANTS, AND GROUND COVER

A. Plants: Provide plant typical of their species or variety; with normal, densely developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sun scale, injuries, and frost cracks, abrasions of the bark, plant diseases, voids and open spaces. Plants held in storage will be rejected if they show signs of growth during storage.

1. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Cracked or mushroomed balls are not acceptable.
2. Container-grown stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.
a. No plants shall be loose in the container. b. Container stock shall not be pot bound.
3. Provide tree species that mature at heights over 25'-0" with a single main trunk. Trees that have the main trunk forming a "Y" shape are not acceptable.
4. Plants planted in a row shall be matched in form.
5. Plants larger than those specified in the plant list may be used when acceptable to the Owner.
a. If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.
6. The height of the trees, measured from the crown of the roots to the top of the top branch, shall not e less than the minimum, size designated in the plant list.

7. No pruning wounds shall be present with a diameter of more than one inch and such wounds must show vigorous bark on all edges.
8. Evergreen trees shall be branched to the ground.
9. Shrubs shall meet the requirements for spread and height indicated in the plant list. a. The measurements for height shall be taken from the ground level to the average height of the top of the plant and not the longest branch.
b. Single stemmed or thin plants will not be accepted.
c. Side branches shall be generous, well-twigged, and the plant as a whole well-bushed to the ground.
d. Plants shall be in moist, vigorous condition, free from dead wood, bruises, or other root or branch injuries.

2.3 SOIL MATERIALS

A. Topsoil for Planting Pits and Beds: Fertile, friable, natural topsoil of loamy character, without a mixture of subsoil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sand, stone, plants, roots, sticks and other foreign material, with an acidity range between 6.0 and 6.5.

1. Identify source location of topsoil proposed for use on the project.
2. Provide topsoil free of substances harmful to the plants which will be grown in the soil.

2.4 SOIL AMENDMENT MATERIALS

A. Fertilizer: Commercial type containing 12% nitrogen, 13% phosphoric acid, and 12% potash by weight. One-quarter of nitrogen in the form of nitrates, one-quarter in the form of ammonia salt, and one-half in the form of organic nitrogen.

B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; weed and seed free, granulated raw peat or baled peat, containing not more than 9% mineral on a dry basis.

C. Bone Meal: Commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.

D. Lime: Ground limestone, dolomite type, minimum 95 percent carbonates.

E. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of plants.

F. ‘M Roots’ or approved substitute.

2.5 MULCH MATERIALS

A. Mulching Material: Shredded bark type, approved by the Landscape Architect.

2.6 ACCESSORIES

A. Wrapping Materials: Standard waterproof tree wrapping paper; Krinkle Kraft or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that prepared subsoil is ready to receive work.

B. Beginning to installation means acceptance of existing conditions.

3.2 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas. Remove foreign materials, weeds, and undesirable plants and their roots. Remove contaminated subsoil.

B. Scarify subsoil to a depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted subsoil. C. Dig pits and beds 6 inches larger than plant root system.

3.3 PREPARATION

A. Time of planting:

1. Evergreen material: Plant evergreen materials between August 15 and September 30 or March 1 to May30. If project requirements require planting at other times, plants shall be sprayed with anti-desiccant prior to planting operations.
2. Deciduous material: Plant deciduous material in a dormant condition. If deciduous trees are planted in leaf, they shall be sprayed with an anti-desiccant prior to planting.

B. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

C. Locate plants as indicated or as approved in the field after staking by the Contractor. If obstructions are encountered discontinue operations until alternate plant locations are chosen by the Landscape Architect.

D. Excavate circular plant pit with vertical sides, except for plants specifically indicated to be planted in beds. Provide shrub pits at least twelve (12) inches greater than the diameter of the root system and 24" greater for trees. Depth of pit shall accommodate the root system. Scarify the bottom of the pit to a depth of four (4) inches. Remove excavated materials from the site.

E. Provide pre-mixed planting mixture for use around the balls and roots of the plants consisting of six parts planting topsoil, one part peat moss and one part dehydrated cow manure. Add 1/2 pound plant fertilizer for each cubic yard of mixture.

F. Provide pre-mixed ground cover bed planting mixture consisting of three parts planting topsoil to one part peat moss and 1/2 pound of fertilizer per cubic yard. Provide beds a minimum of eight inches deep.

3.4 INSTALLATION

A. Set plant material in the planting pit to proper grade and alignment. Set plant upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material two (2) to three (3) inches above the finish grade. No filling will be permitted around the trunks or stems. Backfill the pit with planting mixture. Do not use frozen or muddy mixtures for backfill.

B. After balled and burlapped plants are set, muddle planting soil mixture around base of balls and fill all voids.

1. Remove all burlap, ropes and wires from the tops of balls.
2. Remove completely all non bio-degradable materials.

C. Space ground cover plants in accordance with indicated dimensions. Adjust planting as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within twelve (12) inches of trunks of trees and shrubs with the planting bed, and to with six (6) inches of the edge of the bed.

3.5 MULCHING

A. Mulch trees and shrub planting pits and shrub beds with required mulching material three (3) inches deep immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.

3.07 WRAPPING, GUYING, AND STAKING

A. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before planting.

B. Wrap trunks of all trees spirally from bottom to top with specified tree wrap and secure in place.

1. Overlap 1/2" the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
2. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least three (3) places in addition to the top and bottom.

C. Remove all wrapping at the end of the one (1) year warranty period and before final acceptance.

3.8 FIELD QUALITY CONTROL

A. Field inspection will be performed under provisions of Section 01400.

B. Plants will be rejected when ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.9 PRUNING

A. Prune branches of deciduous stock, after planting, to remove or cut back broken, damaged, and unsymmetrical growth of new wood.

B. Multiple leader plants: Preserve the leaders which will best promote the symmetry of

the plant. Cut branches close to flush with the trunk or main branch at a point beyond a lateral shoot or bud a distance of not less than 1/2 the diameter of the supporting branch.
Make cut perpendicular to branch.

C. Prune evergreens only to remove broken or damaged branches.

3.10 MAINTENANCE

A. Maintain plantings for a period of at least 60 days after completion of planting operation or until all plants are sufficiently recovered from transplanting and in a healthy growing condition. Maintain planting installed in the fall after September 15 until May 30 of the
following year.

B. Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.

1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
2. Correct defective work as soon as possible after deficiencies become apparent, and weather permits.
3. Water trees, plants, and ground cover beds within the first 24 hours of initial planting, and not less than twice a week until acceptance.

C. Maintenance Schedule: Contractor shall submit a maintenance schedule to Owner for approval before any payments are made. The schedule shall include periodic inspections with Owner. Work not completed within five (5) days after notification or within ten (10) days of Maintenance. Maintenance shall include, but not be limited to: all necessary and proper replacements of unacceptable material, straightening plants, fertilizing, pruning and any other operations necessary for proper plant growth and to keep the landscaped areas in a neat, clean, safe condition. The itemized Maintenance Schedule shall include such work as: weeds not allowed to attain more than six (6) inches of growth; replacing, repairing, and tightening stakes, wrapping materials as many times as necessary; promptly removing dead, badly injured or unhealthy plant material and replacing during next planting season. Reconstruction of settled planting areas to their proper grade; removing tree wrapping to inspect trunks and repairing damage and removing insects before rewrapping with new tree wrap; adding mulch as required, etc.

3.11 REPLACEMENTS

A. Plants shall be free of dead or dying branches and branch tips and shall bear foliage of a normal density, size, and color. Promptly remove dead, unsightly, unhealthy, or excessively pruned plants as directed. These and any plants missing, due to the Contractor's negligence, shall be replaced or added with the same kind and size as originally specified as soon as conditions permit.

B. Material and method of replacement shall be the same as specified for the original planting with replacements matching adjacent specimens of the same species. Replacing shall be made as many times as necessary to insure healthy plants and they shall be maintained and guaranteed for twelve (12) months from time of replacement. Necessary repairs due to replacements shall estimated cost of

possible replacements may be retained until the end of the Warranty Period and paid after all work is satisfactorily maintained and approved in writing by the Owner.

3.12 INSPECTION AND ACCEPTANCE

A. All work in this contract shall be found in a neat, clean and safe condition and only those plants that have been properly maintained and are alive and in satisfactory health will be accepted.

END OF SECTION 329300

SECTION 334100 - STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Description of The Work

1. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the Work specified in this Section, and as shown on the Drawings.
2. The Work of this Section shall include, but not be necessarily limited to, the installation of new storm drain pipe, manholes, and catch basins, the relocation/replacement of existing storm drain pipe and catch basins, connection of building roof drains and perimeter drains from a point 5 feet outside of the foundations, and the installation of under drain pipe all as shown on the Drawings, as directed by the Owner's representative, and as specified herein.

B. Related Sections

1. Carefully examine all the Contract Documents for requirements, which affect the Work in this Section. Other specification Sections, which directly relate to the Work of this Section include, but are not limited to, the following:

a. Section 312000 "Earth Moving"
b. Section 317000 "Maintenance and Protection of Traffic"
c. Section 321314 "Site Cast-in-Place Concrete"

1.3 SUBMITTALS

A. Shop Drawings

1. Materials list of items proposed to be provided under this Section.
2. Submit shop drawings or descriptive literature, or both, showing dimensions, joint, and other details of all materials to be furnished under this Section. Shop drawings shall be submitted to the Owner's representative for approval prior to ordering material.

B. As-Built Drawings

1. Submit two (2) copies of As-Built Drawings upon completion and acceptance of work.
2. As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built drawings shall include a minimum of three (3) ties showing the distance to each catch basin and manhole, and the location of service connections measured from fixed permanent objects. As-Built drawings shall also contain any additional information required by the Owner's representative (including stamping by a licensed Professional Engineer or Land Surveyor as required).

1.4 COORDINATION

A. Coordinate the Work with the termination of storm sewer connections outside the buildings, connections to the existing storm sewer system, and trenching operations.

PART 2 - PRODUCTS

2.1 GENERAL

A. Reinforced Concrete Pipe: Pipe shall comply with the requirements of ASTM C 76-04a. All pipe 18 inches and smaller shall be Class V. All other pipe shall be Class IV unless indicated otherwise on the drawings.

1. Joints for the reinforced concrete pipe shall be the tongue and groove or bell and spigot type of joint and shall conform to ASTM C 443-03. All pipe shall have flexible, watertight rubber-type gaskets conforming to AASHTO M198.

B. Polyvinyl Chloride (PVC) Pipe: Only permitted when specifically indicated on the Drawings. Pipe and fittings shall comply with ASTM D 3034-04, rated SDR 35. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034-04 classification.

1. Pipe joints shall be integrally molded bell ends in accordance with ASTM D 3034-04, Table 2, with factory supplied elastomeric gaskets and lubricant.

C. Ductile Iron Pipe: Pipe shall be ductile iron pipe, Class 52, per ANSI A21.51-02. Joints shall be push-on joints with synthetic rubber or neoprene gaskets per ANSI A21.11.

D. High Density Corrugated Polyethylene Pipe (HDPP) and Fittings with smooth interior shall meet the requirements of ASTM D 3350-04. Four-inch through 10-inch-diameter pipe corrugated polyethylene drainage tubing shall meet the requirements of AASHTO M252. 12-inch through 36-inch-diameter corrugated polyethylene pipe shall meet the requirements of AASHTO M294, Type S. Standard 45-degree "Y" connections shall be fabricated to sizes shown on the Drawings.

1. Pipe joints and fittings shall conform to the requirements of AASHTO M252 or AASHTO M294 and shall be bell and spigot type with rubber gasket and shall be soil tight in accordance with ASTM F 2306.

2.2 STORM DRAIN MANHOLES

A. Precast Units

1. Structure: 48-inch-diameter, unless otherwise noted, precast units (4,000 psi minimum compressive strength) with eccentric cone section tapering to 36-inch-diameter and one (1) pour monolithic base section per ASTM C 478-03a.

a. Wall thickness shall be a minimum of 5 inches.

2. Precast Unit Joint: Butyl rubber gasket joints shall be per ASTM C 990-03a.
3. Steps: Steps for manholes shall be steel reinforced copolymer polypropylene plastic with at least a 14-inch-wide stepping surface, per ASTM C 478-03a, D 4101-04, and A 615.
4. Manhole Frame and Cover: Grey iron casting per ASTM A 48-03, heavy duty, with word "DRAIN" on cover. Letter size shall be 2 inches. Frame and cover shall conform to the

Owner's representative standard, unless otherwise noted on the Drawings or directed by the Owner's representative.

B. Masonry Units

1. Brick shall conform to "Sewer Brick (Made from Clay or Shale)", ASTM C 32-04, Grade MS or "Building Brick" (Solid Masonry Units Made from Clay or Shale)", ASTM C 62-04, Grade SW.
2. Concrete block shall be solid block and shall conform to the "Specifications for Concrete Masonry Units for Construction of Catch Basins and Manholes," ASTM C 139-03, latest issue.
3. Mortar shall be in conformance with ASTM C 270-04a, Type M. The mortar shall be composed of Portland cement, hydrated lime, and sand, in the proportions of 1-part cement to ¼-part hydrated limit to 3½-parts sand (by volume).
4. Cement shall be Type I or II Portland Cement conforming to ASTM C 150-04, Standard Specification for Portland Cement. Where masonry is exposed to salt water, Type II shall be used.
5. Hydrated lime shall be Type S conforming to ASTM C 207-04.
6. Sand for masonry mortar shall conform to the gradation requirements of ASTM C 144-03.
7. Wall thickness for units over 10 feet deep shall be 12 inches. Inside dimensions shall remain the same.

2.3 CATCH BASINS

A. Precast catch basins shall be manufactured in accordance with ASTM C 478-03a (4,000 psi minimum compressive strength), the size and depth shall conform to the Connecticut DOT standard detail, unless otherwise noted on the Drawings.

B. When approved by the Owner's representative, catch basins may be constructed with brick or concrete block walls and poured reinforced concrete bases as an alternative to precast concrete units.

C. Brick and concrete block and other materials shall conform to Section 2.2B of these specifications.

D. Cast iron frames and grates for precast concrete units shall conform to the Connecticut DOT standard detail, unless otherwise noted on the Drawings or directed by the Owner's representative.

E. Catch basin traps shall conform to Neenah **Model R-3701**, LeBaron Oil and Grease Trap **Model L-219**, or Neenah **Model R-3707**, or approved equivalent.

2.4 STORMWATER CHAMBERS

A. Chambers shall be Cultec **150 XLHD** or approved equal.

B. Chambers shall be manufactured from virgin polypropylene or polyethylene resins tested using ASTM standards.

C. Chambers shall be designed in accordance with ASTM F 2787, standard practice for structural design of thermoplastic corrugated wall stormwater collection chambers.

D. Chamber rows shall provide continuous, unobstructed internal space with no internal support panels.

E. The structural design of the chambers, the structural backfill, and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD bridge design specifications, Section 12.12 are met for 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO design truck with consideration for impact and multiple vehicle presence.

F. Chambers shall be produced at an iso 9001 certified manufacturing facility.

G. All design specifications for chambers shall be in accordance with the manufacturer's latest design manual.

2.5 HYDRODYNAMIC SEPARATOR

A. The hydrodynamic separator shall be Stormceptor **STC 900**, or approved equal, conforming to the following requirements:

1. General: The separator shall be circular and constructed from pre-cast concrete circular riser and slab components. The internal fiberglass insert shall be bolted and sealed watertight inside the reinforced concrete component. The separator shall be capable to be used as a bend or junction structure within the stormwater drainage system.
2. Precast Concrete Sections: All precast concrete components shall be designed and manufactured to a minimum live load of AASHTO HS-20 truck loading or greater based on local regulatory specifications.
3. Joints: The concrete joints shall be water-tight and meet the design criteria according to ASTM C 443. Mastic sealants or butyl tape are not an acceptable alternative.
4. Frame and Cover: The frame and cover shall include an indented top design with lettering of the unit’s name cast into the cover to allow for easy identification in the field.
5. Concrete: All reinforced concrete components shall be manufactured according to local specifications and shall meet the requirements of ASTM C 478.
6. Fiberglass: The fiberglass portion of the water treatment device shall be constructed in accordance with the following standard: ASTM D 4097: Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks.
7. Inspection: All precast concrete sections shall be inspected to ensure that dimensions, appearance, and quality of the product meet local specifications and ASTM C 478

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. As soon as the excavation is completed to the normal grade of the bottom of the trench, the Contractor shall immediately place the bedding material in the trench. Then the pipe shall be firmly bedded in the compacted bedding material to conform accurately to the lines and grade indicated on the Drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer’s instructions.

C. Notch under pipe bells and joints, where applicable to provide for uniform bearing under entire length of pipe.

D. Excavation, backfilling, and compaction shall be as specified in Section 312000 “Earth Moving” of these Specifications.

E. Maintain optimum moisture content of bedding material to attain required compaction density.

3.2 MANHOLES AND CATCH BASINS

A. Manholes and Catch Basins shall be constructed at the locations and to the lines, grades, and dimensions noted on the Drawings, or as required.

B. Precast concrete construction shall be done in a manner to ensure watertight construction and all leaks in precast concrete shall be sealed. If required, precast concrete shall be repaired or replaced to obtain watertight construction.

C. Concrete barrels and cones shall be precast concrete sections.

1. Bases shall be either precast with a barrel integrally cast with the base, or poured concrete suitably shaped by means of accurate bell-rung forms to receive the barrel sections. Manhole invert channels in manholes shall be formed in concrete.
2. Precast manholes shall have an adjustment ring at the top of the cone to permit the frame and cover to meet the finished surface. This shall consist of courses of brick or reinforced grading rings not to exceed 11 inches.

D. Stubs shall be short pieces cut from the bell ends of the appropriate size and class of pipe. Concrete stubs shall be plugged with brick masonry unless otherwise directed.

E. Manhole inverts shall conform accurately to the size of the adjoining pipes.

1. Manhole inverts shall be constructed of concrete developing 3,500 psi with the concrete being placed to the spring line of the pipe form.
2. Smooth plastic pipe, matching the dimension of the outlet pipe, shall be used to form the invert.
3. Side inverts and main inverts, where the direction changes, shall be laid out in smooth curves of the longest possible radius, which is tangent, within the manhole, to the centerline of adjoining pipelines.
4. Invert shelves shall be graded to provide a 1-inch per 1-foot wash from the manhole walls.

F. Manhole sections shall contain manhole steps accurately positioned and embedded in the concrete when the section is cast. Precast-reinforced concrete manhole sections shall be set so as to be vertical and with sections and steps in true alignment.

G. All holes in sections used for their handling shall be thoroughly plugged with rubber plugs, made specifically for this purpose, or with mortar. The mortar shall be 1-part cement to 1½-parts sand, mixed slightly damp to the touch (just short of “balling”), hammered into the holes until it is dense and an excess of paste appears on the surface, and then finished smooth and flush with the adjoining surfaces.

H. The Contractor may, as an alternate to suitable non-shrink mortar joints, use premolded elastomeric-sealed joints for pipe into precast manhole bases.

1. All materials, accessories and construction methods used in making the joints shall be supplied or approved by the manufacturer of the premolded elastomeric-sealed joint.

I. Openings for pipe and materials to be embedded in the walls of the base for these joints shall be cast in the base at the required locations during the manufacturer of the base. Incorrectly cast and patched pipe openings will be rejected.

J. Manhole risers and tops shall be installed using approved “o-ring” type, neoprene gaskets for sealing joints. Units shall be installed level and plumb. Water shall not be permitted to rise over

newly made joints nor until after inspection as to their acceptability. All jointing shall be done in a manner to insure water tightness.

K. Openings shall be provided in the risers to receive entering pipes. These openings may be made at the place of manufacture. The openings shall be sized to provide a uniform 1-inch maximum annular space between the outside of the pipe wall and the opening in the riser. After the pipe is in position, the annular space shall be solidly filled with non-shrink mortar. Care shall be taken to assure that the openings are located to permit setting of the entering pipe at its correct elevation as indicated.

L. Openings, which are cut in the risers in the field, shall be carefully made by coring so as not to damage the riser. Damaged risers will be rejected and shall be replaced at no additional expense to the Owner.

M. Where required by the Drawings, a slot and opening shall be cast in the catch basin wall suitable for mounting the cast iron hood and discharge pipe. The hood hinge may be furnished to the precast supplier by the Contractor for incorporation into the casting during manufacture.

3.3 BRICK MASONRY

A. Brick masonry construction shall be done in a manner to ensure watertight construction and all leaks in brick masonry shall be sealed. All workmanship shall conform to the best standard practice and all brick masonry shall be laid by skilled workmen.

B. All beds on which masonry is to be laid shall be cleaned and wetted properly. Brick shall be wetted as required and shall be damp but free of any surface water when placed in the Work. Bed joints shall be formed of a thick layer of mortar, which shall be smoothed or furrowed slightly. Head joints shall be formed by applying to the brick to be laid a full coast of mortar on the entire end, or on the entire side as the case requires, and then shoving the mortar covered end or side of the brick tightly against the bricks laid previously. The practice of buttering at the corners of the brick and then throwing the mortar or scrapings in the empty joints will not be permitted. Dry or butt joints will not be permitted. Joints shall be uniform in thickness and shall be approximately 1¼-inch-thick.

C. Brickwork shall be constructed accurately to dimensions and brickwork at top of manholes shall be to the dimensions of the flanges of the cast-iron frames.

D. Joints on the inside face of walls shall be tooled slightly concave with an approved jointer when the mortar is thumbprint hard. The mortar shall be compressed with complete contact along the edges to seal the surface of the joints.

E. All castings to be embedded in the brickwork shall be accurately set and built-in as the Work progresses. Cast-iron frames and manhole covers shall be well bedded in mortar and accurately set to finished graded indicated or as directed.

F. Water shall not be allowed to flow against brickwork or to rise on the masonry for 60 hours after it has been laid, and any brick masonry damaged in this manner shall be replaced as directed at no additional expense to the Owner. Adequate precautions shall be taken in freezing weather to protect the masonry from damage by frost.

3.4 CONCRETE MASONRY UNITS

A. Concrete masonry unit construction shall be soaked in water before laying. As circular concrete block walls are laid-up, the horizontal joints and keyways shall be flushed full with mortar. As rectangular blocks are laid-up, all horizontal and vertical joints shall be flushed full with mortar.

Plastering of the outside of block structures will not be required. The joints in precast units shall be wetted and completely mortared immediately prior to setting a section. No structure shall be backfilled until all mortar has completely set.

3.5 MANHOLE STEPS

A. Placement of steps into the precast walls shall be by a proven method as recommended by the supplier of the precast manhole sections. Details of the steps and method of placement shall be submitted for approval.

B. Plastic steps shall be placed into the wet concrete wall during manufacture or if designed for press fit installation shall be driven into a wall opening according to the manufacturer's specifications. Steps shall not be mortared into place after the concrete has set.

C. All manholes, catch basins, lawn inlets, etc., which are in excess of 5 feet in depth, shall be constructed with standard aluminum steps, spaced at 12-inch on center.

3.6 DROP INLETS

A. Drop inlets shall be constructed to the lines, grades, dimensions, and design at the locations indicated on the plans or as required.

B. The Owner's representative may permit brick or concrete masonry construction. If this alternate is being employed, construction shall be done in accordance with Paragraphs 3.3 or 3.4 in this Section.

3.7 STORMWATER CHAMBERS

A. The installation of the chambers shall be in accordance with the manufacturer's latest installation instructions.

3.8 HYDRODYNAMIC SEPARATOR

A. The hydrodynamic separator shall be installed at the location shown on the Drawings in accordance with the manufacturer's standard installation requirements.

B. The hydrodynamic separator shall be constructed in accordance with the details shown on the Drawings.

C. A representative of the hydrodynamic separator manufacturer and the design engineer must inspect the installation after the contractor has installed the separator to ensure that the separator was installed as designed.

3.9 CASTINGS

A. Cast-iron frames for grates and covers shall be well bedded in cement mortar and accurately set to the grades indicated or as directed. The frames shall be encased with a thick cement-mortar collar around the entire perimeter of the frames.

B. All voids between the bottom flange shall be completely filled to make a watertight fit. A ring of mortar, at least 1-inch-thick and pitched to shed water away from the frame shall be placed over and around the outside of the bottom flange. The mortar shall extend to the outer edge of the masonry all around its circumference and shall be finished smooth. No visible leakage will be permitted.

C. Structures within the limits of bituminous concrete pavement shall be temporarily set at the elevation of the bottom of the binder course or as ordered. After the binder course has been compacted, these structures shall be set at their final grade. Backfill necessary around such structures after the binder course has been completed shall be made with Class A concrete unless otherwise ordered.

3.10 CLEANING

A. At the completion of the Work, clean all piping, structures, and open drainage courses, through and to which water from this construction is directed, to the satisfaction of the Owner's representative.

3.11 AS-BUILT DRAWINGS

A. As work progresses, record on two (2) sets of plans all changes and deviations from the Contract Drawings in size, line, and grade. Make sufficient measurements to locate the Work completed. Record on the plans, any uncharted locations of utilities encountered during installation of the storm drainage system (denote utility type, size, material, etc.). Deliver the plans to the Owner's representative.

END OF SECTION 334100

SECTION 334300 – SITE WATER UTILITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and other Division 1 Specification Sections, apply to this Section.

B. Installation of fire protection piping shall comply with “NFPA 24, Private Fire Service Mains and their Appurtenances” and “Factory Mutual Data Sheet 3-10, Fire Service Mains”.

1.2 DESCRIPTION

A. This Section specifies requirements for the proposed water system pipe, fittings, appurtenances and services.

B. The work includes:

1. Furnishing and installation of new domestic water piping, valves and valve boxes, pipe fittings, anchors, thrust blocks, required accessories and connections to existing water systems.

2. Disinfection and testing of the system.

1.3 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements, which affect the Work in this Section. Other Specification Sections, which directly relate to the Work of this Section include, but are not limited to, the following:

1. Section 312000 – Earth Moving

2. Section 334200 – Sanitary Sewers

3. Section 321314 - Site Cast-in-Place Concrete

1.4 COORDINATION WITH THE LOCAL WATER AUTHORITY’S REPRESENTATIVE

A. The Local Water Authority shall be notified prior to starting construction for a connection to, or extension of, any portion of the domestic or fire protection water systems.

B. The closing of valves necessary for making connections with the existing water systems will be done by the Contractor with the assistance of the Local Water Authority. Sufficient notice shall be given the Local Water Authority for a planned connection. No allowance will be made for any delay in the closing of valves. A 48-hour notice shall be given to adjacent buildings/residences affected by the shutdown, and shall be done by the Contractor under the direction of the Local Water Authority’s representative. The Local Water Authority’s representative may require the work be done at night during the low use time period.

C The Contractor shall pay all costs for all testing, flushing, chlorinating, laboratory analyses, sampling, water supply and connection charges as well as any charges associated with the use of a Local Water Authority “Approved” Contractor to perform any or all of the required work.

1.5 SUBMITTALS

A. Shop Drawings

1. Submit Shop Drawings or descriptive literature, or both, showing dimensions, joints and other details of all pipe materials and appurtenances to be furnished. Shop Drawings shall be submitted to the Local Water Authority for approval prior to ordering materials.

B. As-Built Drawings

1. Submit 3 copies of As-Built Drawings upon completion and acceptance of work.

2. As-Built Drawings shall be complete and shall indicate the true measurements and locations, horizontal and vertical, of all new construction. As-Built Drawings shall include a minimum of three ties to each gate valve box from fixed permanent objects. As-Built Drawings shall also contain the location of service lines and any additional information required by the Local Water Authority’s representative, and shall be stamped with the seal of a Licensed Land Surveyor or Licensed Professional Engineer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Storage of pipe, fittings, valves, hydrants and other water line appurtenances on the site shall be in accordance with the manufacturer's recommendations, subject to the approval of the Owner’s representative.

B. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, fittings, valves, hydrants, and other water line appurtenances. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to pipe and fitting coatings shall be repaired as directed by the Local Water Authority’s representative.

C. Pipe, fittings, valves, hydrants and other water system appurtenances which are defective from any cause, including damage caused by handling, and determined by the Owner’s representative as non-repairable, shall be unacceptable for installation and shall be replaced at no cost to the Owner.

D. Pipe, and all water system appurtenances that are damaged or disturbed through any cause prior to acceptance of the work shall be repaired, realigned or replaced as required by the Local Water Authority’s representative at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Drawings are diagrammatic only and are intended to indicate the extent, but not all details, of the system, which shall be constructed. All materials and fittings are not shown; but the Contractor shall furnish and install all materials and fittings required for the complete system.

B. All work, materials and fittings shall comply with the latest edition of the Local Water Authority Standard Details. In the event of a conflict between these specifications, the project drawings and details and the Local Water Authority's Standard Details, the Authority's Standard details shall prevail.

2.2 WATER SERVICE

A. Services two inches or smaller shall be copper water tubing, Type K, for underground water service and shall be in accordance with AWWA C800-01.

B. Water service fittings, including couplings and adapters, check valves and service saddles shall be in conformance with AWWA C800-01, Underground Service Line Valves and Fittings.

C. Joints in copper tubing shall be made with three part compression couplings or an approved equal.

D. Services 3 inches and greater shall be ductile iron pipe.

2.3 BACKFLOW PREVENTERS

As required by the Local Water Authority's representative. Refer to Plumbing Specifications.

2.4 PRESSURE REDUCING VALVES

None Required

2.5 METERS

As required by the Local Water Authority's representative. Refer to Plumbing Specifications.

PART 3—EXECUTION

3.1 GENERAL

A. All water pipes, fittings, valves, hydrants and other appurtenances shall be installed at the locations as shown on the Drawings and/or directed by the Local Water Authority's representative.

The proposed location and vertical alignment may be altered to avoid conflicts with existing and proposed utilities, as approved by the Local Water Authority's representative.

3.2 LAYING COPPER WATER SERVICE PIPE

A. Copper pipe and fittings shall be installed in accordance with the requirements of AWWA C600-99.

B. Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a trench prepared and maintained in accordance with Section 312000, Earth Moving. The type of materials to be used in bedding and backfilling and method of placement shall conform to the requirements of Section 312000, Earth Moving and the details.

C. All pipe shall be clean before laying. When installation is stopped for any reason, the open ends of the pipe shall be closed by watertight plugs or other approved means. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe has been eliminated.

D. Fittings, in addition to those shown on the Drawings, shall be provided if required to avoid utility conflicts.

E. The pipe shall be laid with a minimum cover of 4.5-feet below finished grade, unless otherwise required by the Southeastern CT Water Authority's representative.

3.3 WATER / SANITARY SEWER SEPARATION

When a sewer pipe crosses above or below a water pipe, the following procedures shall be utilized. The Contractor shall comply with these following procedures:

A. Relation to Water Mains

1. *Horizontal Separation*: Whenever possible, sewers shall be laid below, and at a minimum at least 10 feet, horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if:

   a. It is laid in a separate trench, or if

   b. It is laid in the same trench with the water main located at one side on a bench of undistributed earth, and if

   c. In either case, the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

2. *Vertical Separation*: Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

   When it is impossible to obtain horizontal and/or vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical-joint cement lined

ductile iron pipe, or other equivalent based on watertightness and structural soundness. Both pipes shall be pressure tested by an approved method to assure watertightness, or both pipes shall be encased in concrete.

3.4 PRESSURE TESTING

A. Hydrostatic and leakage test shall be conducted in accordance with AWWA Standard C600-99 and C900-97, and as directed by the Local Water Authority's representative. Testing shall be conducted by a certified Independent Water Testing Company.

B. Conduct pipe tests after concrete thrust blocks have cured to the required 3000-psi strength. Fill pipe 24 hours prior to testing, and apply test pressure to stabilize system. Use only potable water.

C. Prior to pressure testing, the entire pipe section shall be flushed to remove any rocks or debris, which may have inadvertently entered the pipe during construction.

D. Once the pipe section has been filled at normal pressure and all entrapped air removed, the Contractor shall raise the pressure to 150 psi or two times the operating pressure (whichever is greater) by a special pressure pump, taking water from a small tank of proper dimensions for satisfactorily measuring the rate of pumping into the pipe. This pressure shall be maintained for a minimum of 2 hours, during which time the line shall be checked for leaks. Measured rate of water leakage shall not exceed the allowable leakage listed below.

Allowable leakage in gallons per hour, per 1,000 feet of exterior pipeline:

Test Pressure	Nominal Pipe Diameter [inches]					
	4	6	8	10	12	16
150 psi	0.36	0.55	0.74	0.92	1.10	1.47

Interior piping in vaults, buildings, etc. shall have zero leakage.

Should leakage exceed this rate, the Contractor shall immediately locate the leak or leaks and repair them. Pipe will be accepted only when leakage is zero, or less than the allowable amount. Approval does not absolve the Contractor from responsibility if leaks develop later within the period of warranty.

3.5 Disinfection

A. Before being placed in service, all new water pipe shall be chlorinated in accordance with AWWA C651-99 Standard for Disinfecting Water Mains or the Local Water Authority's requirements/regulations, whichever is the more stringent.

B. The location of the chlorination and sampling points will be determined by the Local Water Authority's representative in the field. Taps for chlorination and sampling shall be installed by the Contractor. The Contractor shall uncover and backfill the taps as required.

C. The pipe section being disinfected shall be flushed to remove discolored water and sediment from the pipe. A 25-mg/l chlorine solution in approved dosages shall be inserted through a tap at one end while water is being withdrawn at the other end of the pipe section. The chlorine concentration in the water in the pipe shall be maintained at a minimum 25-mg/l available chlorine during filling. To assure that this concentration is maintained, the chlorine residual shall be measured at regular intervals in accordance with procedures described in Standard Methods and AWWA M12, Simplified Procedure for Water Examination [Section K].

D. During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the pipe supplying the water. Chlorine application shall not cease until the entire pipe section is filled with chlorine solution. The chlorinated water shall be retained in the pipe for at least a twenty-four hour period. The treated water shall contain chlorine residual throughout the length of the pipe section as indicated in AWWA C651-99.

E. Following the chlorination period, all treated water shall be flushed from the pipe section and replaced with water from the distribution system. Prior to disposal of treated water the Contractor shall check with local authorities to determine if the discharge will cause damage to the receiving body or sewer and, if required, the Contractor shall neutralize the chlorinated water in accordance with AWWA recommendations. Bacteriological sampling and analysis of the replacement water may then be made by the Contractor in full accordance with AWWA C651-99. A minimum of three samples shall be taken by the Contractor at locations directed by the Local Water Authority's representative along the length of water pipe being chlorinated and sent to a State approved private laboratory for analyses. The Contractor shall rechlorinate if the samples show presence of coliform, and the pipe section shall not be placed in service until all of the repeat samples show no presence of coliform.

F. Furnish two copies of a Certificate of Disinfection Report to the Owner's representative and one copy to the Local Water Authority's representative.

G. The Contractor shall pay all costs for all testing, flushing, chlorinating, laboratory analyses, sampling, water supply and connection charges as well as any charges associated with the use of a Local Water Authority "Approved" Contractor to perform any or all of the required work.

END OF SECTION 334300

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

GEOTECHNICAL ENGINEERING REPORT
MONTVILLE ANIMAL SHELTER
222 MAPLE AVENUE
MONTVILLE, CONNECTICUT

Prepared for:

e2 Engineers
488 Montauk Avenue
New London, Connecticut 06320

Prepared by:

Down To Earth Consulting, LLC
27 Siemon Company Drive - Suite No. 363 West
Watertown, Connecticut 06795

File No. 0020-126.00
September 2023

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

September 20, 2023
File No. 0020-126.00

Scott Erricson, P.E.
e2 Engineers
488 Montauk Avenue
New London, Connecticut 06320

Re: Geotechnical Engineering Report
Montville Animal Shelter
222 Maple Avenue
Montville, Connecticut

Dear Mr. Erricson:

Down To Earth Consulting, LLC (DTE) is pleased to submit this geotechnical engineering report for the proposed Montville Animal Shelter building that will be located at 222 Maple Avenue in Montville, Connecticut. We appreciate this opportunity to work with you. Please call if you have any questions.

Sincerely,

Down To Earth Consulting, LLC

Thomas J. Orszulak, P.E.
Project Manager

Daniel F. LaMesa, P.E.
Reviewer/Principal

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

This report provides geotechnical design and construction recommendations for the proposed Montville Animal Shelter building that will be located at 222 Maple Avenue in Monteville, Connecticut. Refer to Figures 1 and 2 (in Appendix 1) for the approximate site and proposed building location, respectively.

Our geotechnical engineering services included: reviewing project plans, observing test borings, performing in-situ hydraulic conductivity tests, characterizing subsurface conditions within the project limits, performing geotechnical engineering analyses, and providing geotechnical design and construction recommendations for the proposed building. Our services were performed in accordance with our August 14, 2023 proposal (revised September 1, 2023). Our project understanding is based on the drawing titled *Schematic Site & Utility Plan, Montville Animal Shelter,* Sheet 1 of 1, prepared by Donald W. Smith, Jr., P.E. dated November 22, 2022.

Our recommendations are based on allowable stress design methods and the 2021 International Building Code with 2022 Connecticut Supplements (Building Code).

2.0 BACKGROUND

The Site is bordered by Maple Avenue to the west, residential properties to the north, and Montville Public Works Department metal buildings to the east and south. The Oxoboxo Brook is located approximately 600 feet east of the proposed building. The existing conditions of the site consist of a generally flat, grassy area with ground surface elevations ranging between about El. 172 and 174.

We understand that the project consists of constructing a new, approximately 3,200 square-foot animal shelter building. The proposed building will have concrete foundations with a slab-on-grade at El. 174. Foundation and slab loads were not available at the time this report was prepared. Associated parking lots, sidewalks, patios, drainage structures, and landscaped areas will also be constructed.

3.0 SUBSURFACE DATA

3.1 GENERAL SITE GEOLOGY

Published surficial and bedrock geological map data (*1:24,000 scale, Geologic Map of the Montville Quadrangle, Connecticut, Richard Goldsmith, 1962, and 1:250,000 scale, Bedrock Geological Map of Connecticut, John Rodgers, 1985*) was reviewed. The Site surficial material is mapped as a variable mixture of gravel, sand, and silt (Glacial Stream Deposit). The underlying bedrock is classified as light pink to gray, medium to coarse-grained granitic gneiss (Hope Valley Alaskite Gneiss).

3.2 TEST BORINGS

We observed and logged two test borings (B-1 through B-2) drilled by our subcontractor Associated Borings Company, Inc. on September 12, 2023. Boring locations are depicted on Figure 2 (Appendix 1) and the logs are included in Appendix 2. Borings were located in the field by taping/pacing from existing site features and should be considered approximate. The ground

surface elevation at each boring was scaled from the project grading plan (provided by others) and should also be considered approximate.

The borings were performed to explore the general soil, bedrock, and groundwater conditions in the project area. Hollow-stem auger methods were used to advance Borings B-1 and B-2 to depths of approximately 12 and 17.5 feet below existing grades, respectively. All test borings were terminated upon auger refusal on possible Bedrock or boulders within natural soil deposits.

Representative soil samples were obtained for soil classification by split barrel sampling procedures in general accordance with ASTM D-1586. The split-spoon sampling procedure utilizes a standard 2-inch O.D. split-barrel sampler that is driven into the bottom of the boring with a 140-pound hammer falling a distance of 30 inches. The number of blows required to advance the sampler the middle 12-inches of a normal 24-inch penetration is recorded as the Standard Penetration Resistance Value (N). The blows (i.e., “N-Value”) are indicated on the boring logs at their depth of occurrence and provide an indication of the relative consistency of the material.

Groundwater levels were measured using a weighted tape in open drill holes or inferred from wet soil samples during drilling.

3.3 IN-SITU HYDRAULIC CONDUCTIVITY TESTS

We performed falling head hydraulic conductivity tests at a proposed infiltration basin location northeast of the proposed building location identified as I-1 (refer to Figure 2). The tests were location I-1 was advanced to a depth of approximately 7 feet below grade. Using the measured data, we estimated a hydraulic conductivity of about 20 to 21 inches per hour. Permeability rates will vary with location and depth, thus, an appropriate factor of safety should be applied to the estimated rates during design. The test results and hydraulic conductivities are included in Appendix 3.

4.0 SUBSURFACE CONDITIONS

4.1 SUBSURFACE PROFILE

The subsurface conditions from the test borings generally consisted of an approximate 6-inch surficial layer of Topsoil over Uncontrolled Fill, Silt, and Gravelly Sand Deposits. Borings B-1 and B-2 ended due to refusal on possible Bedrock or boulders within the Gravelly Sand Deposits.

The following is a more detailed description of the primary subsurface materials encountered at the site.

4.1.1 Fill

Uncontrolled Fill was encountered at each boring location beneath the surficial layer of Topsoil and extended about 5 to 6 feet below existing grades within the proposed building footprint (Borings B-1 and B-2). The Fill generally consisted of loose to dense, dark brown to brown, fine to coarse sand with varying amounts of fine to coarse gravel and silt. The thickness, character, and consistency of the Fill will vary between boring locations.

4.1.2 Silt

An approximate 2 to 4-foot-thick Silt layer was encountered below the Fill at Borings B-1 and B-2. The Silt generally consisted of very loose to medium dense, dark brown silt with little to and (10 to 50%) amounts of fine to coarse sand and trace (0 to 5%) amounts of organics. Samples of the Silt layer were not recovered at Boring B-1, and the layer was inferred based on drilling action and auger spoils during drilling.

4.1.3 Gravelly Sand

A natural Gravelly Sand deposit was encountered below the Silt at Borings B-1 and B-2 at depths of approximately 8 and 9 feet below existing grades, respectively (about El. 166 and 164, respectively). The Gravelly Sand deposit generally consisted of medium dense to very dense, brown, fine to coarse sand with some to and (20 to 50%) amounts of fine to coarse gravel and trace to little (0 to 20%) amounts of silt.

4.2 GROUNDWATER

Groundwater was encountered at Borings B-1 and B-2 at depths of about 8.3 and 9.3 feet below existing grades, respectively (El. 165.7 and 163.7, respectively). Groundwater was not encountered at the I-1 location. Groundwater levels measured during drilling may not have had sufficient time to stabilize and should be considered approximate. Groundwater levels will vary depending on factors such as temperature, season, precipitation, construction activity, and other conditions, which may be different from those at the time of these measurements.

5.0 GEOTECHNICAL RECOMMENDATIONS

We offer the following geotechnical design recommendations based on the subsurface conditions encountered at the site, available project information, and proposed construction.

5.1 FOUNDATIONS

5.1.1 Foundation Type and Bearing Strata

We recommend supporting the proposed buildings on conventional, shallow spread footings. The footings should bear on undisturbed natural Gravelly Sand Deposits or on Structural Fill (hereinafter specified as Compacted Granular Fill, CGF) over natural Gravelly Sand Deposits.

The existing Topsoil, Fill, and/or Silt should be completely removed from foundation areas and replaced with CGF. Actual bottom of unsuitable soil elevations will vary across the site and must be verified during construction excavation by a DTE representative. When CGF is used beneath the footings (e.g., in backfill areas), we recommend that it be placed one foot beyond the edge of the footings and at a one horizontal to one vertical slope away and down from the bottom outside edge of the footings. Crushed Stone can be used in place of CGF as it is much easier to compact.

Other foundation systems such as piles or ground improvement can also be considered if they are found to be more economical than over-excavating and replacing the unsuitable bearing soils. DTE should be consulted if another foundation system would like to be considered.

5.1.2 Footing Levels and Sizes

Exterior footings (and footings in unheated areas) should be constructed at a minimum frost depth of 42-inches below proposed site grade. Interior footings, in heated areas, should be constructed at a minimum depth of 18-inches below proposed top of slab-on-grade level. The minimum footing width should be 2 feet.

5.1.3 Allowable Bearing Pressures and Settlement Estimates

We recommend a maximum allowable design bearing pressure of four kips per square foot (ksf) for footings bearing on the recommended bearing materials. Based on the recommended bearing strata and anticipated loads, we anticipate that footings will undergo less than one inch of total settlement and less than a half inch of differential settlement. Settlements will occur as the loads are applied and are expected to be complete at the end of construction.

DTE should be provided the final foundation loads and geometries once they are available to confirm the above recommended bearing capacity and settlement estimates.

5.1.4 Drainage

We recommend the use of a perimeter footing drain consisting of 4-inch diameter perforated PVC pipe, surrounded by 4-inches of Crushed Stone, wrapped in non-woven filter fabric. Cleanouts should be installed in the direction of flow at the beginning of piping runs and consist of 45-degree elbows (90-degree elbows should not be allowed). The drains should be gravity drained to the site drainage system or daylight with a rodent screen at the end of pipe(s).

5.2 SLAB

We recommend supporting the proposed slab on an 8-inch-thick layer of compacted Crushed Stone over existing Fill that has been improved using the following procedure:

1. Remove a minimum of 24-inches of Fill from below the bottom of proposed slab (including hunches if present) and densify the remaining Fill with a minimum of six passes with a 20-ton vibratory drum roller having a minimum dynamic force of 6,000 lbs. per foot of drum width. Areas exhibiting instability shall receive additional compaction and/or be over-excavated and replaced with CGF at the direction of a DTE representative.

2. Install a layer of Tenser TriAx TX140 (or equivalent) geogrid over the densified Fill. Geogrid should be overlapped a minimum of four inches at seams.

3. Backfill up to the bottom of 8-inch Crushed Stone Layer with CGF placed in maximum 8-inch lifts and compacted to a minimum in-place dry density of 95-percent as per ASTM D1557.

The above Fill improvement procedure must be observed and documented by a DTE representative and may have to be modified (e.g. additional excavation) if the soils are observed to contain appreciable deleterious materials (e.g. organics) or are too unstable during densification. Areas with thick Fill deposits may require more than 24-inches of over excavation to limit the existing Fill to about 4 feet thick below the slab. If a DTE representative is not present to observe the Fill improvement, we recommend completely removing the Fill below the 8-inch Crushed Stone Layer and replacing it with CGF compacted to a minimum in-place dry density of 95-percent as per ASTM D1557.

When CGF and Crushed Stone are used beneath the concrete slab, we recommend that it be placed one foot beyond the edge of the pads and wall and at a one horizontal to one vertical slope away and down from the bottom outside edge of the slab. We recommend a subgrade modulus of 150 pci.

5.3 RETAINING WALLS

5.3.1 Backfill and Drainage

We recommend backfilling earth retaining structures with compacted Sand and Gravel and installing footing drains. The drains should consist of 4-inch diameter perforated PVC pipe, surrounded by 6-inches of Crushed Stone, wrapped in non-woven filter fabric. Footing drain inverts should be set flush with or up to 6-inches above bottom of footing levels. The drains should be gravity drained to daylight, site drainage system, or sump pits with pumps (if needed).

5.3.2 Lateral Earth Pressures

Walls that are free to rotate at the top and are not braced should be designed to resist an equivalent active static horizontal fluid earth pressure equal to 35 pcf (based on $\varphi' = 34°$, $c = 0$, $K_a = 0.28$, $\delta = 17°$, and $\gamma = 125$ pcf). Braced retaining walls should be designed to resist an equivalent at-rest static horizontal fluid earth pressure equal to 56 pcf (based on $\varphi' = 34°$, $c = 0$, $K_o = 0.44$, and $\gamma = 125$ pcf). This assumes level backfill and no unbalanced hydrostatic pressures, seismic forces, or surcharges from traffic, foundations, or other external loads. We recommend using a minimum surcharge load of 250 psf for walls exposed to traffic loading. Due to the limited expected wall movement and depth of footings, we do not recommend the use of passive earth pressures against the base of walls.

The minimum factors of safety for sliding and overturning of retaining walls under static loads should be 1.5 and 2, respectively. If the stability or factor of safety against sliding of the building foundation walls depend on additional resistance of the completed structure, the structural engineer should identify on the plans when the walls may be backfilled.

For mechanically stabilized modular block retaining walls, factors of safety and designs should be in accordance with the manufacturer's recommendations and the latest edition of the Design Manual for Segmental Retaining Walls as published by the National Concrete Masonry Association (NCMA). Modular block wall designers should perform global stability analyses of the proposed walls and slopes systems. These analyses should include the surcharge loads from roads, buildings, and other proposed structures. DTE should be provided these analyses for review and approval prior to wall construction.

5.3.3 Resistance to Lateral Loads

The lateral load on retaining wall footings can be resisted by friction at the base of the footings in contact with the above recommended bearing materials. We recommend a maximum coefficient of friction of 0.5 between foundations and soil. Passive pressures against shallow footings should be ignored in calculating lateral load resistance.

5.4 SEISMIC DESIGN

The site class is “D” per the Building Code. Based on the standard penetration test results, visual soil classification, and design peak ground acceleration at this locale, the site soils are not susceptible to liquefaction.

6.0 MATERIALS RECOMMENDATIONS

6.1 COMPACTED GRANULAR FILL

Compacted Granular Fill (CGF) for use as structural fill below footings and other structures shall consist of inorganic soil free of clay, loam, ice and snow, tree stumps, roots, and other organic matter; graded within the following limits:

Sieve Size	Percent finer by weight
4-inches	100%
No. 10	30 - 100
No. 40	10 - 90
No. 200	0 - 12

6.2 SAND AND GRAVEL

Sand and Gravel for use as retaining wall backfill shall consist of hard, durable sand and gravel; free of ice, clay, shale, roots, sod, rubbish, and other organic matter; graded within the following limits:

Sieve Size	Percent finer by weight
2-inches	100%
1/2-inch	50 - 85
No. 4	40 - 75
No. 40	10 - 35
No. 200	0 - 5

6.3 CRUSHED STONE

Crushed Stone for use around drains or below foundations and slabs shall consist of sound, tough, durable, rock that is graded within the following:

Sieve Size	Percent finer by weight
5/8-inches	100%
1/2-inch	85 - 100
3/8 inch	15 - 45
No. 4	0 - 15
No. 8	0 - 5

6.4 GEOTEXTILE FABRIC

Geotextile fabric placed around crushed stone pipe bedding or used as a separation fabric for crushed stone and soil material should meet the following criteria:

Property	Criteria	Test Method
Grab Strength	min. 80lbs	ASTM D4632
Static (CBR) Puncture	min. 50lbs	ASTM D6241
Trapezoid Tear	min. 25lbs	ASTM D4533
Apparent Opening Size	No. 70-100 U.S. Sieve Size	ASTM D4751

Fabric should be needle-punched non-woven material. Seams should be overlapped a minimum of six inches. During stone placement, the stone drop height should not exceed three feet and equipment traffic should be kept off the fabric until at least 6 to 12 inches of material is placed.

6.5 PLACEMENT AND COMPACTION REQUIREMENTS

The required degree of compaction shall be based on a maximum dry density as determined by a Modified Proctor (ASTM D1557). The degree of compaction for fill placed in various areas shall be as follows:

Placement areas	Minimum degree of compaction
1. Below foundations and slabs	95%
2. Below utility trenches and pavement	92%
3. Against foundations, retaining walls, and slopes	92%
4. Landscaped areas	90%

Crushed stone is considered to be self-compacting, and would negate the need to run laboratory proctor testing and have field density testing of in-place lifts. The crushed stone should be plate compacted to “chink up” the working surface in lifts. We recommend placing Crushed Stone in maximum 12-inch lifts and compacting the lifts with a minimum of four passes with a vibratory plate compactor weight of a minimum of 1,000 pounds. Generalized loose lift thickness for granular fill and the minimum number of passes of compaction equipment are summarized on the table below. Specifications should require the contractor to adjust loose lift thicknesses as required to meet the required compaction requirements.

Compaction Method	Maximum Stone Size	Maximum Loose Lift Thickness		Minimum Number of Passes	
		Below Structures	Less Critical Areas	Below Structures	Less Critical Areas
Hand-operated vibratory plate or light roller in confined areas	4”	6”	8”	6	4
Hand-operated vibratory drum rollers weighing at least 1,000 lbs.	6”	8”	10”	6	4
Light vibratory roller, min. dynamic force 3,000 lbs. per ft. of drum width	6”	10”	14”	6	4
Medium vibratory roller, min. dynamic force 5,000 lbs. per ft. of drum width	8”	12”	18”	6	4
Large vibratory roller, min. dynamic force 8,000 lbs. per ft. of drum width	10”	16”	24”	6	4

The Contractor should reduce or stop drum vibration if pumping or weaving of the subgrade is observed, under the observation and direction of a qualified Geotechnical Engineer.

Extra care should be used when compacting adjacent to walls. Hand-operated rollers or plate compactors weighing not more than 250 pounds should be used within a lateral distance of 5 feet of walls. Where walls are buried on both sides, backfill and compaction should proceed on both sides of the wall so that the difference in top of fill on either side of the wall does not exceed 2 feet.

7.0 CONSTRUCTION RECOMMENDATIONS

7.1 FOOTING PREPARATION

The base of footing and slab excavations should be free of debris materials, water, ice, and loose and frozen soils prior placing CGF, Crushed Stone, or concrete. Should the materials at bearing level become disturbed, the affected materials should be removed prior to placing CGF, Crushed Stone, or concrete. Boulders encountered at the exposed foundation subgrade should be removed to a depth of at least 12 inches below bottom of footings. All existing structures (i.e. foundations, utilities, etc.) within the zones of influence of the proposed buildings footprints shall be removed in their entirety. Voids that result from boulder and existing structure excavations should be backfilled with CGF or Crushed Stone.

We recommend the use of smooth-edged excavator buckets (not back-bladed) to make the final excavations and placing and compacting a four-inch-thick layer of Crushed Stone over footing subgrades for protection.

The base of footing and slab subgrades should be proof-compacted with a minimum of six passes of a large vibratory roller having a minimum dynamic force of 3,000 pounds per foot drum width. Any weak or unstable areas identified should be over excavated and replaced with compacted CGF, at the direction of DTE. Vibrations should be discontinued if disturbance or weaving of the subgrade is observed.

Soil bearing surfaces below completed foundations and slabs should be protected against freezing before and after concrete placement. If construction is performed during winter weather, footings bearing on soil should be backfilled to a sufficient depth as soon as possible after they are constructed. Alternatively, insulating blankets or other measures should be used for protection against freezing.

7.2 TEMPORARY EXCAVATIONS

The Contractor is responsible for construction site safety and should be aware that slope height, slope inclination, and excavation depths should in no case exceed those specified in local, state, or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926).

The site soils are classified as OSHA Class “C” soil and can be cut at a maximum one vertical to one and a half horizontal (1V:1.5H) slope up to a maximum excavation depth of 20 feet. These maximum slope and excavation depths assume no surcharge load (i.e., stockpiles, construction equipment, traffic, etc.) at the top of the excavations or groundwater seepage. Slopes that are not fully dewatered should be no steeper than 3H:1V. As a safety measure, it is recommended that all vehicles and earth stockpiles be kept a lateral distance away from the edge of excavations at least equal to the slope height. Protect slope faces against the weather elements.

Care should be taken to not undermine the adjacent roads, sidewalks, and utilities. If excavations cannot be sloped in accordance with OSHA requirements or will undermine adjacent structures, temporary excavation support systems will be required. These systems should be chosen and installed by the contractor and designed by a Professional Engineer registered in the State of Connecticut.

7.3 TEMPORARY GROUNDWATER CONTROL

We expect that temporary groundwater/storm water control can largely be accomplished by means of shallow trenches and sumps and grading the excavation to low points. Dewatering should be performed as necessary to allow excavation and observation of the subgrades in the dry and to maintain a stable and dry bottom. In addition, constructing small temporary earth berms and grading to allow drainage away from the excavation is recommended to control surface water runoff. The construction dewatering system means and methods should be chosen by the contractor and designed by a Professional Engineer registered in the State of Connecticut. This should include providing a discharge water management plan that avoids endangering public health and nearby property and meets applicable local, state, and environmental regulations.

8.0 REVIEW OF FINAL DESIGN, PLANS, AND SPECIFICATIONS

When project plans and specifications are available they should be provided to DTE for review of conformance with our geotechnical recommendations. If any changes are made to the proposed structure, the recommendations provided in this report will need to be verified by DTE for applicability.

9.0 CONSTRUCTION QUALITY CONTROL

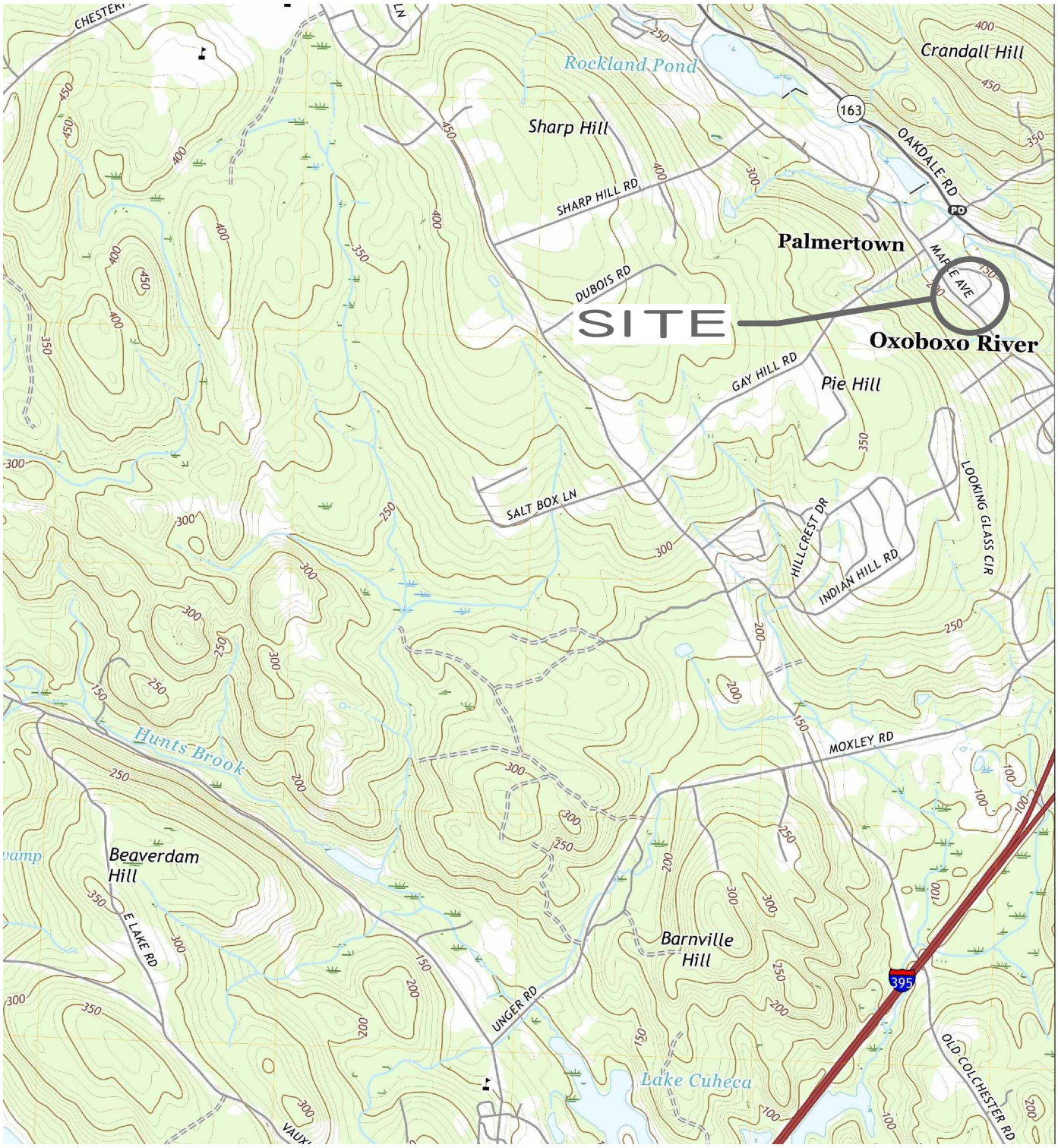
We recommend that DTE make field observations of excavations and foundation preparation to monitor compliance with our recommendations and project specifications. Specifically, we recommend field observation of footing subgrades, removal of unsuitable materials, Fill improvement, and Fill placement and compaction to monitor compliance with project specifications.

10.0 LIMITATIONS

This report is subject to the limitations included in Appendix 4.

APPENDIX 1 -

FIGURES



DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

27 SIEMON COMPANY DRIVE #363W
WATERTOWN, CONNECTICUT 06795

QUADRANGLE LOCATION

AREA PLAN
PROPOSED ANIMAL SHELTER
222 MAPLE AVENUE
MONTVILLE, CONNECTICUT

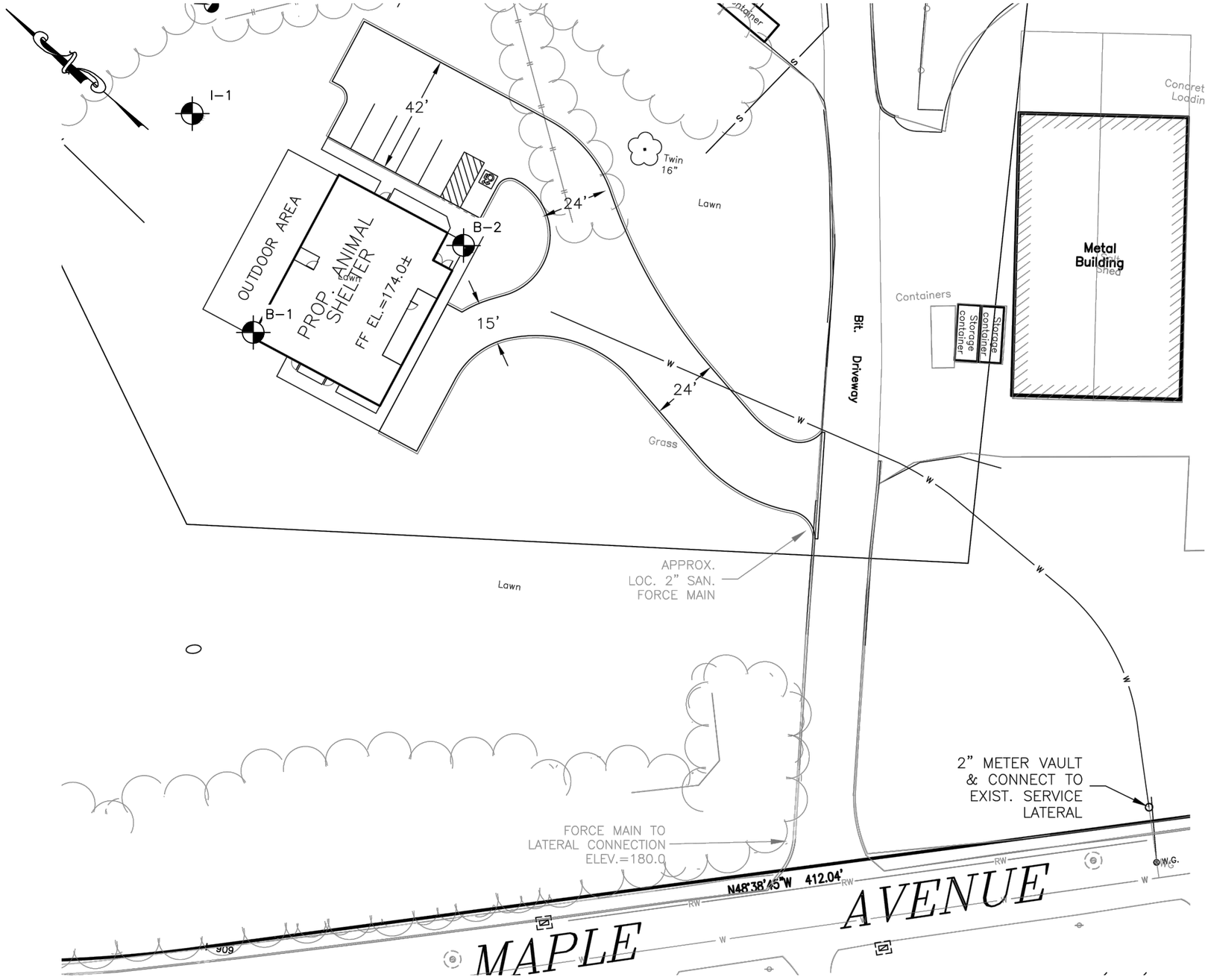
REFERENCE:
USGS TOPOGRAPHIC QUADRANGLE: MONTVILLE, CT

SCALE 1"= 2,000'

2,000' 1,000' 0 2,000'

PROJECT NO.	0020-126.00
DATE:	9/8/2023
FIGURE NO.	1

DRAWN BY: MF	REVIEWED BY: DFL



LEGEND

B-1 — TEST BORING NO. AND LOCATION BY DOWN TO EARTH CONSULTING, LLC

NOTES:
1) BASE MAP DEVELOPED FROM AN ELECTRONIC FILE PREPARED BY DONALD W. SMITH, JR., P.E. ENTITLED 'SCHEMATIC SITE & UTILITY PLAN, MONTVILLE ANIMAL SHELTER' DATED NOVEMBER 22, 2022. ORIGINAL SCALE 1"=30'.
2) BORINGS WERE PERFORMED BY ASSOCIATED BORINGS COMPANY, INC. AND OBSERVED AND LOGGED BY DOWN TO EARTH CONSULTING, LLC.
3) THE LOCATIONS OF THE BORINGS WERE DETERMINED BY TAPING AND VISUAL ESTIMATES FROM EXISTING SITE FEATURES. THIS DESIGN SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

DESIGNED BY OTHERS						
DRAWN BY MF						
CHECKED BY DFL						
APPROVED BY DFL	NO.	DATE	REVISIONS	DRWN.	CHKD	APPVD

SCALE 1" = 40'
40 25 0 40

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING
27 SIEMON COMPANY DRIVE #363W
WATERTOWN, CONNECTICUT 06795

PROJECT
PROPOSED ANIMAL SHELTER
222 MAPLE AVENUE
MONTVILLE, CONNECTICUT

DWG. TITLE.
BORING LOCATION PLAN

FILE NO. 0020-126.00
SCALE AS NOTED
DATE 9/19/2023
FIGURE NO. 2

APPENDIX 2 -

TEST BORING LOGS

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

PROJECT
PROPOSED ANIMAL SHELTER
222 MAPLE AVENUE
MONTVILLE, CONNECTICUT

BORING NO. I-1
SHEET 1 of 1
FILE NO. 0020-0126.00
CHKD. BY TJO

Boring Co.	Associated Borings Company	Boring Location	See Boring Location Plan		
Driller	Jaime Lloret	Ground Surface El.	173'+/-	Datum	Not Available
Logged By	Mateusz Fekieta	Date Start	9/12/2023	Date End	9/12/2023

Hammer Type:	Donut hammer driven by a cathead with 30 inch drop
Sampler Size:	1-3/8" I.D. Split Spoon
Type Drill Rig:	Track Mounted CME 45
Drilling Method:	3.25-inch I.D. Flush Joint Casing

Groundwater Readings (from ground surface)

Date	Time	Depth (ft)	Elev.	Stabilization Time
9/12/23	-	-	-	Not Encoutered

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	REC/PEN (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	Core Time (min./ft)	SAMPLE DESCRIPTION	STRATA
1							From Test Pits: brown, fine to coarse SAND and fine to coarse Gravel, some Silt, with cobbles and bouldes	6"± Topsoil
2								
3								FILL
4								
5								
6								
7								
8		S-1	5/24	7 to 9	4-4-5-13		Loose, brown/dark brown, fine to coarse SAND, some Silt, with coarse gravel at the tip	GRAVELLY SAND
9								
10							END OF EXPLORATION AT 9 FEET BELOW GROUND SURFACE	
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SPT N-Values	SPT N-Values	Proportions	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	Trace = 0 to 10%	1. S denotes split-barrel sampler.	7. WH denotes weight of hammer
5 to 10 - Loose	3 to 4 - Soft	Little = 10 to 20%	2. ST denotes 3-inch O.D. undisturbed sample.	8. WR denotes weight of rods
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	Some = 20 to 35%	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	And = 35 to 50%	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff		5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard		6. SPT denotes Standard Penetration Test.	12. C denotes core run number.

FIELD NOTES: 1) Stratification lines represent approximate boundaries between soil types, transitions may be gradual.
2) Water level readings have been made at times and under conditions stated, fluctuations may occur due to other factors.

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

PROJECT
PROPOSED ANIMAL SHELTER
222 MAPLE AVENUE
MONTVILLE, CONNECTICUT

BORING NO. B-1
SHEET 1 of 1
FILE NO. 0020-0126.00
CHKD. BY TJO

Boring Co.	Associated Borings Company	Boring Location	See Boring Location Plan		
Driller	Jaime Lloret	Ground Surface El.	174'+/-	Datum	Not Available
Logged By	Mateusz Fekieta	Date Start	9/12/2023	Date End	9/12/2023

Hammer Type:	Donut hammer driven by a cathead with 30 inch drop
Sampler Size:	1-3/8" I.D. Split Spoon
Type Drill Rig:	Track Mounted CME 45
Drilling Method:	2.25-inch I.D. Hollow-Stem Augers

Groundwater Readings (from ground surface)

Date	Time	Depth (ft)	Elev.	Stabilization Time
9/12/23	-	10	164'+/-	Wet Sample
9/12/23	-	8.3	165.7'+/-	1.5h

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	REC/PEN (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	Core Time (min./ft)	SAMPLE DESCRIPTION	STRATA
1								6"± Topsoil
2		S-1	7/8	1.5 to 3	5-5-2-3		Loose, brown, fine to coarse SAND, little fine Gravel, trace Silt	
3								FILL
4		S-2	0/24	3 to 5	6-16-20-31		Dense, No Recovery	
5								
6		S-3	1/24	5 to 7	6-7-4-2		Medium dense, brown, coarse GRAVEL fragments	
7								SILT
8		S-4	5/24	7 to 9	2-2-4-9		Loose, brown, fine to coarse SAND, and fine to coarse GRAVEL, little Silt	
9								GRAVELLY SAND
10								
11		S-5	7/7	10 to 10.6	42-50/1"		Very dense, brown, fine to coarse SAND, some fine to coarse Gravel, trace Silt	
12								
13							END OF EXPLORATION AT 12 FEET BELOW GROUND SURFACE	
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SPT N-Values	SPT N-Values	Proportions
0 to 4 - Very Loose	0 to 2 - Very Soft	Trace = 0 to 10%
5 to 10 - Loose	3 to 4 - Soft	Little = 10 to 20%
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	Some = 20 to 35%
31 to 50 - Dense	9 to 15 - Stiff	And = 35 to 50%
Over 50 - Very Dense	16 to 30 - Very Stiff	
	Over 30 - Hard	

SYMBOL KEY

1. S denotes split-barrel sampler.
2. ST denotes 3-inch O.D. undisturbed sample.
3. UO denotes 3-inch Osterberg undisturbed sample.
4. PEN denotes penetration length of sampler.
5. REC denotes recovered length of sample.
6. SPT denotes Standard Penetration Test.
7. WH denotes weight of hammer
8. WR denotes weight of rods
9. PP denotes Pocket Penetrometer.
10. FVST denotes field vane shear test.
11. RQD denotes Rock Quality Designation.
12. C denotes core run number.

FIELD NOTES: 1) Stratification lines represent approximate boundaries between soil types, transitions may be gradual.
2) Water level readings have been made at times and under conditions stated, fluctuations may occur due to other factors.
3) Auger refusal at about 12 feet on cobbles/boulder or possible bedrock.

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

PROJECT
PROPOSED ANIMAL SHELTER
222 MAPLE AVENUE
MONTVILLE, CONNECTICUT

BORING NO. B-2
SHEET 1 of 1
FILE NO. 0020-0126.00
CHKD. BY TJO

Boring Co.	Associated Borings Company	Boring Location	See Boring Location Plan		
Driller	Jaime Lloret	Ground Surface El.	173'+/-	Datum	Not Available
Logged By	Mateusz Fekieta	Date Start	9/12/2023	Date End	9/12/2023

Hammer Type:	Donut hammer driven by a cathead with 30 inch drop
Sampler Size:	1-3/8" I.D. Split Spoon
Type Drill Rig:	Track Mounted CME 45
Drilling Method:	2.25-inch I.D. Hollow-Stem Augers

Groundwater Readings (from ground surface)

Date	Time	Depth (ft)	Elev.	Stabilization Time
9/12/23	-	10	163'+/-	Wet Sample
9/12/23	-	9.3	163.7'+/-	10 min

DEPTH	Casing Blows (ft)	SAMPLE INFORMATION Type & No.	REC/PEN (inches)	DEPTH (feet)	BLOWS PER 6 INCHES	Core Time (min./ft)	SAMPLE DESCRIPTION	STRATA
1								6"± Topsoil
2		S-1	0/24	1 to 3	9-9-8-13		Medium dense, No Recovery	FILL
3								
4		S-2	2/24	3 to 5	18-25-14-14		Dense, brown/white, fine to coarse SAND and fine to coarse GRAVEL, trace Silt	
5								
6		S-3	7/24	5 to 7	3-1-2-2		Very loose, brown to dark brown, fine to coarse SAND and SILT, trace fine Gravel	SILT
7								
8		S-4	11/24	7 to 9	1-2-8-14		Loose, dark brown, SILT, little fine SAND, trace Organics	
9								
10								GRAVELLY SAND
11		S-5	10/24	10 to 12	6-8-17-31		Medium dense, Top 8" gray, fine SAND, some Silt; Bottom 2" white, pulverized COBBLE	
12								
13								
14								
15								
16		S-6	8/24	15 to 17	26-32-39-44		Very dense, brown, fine to coarse SAND, some fine to coarse Gravel, trace Silt	
17								
18							END OF EXPLORATION AT 17.5 FEET BELOW GROUND SURFACE	
19								
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SPT N-Values	SPT N-Values	Proportions	SYMBOL KEY	
0 to 4 - Very Loose	0 to 2 - Very Soft	Trace = 0 to 10%	1. S denotes split-barrel sampler.	7. WH denotes weight of hammer
5 to 10 - Loose	3 to 4 - Soft	Little = 10 to 20%	2. ST denotes 3-inch O.D. undisturbed sample.	8. WR denotes weight of rods
11 to 30 - Medium Dense	5 to 8 - Medium Stiff	Some = 20 to 35%	3. UO denotes 3-inch Osterberg undisturbed sample.	9. PP denotes Pocket Penetrometer.
31 to 50 - Dense	9 to 15 - Stiff	And = 35 to 50%	4. PEN denotes penetration length of sampler.	10. FVST denotes field vane shear test.
Over 50 - Very Dense	16 to 30 - Very Stiff		5. REC denotes recovered length of sample.	11. RQD denotes Rock Quality Designation.
	Over 30 - Hard		6. SPT denotes Standard Penetration Test.	12. C denotes core run number.

FIELD NOTES: 1) Stratification lines represent approximate boundaries between soil types, transitions may be gradual.
2) Water level readings have been made at times and under conditions stated, fluctuations may occur due to other factors.
3) Cobbles and/or boulders were inferred based on auger chatter from about 1 to 4 feet.
4) Auger refusal at about 17.5 feet on cobbles/boulder or possible bedrock.

APPENDIX 3 -

IN-SITU HYDRAULIC CONDUCTIVITY ANALYSIS AND RESULTS

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

Falling Head Test
Proposed Animal Shelter
222 Maple Avenue
Montville, CT
File No. 0020-126.00

Test Location: I-1 Trial 1
Test Type: Falling Head
Date: 9/12/2023

Driller: Jaime Lloret
Engineer: M. Fekieta
Weather: Sunny 70s/80s

Ground surface El.: 173.0 (ft.)
Top of Casing El.: 173.5 (ft.)
Bottom of Casing El.: 166.0 (ft.)

Total Casing Length: 7.5 (ft.)

Inside Casing Diameter: 3.25 (in.)

Hydraulic Conductivity (Kv) = π [D {Ln (h1/h2) }] / 11 (t2-t1)

Elapsed Time (min.)	t2 - t1 (min.)	DTW (in.)	h1 (in.)	h2 (in.)	ln(h1/h2)	Kv (in/min)	Kv (cm/sec)	Kv (in/hr)
0.07	0.07	6.00	90.0	84.0	0.0690	9.6E-01	4.1E-02	5.8E+01
0.18	0.12	12.00	84.0	78.0	0.0741	5.9E-01	2.5E-02	3.5E+01
0.5	0.32	28.80	78.0	61.2	0.2426	7.1E-01	3.0E-02	4.3E+01
1	0.50	39.00	61.2	51.0	0.1823	3.4E-01	1.4E-02	2.0E+01
1.5	0.50	46.20	51.0	43.8	0.1522	2.8E-01	1.2E-02	1.7E+01
2	0.50	52.80	43.8	37.2	0.1633	3.0E-01	1.3E-02	1.8E+01
2.5	0.50	58.20	37.2	31.8	0.1568	2.9E-01	1.2E-02	1.7E+01
3	0.50	60.60	31.8	29.4	0.0785	1.5E-01	6.2E-03	8.7E+00
3.5	0.50	62.40	29.4	27.6	0.0632	1.2E-01	5.0E-03	7.0E+00
4	0.50	63.60	27.6	26.4	0.0445	8.3E-02	3.5E-03	5.0E+00
5	1.00	64.20	26.4	25.8	0.0230	2.1E-02	9.0E-04	1.3E+00
6	1.00	66.00	25.8	24.0	0.0723	6.7E-02	2.8E-03	4.0E+00
					Average	3.3E-01	1.4E-02	2.0E+01

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

Falling Head Test
Proposed Animal Shelter
222 Maple Avenue
Montville, CT
File No. 0020-126.00

Test Location:	I-1	Trial 2	**Driller:**	Jaime Lloret
Test Type:	Falling Head		**Engineer:**	M. Fekieta
Date:	9/12/2023		**Weather:**	Sunny 70s/80s

Ground surface El.:	173.0	(ft.)	Total Casing Length:	7.5	(ft.)	Inside Casing Diameter:	3.25	(in.)
Top of Casing El.:	173.5	(ft.)						
Bottom of Casing El.:	166.0	(ft.)						

Hydraulic Conductivity (Kv) = π [D {Ln (h1/h2) }] / 11 (t2-t1)

Elapsed Time	t2 - t1	DTW	h1	h2	ln(h1/h2)	Kv	Kv	Kv
(min.)	(min.)	(in.)	(in.)	(in.)		(in/min)	(cm/sec)	(in/hr)
0.07	0.07	6.00	90.0	84.0	0.0690	9.6E-01	4.1E-02	5.8E+01
0.13	0.07	12.00	84.0	78.0	0.0741	1.0E+00	4.4E-02	6.2E+01
0.5	0.37	26.40	78.0	63.6	0.2041	5.2E-01	2.2E-02	3.1E+01
1	0.50	39.00	63.6	51.0	0.2208	4.1E-01	1.7E-02	2.5E+01
1.5	0.50	46.80	51.0	43.2	0.1660	3.1E-01	1.3E-02	1.8E+01
2	0.50	51.60	43.2	38.4	0.1178	2.2E-01	9.3E-03	1.3E+01
2.5	0.50	55.20	38.4	34.8	0.0984	1.8E-01	7.7E-03	1.1E+01
3	0.50	57.60	34.8	32.4	0.0715	1.3E-01	5.6E-03	8.0E+00
3.5	0.50	59.52	32.4	30.5	0.0611	1.1E-01	4.8E-03	6.8E+00
4	0.50	62.40	30.5	27.6	0.0993	1.8E-01	7.8E-03	1.1E+01
5	1.00	64.20	27.6	25.8	0.0674	6.3E-02	2.7E-03	3.8E+00
6	1.00	66.00	25.8	24.0	0.0723	6.7E-02	2.8E-03	4.0E+00
					Average	3.5E-01	1.5E-02	2.1E+01

DOWN TO EARTH CONSULTING, LLC
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING

Falling Head Test
Proposed Animal Shelter
222 Maple Avenue
Montville, CT
File No. 0020-126.00

Test Location: I-1 Trial 3
Test Type: Falling Head
Date: 9/12/2023

Driller: Jaime Lloret
Engineer: M. Fekieta
Weather: Sunny, 70s/80s

Ground surface El.: 173.0 (ft.)
Top of Casing El.: 173.5 (ft.)
Bottom of Casing El.: 166.0 (ft.)

Total Casing Length: 7.5 (ft.)

Inside Casing Diameter: 3.25 (in.)

Hydraulic Conductivity (Kv) = π [D {Ln (h1/h2) }] / 11 (t2-t1)

Elapsed Time (min.)	t2 - t1 (min.)	DTW (in.)	h1 (in.)	h2 (in.)	ln(h1/h2)	Kv (in/min)	Kv (cm/sec)	Kv (in/hr)
0.06	0.06	6.00	90.0	84.0	0.0690	1.1E+00	4.6E-02	6.6E+01
0.12	0.06	12.00	84.0	78.0	0.0741	1.2E+00	5.0E-02	7.1E+01
0.5	0.38	24.00	78.0	66.0	0.1671	4.0E-01	1.7E-02	2.4E+01
1	0.50	34.80	66.0	55.2	0.1787	3.3E-01	1.4E-02	2.0E+01
1.5	0.50	42.00	55.2	48.0	0.1398	2.6E-01	1.1E-02	1.6E+01
2	0.50	45.60	48.0	44.4	0.0780	1.4E-01	6.1E-03	8.7E+00
2.5	0.50	49.20	44.4	40.8	0.0846	1.6E-01	6.6E-03	9.4E+00
3	0.50	53.04	40.8	37.0	0.0988	1.8E-01	7.8E-03	1.1E+01
3.5	0.50	56.40	37.0	33.6	0.0953	1.8E-01	7.5E-03	1.1E+01
4	0.50	59.40	33.6	30.6	0.0935	1.7E-01	7.3E-03	1.0E+01
5	1.00	61.80	30.6	28.2	0.0817	7.6E-02	3.2E-03	4.5E+00
6	1.00	63.60	28.2	26.4	0.0660	6.1E-02	2.6E-03	3.7E+00
					Average	3.5E-01	1.5E-02	2.1E+01

APPENDIX 4 -

LIMITATIONS

LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from subsurface explorations by Down To Earth Consulting, LLC (DTE) and others. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

3. Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, tidal, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design or location of the proposed building are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by DTE. It is recommended that this firm be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Construction

5. It is recommended that this firm be retained to provide soil engineering services during construction of the earthworks and foundation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Use of Report

6. This report has been prepared for the exclusive use of e2 Engineers for specific application to the project noted in this geotechnical report in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

7. This soil and foundation engineering report has been prepared for this project by DTE. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only.

8. This report may contain comparative cost estimates for the purpose of evaluating alternative foundation schemes. These estimates may also involve approximate quantity evaluations. It should be noted that quantity estimates may not be accurate enough for construction bids. Since DTE has no control over labor and materials cost and design, the estimates of construction costs have been made on the basis of experience. DTE does not guarantee the accuracy of cost estimates as compared to contractor's bids for construction costs.