Technical Special Provisions (TSPs) required for Roadside Tolling Cabinet (RTC) Infrastructure

August 16, 2023

These TSPs are not applicable to tolling projects that include a Toll Equipment Building (TEB).

SECTION 400
TOLL SITE FOUNDATIONS AND EQUIPMENT SLABS

T736-1 Description.
Construct Portland cement reinforced concrete slab to support toll equipment and toll equipment buildings, on a prepared subgrade or base. Use concrete reinforced with steel bars or welded wire reinforcement, in accordance with details and notes shown in the Plans.

T736-1.1 Submittals and Shop Drawings

1. Product Data: Submit product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint systems, curing compounds, and others as requested by the Department.

2. Shop Drawings, Reinforcement: Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Conform to SP-66, showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required and formed openings through concrete structures.

3. Laboratory Test Reports: Submit copies of laboratory test reports for concrete materials and mix design test as specified or explicitly state the pre-approved mix design already furnished to the Engineer will be used.

4. Material Certificates: It is preferable to provide copies of materials certificates in lieu of materials laboratory test reports when permitted by the Department. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

T736-2 Materials.
Ensure that the materials used for the construction of slabs have certification statements from each source, showing that they meet the applicable requirements of the following:

T736-1.1 Concrete: Use concrete meeting the requirements of Section 346, Class I, unless requirements herein or on plans are more stringent.

Utilize concrete with a target slump of 3 inches plus or minus 1.5 inches.

Provide concrete with a minimum 28-day compressive strength of 3,000 psi and maximum water to cementitious materials ratio of 0.50, unless plans call for more stringent requirements. The requirements of Sections 346-3 and 346-4 do not apply unless called for on plans. Notify the Engineer if any of the component quantities are adjusted. If any material sources change, resubmit the mix design to the Engineer for approval prior to use.

T736-2.1 Reinforcement: For all steel reinforcement required by the Plans, meet the requirements of Section 415.

T736-2.2 Joint Materials: Meet the requirements of Section 932.

T736-2.3 Geotextile: If specified, meet the requirements of Section 514.

T736-2.4 Forms: Provide forms in accordance with 520-3.

1. **Form Release Agent:** Provide commercial formulation form release agent with a maximum of 350 g/l volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

2. **Form Ties:** Use factory-fabricated, adjustable-length, removable or snap off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

a. Unless otherwise indicated and except as noted, provide ties so portion remaining within concrete after removal is 1-1/2 inches inside concrete and will not leave holes larger than 1-inch diameter in concrete surface.

T736-2.5 Perform concrete structures work in accordance with Section 400.

T736-3 Construction Requirements.

T736-3.1 Excavation and Subgrade Preparation

Excavate to the required depth and compact the foundation material upon which these items are to be placed. Shape and compact the foundation materials to a firm, even surface, true to grade and cross-slope. Compact areas that have been excavated more than 6 inches below the bottom of the concrete, to a minimum of 95% of AASHTO T99 density. The area to be compacted includes the area directly under and 1 foot beyond each side of the toll equipment slab, when right-of-way allows.

Maintain the finished subgrade in a smooth, compact condition. Restore any areas which are disturbed prior to placing the concrete. Do not place concrete on a frozen subgrade.

Geotextile Fabric: When called for in the plans, place geotextile fabric in accordance with Section 514.

Coordinate stub-up locations through concrete slab for electrical equipment placement and ensure associated conduit is installed prior to placing concrete.

T736-3.2 Placing Concrete

Place the concrete in the forms, and tamp and spade it to prevent honeycombing, and until the top of the structure can be floated smooth and the edges rounded to the radius shown in the Plans.

Protect unhardened concrete from effects of inclement weather. Cease operations in rain. The following will apply when placing in cold and hot weather:

1. During the cold weather, do not mix or place concrete when the air temperature is below 40ºF. Protect the fresh concrete from freezing in accordance with Section 400 until the concrete reaches a minimum compressive strength of 1,500 psi.

2. During placing in hot weather, cool the aggregates and mixing water as necessary to maintain the concrete temperature at not more than 100ºF at time of placement with the protective covering.

Install expansion and contraction joints in accordance with the Plans and Section 520-6.

T736-3.3 Finishing

1. **Screeding:** Strike-off the concrete by means of a wood or metal screed, used perpendicular to the forms, to obtain the required grade and remove surplus water and laitance.

2. **Surface Requirements:** Finish all exposed surfaces while the concrete is still green. Provide a broom finish unless noted otherwise on plans. Ensure that the surface variations are not more than 1/4 inch under a 10-foot straightedge or more than 1/8 inch on a 5 foot transverse section. Finish the outer edges of the concrete with an edging tool having a radius of 1/2 inch unless noted otherwise on plans.

T736-3.4 Curing: Cure the concrete as specified in 520-8.

T736-3.5 Backfilling and Compaction: After the concrete has set sufficiently, but not later than three days after pouring, install backfill around the toll equipment slab in accordance with the plans, to the required elevation with suitable material. Place and thoroughly compact the material in layers not thicker than 6 inches.

T736-4 Method of Measurement.

The quantity to be paid will be plan quantity, in square yards, completed and accepted.

T736-5 Basis of Payment.

The toll equipment building foundation work specified in this Section will not be paid for directly but will be considered as incidental work.

Price and payment for toll equipment slabs will be full compensation for all work specified in this Section. Excavation for new installations will be paid for under the items for the grading work on the project.

Payment will be made under:

Item No. 400-45-5	Reinforced Concrete, Toll Site Equipment Slab, 12" Thick, per square yard.

TECHNICAL SPECIAL PROVISION

FOR

BOLLARDS

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T519
PIPE BOLLARDS

T519-1 Description.

Construct pipe bollards in accordance with this Section and the Plans.

T519-1 Materials.

T519-1.1 Meet the following requirements:

1. Concrete	Section 347
2. Polyethylene Sleeve	Section 948
3. Galvanized Steel	Section 962

a. Steel Pipe: Conform to ASTM A 53, Type S, Grade B, Schedule 40, black finish unless galvanizing is required.

4. Hardware

a. Nuts and bolts shall be regular hexagon type conforming to ASTM A307, Grade A.

5. Gravel	No. 57 Stone
6. Weed block	Polypropylene or Polyester Fabrics

T519-2 Construction Requirements.

T519-2.1 Removable Pipe Bollard

1. Construct concrete foundation with embedded galvanized steel pipe sleeve and bolt in accordance with the Plans.
2. Construct pipe bollard in accordance with the plans.
3. Attach pre-manufactured yellow high-density polyethylene sleeve (per manufacturer's instructions)
4. Provide gravel surround with weed block at locations depicted in the Plans.

T519-2.2 Permanent Pipe Bollard

1. Construct concrete foundation with embedded galvanized steel pipe in accordance with the Plans.
2. Fill bollard with concrete in accordance with the plans. Round off top.
3. Attach pre-manufactured yellow high-density polyethylene sleeve (per manufacturer's instructions)

T519-3 Method of Measurement.

The quantity paid for will be the number of each type as designated, constructed, in place, and accepted. Includes foundations, sleeves, gravel surround, and weed block.

T519-4 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section, including all materials, hardware, labor, and incidentals required to complete the installation.

Payment will be made under:

Item No. 519- 78 Bollard - each

TECHNICAL SPECIAL PROVISION

FOR

_____

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T731
ACCEPTANCE PROCEDURES FOR TOLL FACILITIES

T731-1 Description.

This Section sets forth general administrative and procedural requirements for Toll Site, Toll Equipment Building, and Toll Gantry acceptance procedures.

T731-2 Record Documentation.

Provide Record Drawings, Maintenance Manuals, and Equipment Operational Instructions/Demonstrations. Provide each record documentation in a bound or filed format with prominent identification on the cover, ready for continued use and reference.

The record documents must contain the following identification as a minimum:

T731-2.1 Operating Instructions and Maintenance Manuals.

1. Provide separate manuals for each unit of equipment, each operating system, and each electric and electronic system.

2. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy- duty 2-inch, 3-ring vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.

3. Submit three (3) copies of each completed manual on equipment and systems, in final form, to the Engineer.

4. Operating instructions and maintenance manuals for each piece of equipment, for each building operating systems, and each electric or electronic system, must include the following at a minimum:

a. Equipment or system function.
b. Operating characteristics.
c. Limiting conditions.
d. Performance curves.
e. Engineering data and tests.
f. Complete nomenclature and number of replacement parts.
g. Copies of warranties.
h. Copies of inspection and test reports.
i. Wiring diagrams.
j. Recommended "turn around" cycles.
k. Inspection procedures.
l. Shop Drawings and Product Data.
m. Fixture lamping schedule.
n. Inspection and test reports

5. Provide manufacturer’s information for each component of an equipment or system including:

a. Printed operating and maintenance instructions.
b. Assembly drawings and diagrams required for maintenance.
c. Parts manuals
d. List of items recommended to be stocked as spare parts.

6. Provide information detailing essential maintenance procedures, including:

a. Routine operations.
b. Trouble-shooting guide.
c. Disassembly, repair, and reassembly.

d. Alignment, adjusting and checking.

7. Provide information on equipment and system operating procedures, including:

a. Start-up procedures.

b. Equipment or system break-in.

c. Routine and normal operating instructions.

d. Regulation and control procedures.

e. Instructions on stopping.

f. Shut-down and emergency instructions.

g. Summer and winter operating instructions.

h. Required sequences for electric or electronic systems.

i. Special operating instructions.

8. Servicing Schedule: Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.

9. Controls: Provide a description of the sequence of operation and as-installed control diagrams by the control manufacturer for systems requiring controls.

10. Coordination Drawings: Provide each Contractor's coordination drawings. Provide as-installed color-coded piping diagrams, where required for identification.

11. Valve Tags: Provide charts of valve tag numbers, with the location and function of each valve.

12. Circuit Directories: For electric and electronic systems, provide complete circuit directors of panelboards, including the following:

a. Electric service.

b. Controls.

c. Communication.

T731-2.1.1 Record Drawings.

1. Maintain a set of documents that indicates the actual installation and/or location where the installation and/or location varies substantially from the Work as originally shown due to Addenda, Alternates, Change Orders, Field Orders, etc. Make note of concealed elements that would be difficult to measure and record at a later date.

2. Note related Change Order numbers where applicable.

3. Review the completed Project Record Drawings and ascertain that all data furnished on the prints is accurate and truly represents the Work as actually installed.

4. Submit the record drawing prints, including those changed and unchanged, to the Engineer for compliance review.

5. Make all necessary changes to the record drawings based on the Engineer's review.

T731-3 As-Built Documents.

Provide As-Built Plans prior to issuing Final Acceptance of each toll facility in accordance with the Chapter 5.12 Final As-Built Plans Process of the Construction Project Administration Manual (TOPIC No. 700-000-000).

As-Built Plans must document changes to contract plans and include the following at a minimum:

1. Changes to site layout such as barrier, sidewalks, equipment foundations, dry wells, maintenance pull-off areas, limits of gravel, and driveways.

2. Actual routing and elevations of underground conduit and duct.

3. Actual locations and elevations of pull boxes and manholes.

4. Actual locations of components, grounding electrodes, and inspection wells.
5. Actual locations and sizes of electrical equipment, devices, and boxes.
6. Actual locations, sizes and routing of raceways, conductors, and cabling.
7. Any panelboard changes and circuit number changes including approved combining of circuits and any changes in the home run outlet boxes.

T731-4 Manufacturer and Supplier Warranties.

All manufacturer and equipment supplier warranties shall commence on the Date of Final Acceptance of the total Contract.

Written warranties made to the Department are in addition to implied warranties, and shall not limit duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Department can enforce such other duties, obligations, rights, or remedies.

The initiation of warranty for Security, AC, Communication, and Standby Power Systems will commence only when these systems are functioning properly and accepted in writing by the Department.

Complete all repairs or replacements resulting from a breach of warranty promptly.

Submit written warranties to the Department prior to the Date of Final Acceptance. If the Department designates a commencement date for warranties other than the Date of Final Acceptance, or a designated portion of the Work, submit written warranties on the Department's request.

Submit properly executed warranties from the supplier or manufacturer, or a combination thereof.

T731-5 Final Cleaning.

Immediately prior to Final Acceptance, clean each surface or unit of Work to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with manufacturer's written instructions for cleaning operations. Cleaning includes but is not limited to the following:

1. Remove labels which are not required as permanent labels, including all gum and glue residue.
2. Clean exposed exterior and interior hard-surface finishes, to a dirt-free condition, free of dust, stains, films, and similar noticeable distracting substances. Except as otherwise indicated, avoid disturbance of natural weathering of exterior surfaces. Restore reflective surfaces to original reflective condition. Buff out scratches and marks on exposed metal surfaces.
3. Wipe surfaces of mechanical and electrical equipment clean; remove excess lubrication and other substances.
4. Remove debris and surface dust from limited-access spaces including roofs and similar spaces. Clean tops of ductwork and horizontal surfaces of structural members in exposed areas.
5. Clean concrete floors in non-occupied spaces broom clean. Remove noticeable paint marks and construction stains.
6. Clean light fixtures and lamps to function at full efficiency. Replace any damaged lens.

Clean each toll site in accordance with Section 4-6 and the following:

1. Remove litter and foreign substances which includes removal of stains, petrochemical spills, and other foreign deposits.
2. Sweep paved areas to a broom-clean condition.

3. Rake grounds that are neither planted nor paved, to a smooth, even-textured surface, breaking up or removing clumps of material.

4. Clean exposed exterior of cabinets and wire troughs, to a dirt-free condition, free of dust, stains, and films.

T731-6 Toll Site Acceptance.

Toll site acceptance procedures include the following:

1. Verification of pre-substantial completion.
2. Toll Site Interim Acceptance.
3. Toll Site Final Acceptance.

Contractor access is prohibited into the toll site after Toll Site Interim Acceptance except as required for Final Acceptance procedures.

T731-6.1 Verification of Pre-Substantial Completion.

Use the following checklists to document the completion of all toll site items. The Engineer will verify that all items on the appropriate checklists are completed, and all outstanding items are corrected and recorded as complete on the checklist. The checklists for Roadside Tolling Cabinet (RTC) sites and Toll Equipment Building (TEB) sites include:

1. Checklist 731-1 – Type 1 (TEB Site with Non-Accessible Gantry)
2. Checklist 731-2 – Type 2 (TEB Site with Accessible Gantry)
3. Checklist 731-3 – Type 3 (RTC Site with Non-Accessible Gantry)
4.

A copy of the checklists may be obtained from the Engineer at the pre-construction conference

T731-6.2 Toll Site Interim Acceptance.

Toll Site Interim Acceptance procedures includes the following:

1. Primary Walk-through(s)
2. Operational Testing Walk-through(s)
3. Equipment Demonstrations for Maintenance Personnel

Complete the following prior to the Primary Walk-through:

1. Verify that all items on the appropriate checklists identified in T731-6.1 are completed and all outstanding items are corrected and recorded as complete on the checklist.

2. The roadway pavement surface course and permanent striping in its final alignment for the toll loop pavement area (100 feet of pavement centered on the gantry) are installed and accepted by the Department and, the approach and departure roadway (1500 feet approaching the gantry and 1000 feet departure from the gantry) is available for the Toll Equipment Contractor's (TEC's) use.

3. Complete sodding per the roadway component plans around each toll site.

4. Provide at least two portable toilets at each toll site for the exclusive use of the FTE and the TEC personnel, during toll equipment installation, commissioning, and testing.

T731-6.2.1 Primary Walk-through is conducted by the Engineer and the FTE Tolls personnel in conjunction with the Contractor's representative to ensure that the toll site has been constructed in compliance with the contract documents and that all elements of the toll site meet the needs of the Department and TEC.

Primary Walk-through shall be repeated until all the requirements as delineated in the contract documents for the toll site have been completed by the Contractor and verified by FTE Tolls.

T731-6.2.2 Operational Testing Walk-through is conducted by the Engineer and the FTE Tolls personnel in conjunction with the Contractor's representative demonstrating successful operational tests and performance verification.

Before the Operational Tests begin, the facility must be clean and all unused materials and equipment must have been removed. After successful completion of the operational tests, the toll facility and equipment will be locked and secured by the Department.

Provide all labor, materials, equipment and services necessary to perform operational tests and performance verification testing for system acceptance.

The contractor will perform the operational tests and a Department representative will observe the process.

1. Stand Alone Tests: Test stand-alone functions of all electrical devices. If any unit fails to pass the stand-alone test, correct the unit or replace another unit instead and then repeat the test.

2. System Acceptance: occurs after all electrical devices have been installed, individually commissioned and Stand Alone Tests have been completed.

a. The systems and equipment will be functionally tested with all the systems and equipment running simultaneously to verify that the normal operation of any one system or piece of equipment does not interfere or aggravate any other system or equipment.

3. An important component of this process is providing the Department with the operation manuals, service manuals, parts manuals, spare parts, keys, system settings, software on discs, and warranty documents for each piece of equipment provided in accordance with the contract documents.

4. A report that shows all systems are functioning properly and the normal operation of any one system or piece of equipment does not interfere or aggravate any other system or equipment will be provided to the Department. The checklists below will be used as the report.

a. If the system or component being tested does not function properly or interferes or aggravates any other system or equipment, then the system will receive a "Fail" grade. Repair or adjust and retest any systems that Fail the operational test.

b. If the system fails the operational test three times, then remove the system or components and replace with a different system or components. Retest the replacement system or components to ensure it is satisfactory

5. Ensure the following systems are energized and operating normally with no alarms:

a. Electrical power distribution system
b. Emergency Power Off Station
c. Backup generator and fuel tank - ready to operate
d. Automatic transfer switch
e. When toll equipment buildings are depicted in the Toll Facility plans, also ensure the following systems are energized and operating normally with no alarms.
f. UPS and UPS Bypass switch
g. HVAC system
h. Lighting – Normal and Emergency
i. SCADA system
j. Tolling Communication Rack
k. Fiber Optic Communications System

l. Lighting System – Normal and Emergency.
m. TEB Above Ground Storage Tank and Fuel Tank Monitor Panel.
n. TEB Access Control System.
o. TEB AC System.
p. TEB UPS Operational Test.
q. Engine Generator and Automatic Transfer Switch

Checklist 731-6-1 Lighting System – Normal and Emergency		**Pass or Fail**
1.	Operate the light switches/toggle switches in each area to verify that the lights are controlled in accordance with the plans.	
2.	Operate the light switches/toggle switches that control the convenience/service lights on the accessible gantry if present. Verify that the lights are controlled in accordance with the plans.	
3.	Test the emergency lights in each room if present. Open the circuit breaker serving the normal lighting and then observe each emergency light as it operates. After 2 minutes, close the circuit breaker for the normal lights and observe the emergency lights turn off automatically.	
4.	Operate the outdoor lights and site lighting. Cover the outdoor photocell and observe the outdoor lights as they illuminate. Uncover the outdoor photocell and observe the outdoor lights turn off.	

Checklist 731-6-2 TEB Above Ground Storage Tank & Fuel Tank Monitor		**Pass or Fail**
1.	Open the circuit breaker that serves the fuel tank monitor (FTM). Verify the panelboard directory card description is accurate. Close the circuit breaker that serves the FTM and observe the FTM "power on" light is energized.	
2.	Press the "TEST" button on the FTM and observe the High level, Low level, and Leak alarm lights energize. Also confirm the alarm horn sounds. Release the test button and clear the alarms.	
3.	Operate the fuel oil pipe valves. The valves should operate easily with no binding. Leave the valves in the open position.	
4.	Inspect the direct reading fuel level gauge on top of the fuel tank. The fuel level should be between 90% and 95% full.	
5.	Inspect the analog fuel level sensor and wiring for proper installation and operation.	
6.	Use the SCADA control panel operator interface to view the level in the fuel tank. The SCADA system should indicate that the fuel level is between 90% and 95% full.	
7.	Turn over the operator manuals and parts manuals to the FTE	

Checklist 731-6-2 TEB Above Ground Storage Tank & Fuel Tank Monitor		**Pass or Fail**
	representative.	

Checklist 731-6-3 TEB Access Control System Commissioning Procedure		**Pass or Fail**
1.	Verify the door key(s) for the toll equipment building are available and are on site.	
2.	Open the circuit breaker(s) in the panelboard that will serve the future access control system. Verify the panelboard directory card description is accurate. Leave the breaker open.	
3.	Inspect the door locking hardware, and the request to exit device J-box. Verify each device is present and installed.	
4.	Demonstrate the operation of the electric door lock by applying 24 VDC to the door lock conductors [redacted] a. When 24 VDC is applied to the door lock conductors, the electric lock will unlock and allow the door to be opened from the unsecure side. The door lock will remain unlocked until the 24 VDC is removed. b. After 24 VDC is removed, verify that the door cannot be opened from the unsecure side. Verify the conductors are labeled as Door lock +, and Door Lock -	
5.	Use an Ohm Meter to measure the continuity of the request to exit switch contacts in the [redacted] When the sensor detects the presence of a person on the secure side of the door, the request to exit contacts should be closed and the Ohm Meter should measure less that 0.1 Ohm. When the sensor does not detect a person near the door, the request to exit contacts should be open and the Ohm Meter should measure greater than 1 Mega Ohm.	
6.	With the access-controlled door closed, open the door from the outside (unsecured side) by using the key to unlock it. Verify the key will lock and unlock the door.	
7.	Review the construction plans and verify that each access control raceway and junction box are present.	
8.	Turn over the door keys to the Department representative.	

	Checklist 731-6-4 TEB A/C System Lead/Lag Operational Test	Pass or Fail
1.	Check the setting of the thermostat and verify it is set for 75 degrees Fahrenheit. Reprogram thermostat if necessary.	
2.	Measure the dry bulb temperature and relative humidity in the toll equipment building near the center of the room for 1 hour. Ensure the temperature is maintained between 73 degrees and 78 degrees and the relative humidity remains less than 50%.	
3.	Verify that only one A/C unit is running and that one A/C unit running with the 1st stage compressor running will cool the toll equipment building to 75 degrees and less than 50% relative humidity.	
4.	Open the circuit breaker that serves the A/C unit that is running. This is the "Lead" unit. Verify the panelboard directory card description is accurate and agrees with the Name Plate Label affixed to the unit.	
5.	Monitor the other A/C unit (the Lag unit) and verify it starts and begins to cool the room within 60 seconds.	
6.	Close the circuit breaker that serves the A/C unit in step 1 above. Verify the unit is re-energized.	
7.	Repeat steps 4, 5, and 6 for the other A/C unit.	
8.	Measure and record the full load Amperage of each A/C unit when operating with the compressor at 1st stage cooling level. Also measure and record the full load Amperage of each A/C unit when operating at 2nd stage cooling. Verify the full load Amperage when operating in 2nd stage cooling is at least 10% greater than when operating in 1st stage cooling.	Amps 1st ____ Amps 1st ____ Amps 2nd ____ Amps 2nd ____
9.	Turn over the operator manuals and parts manuals to the FTE representative.	

	Checklist 731-6-5 TEB UPS Operational Test	Pass or Fail
1.	Ensure the UPS unit is operating normally with no active alarms and the external UPS Bypass Switch in the NOT BYPASSED mode. Also ensure the clean power panel is energized by the output from the UPS.	
2.	Review the configuration settings that are programmed into the UPS. Verify the settings agree with those provided by FTE during equipment start-up.	
3.	The Department representative will change the default UPS password.	

	Checklist 731-6-5 TEB UPS Operational Test	Pass or Fail
3.	The FTE representative will telephone Sunwatch and verify: a) The UPS network interface card is communicating and operating satisfactorily. b) The on-site Department provided Network switch is communicating and operating satisfactorily.	 a) b)
4.	Locate the circuit breaker(s) that serve the UPS and the external UPS Bypass switch. Ensure the panelboard directory card description is accurate and it agrees with the Name Plate Label affixed to the UPS unit.	
5.	Place the UPS in the Internal Bypass mode. Verify the following: a) The LCD display on the UPS indicates the Bypass Mode. b) Ensure Sunwatch received the "UPS Internal Bypass" alarm? c) Ensure the Department's Network Switch did not re-boot due to loss of power.	 a) b) c)
6.	Place the UPS On-Line (not in Internal Bypass). Verify the following: a) The LCD display on the UPS indicates the Normal Mode. b) Ensure Sunwatch received the "UPS No Longer In Internal Bypass" alarm? c) Ensure the Department Network Switch did not lose power or re-boot due to a power disruption.	 a) b) c)
7.	Place the UPS external maintenance bypass switch in the "UPS Bypassed" position. Ensure the Department network Switch did not lose power or re-boot.	
8.	Place the UPS external maintenance bypass switch in the "UPS" position. Ensure the Department network Switch did not lose power or re-boot due to a power disruption.	
9.	Open the circuit breaker that serves the UPS. Verify the following: a) The LCD display on the UPS indicates the reserve battery mode and displays the number of reserve minutes remaining. b) Ensure Sunwatch received the "UPS On Battery" alarm. c) Ensure the Department Network Switch did not lose power or re-boot due to a power disturbance.	 a) b) c)

Checklist 731-6-5 TEB UPS Operational Test		Pass or Fail
10.	Close the circuit breaker that serves the UPS. Verify the following: a) The LCD display on the UPS indicates the normal mode. b) Verify Sunwatch received the "UPS Normal" alarm. c) Ensure the Department Network Switch did not lose power or re-boot due to a power disturbance.	a) b) c)
11.	Turn over the operator manuals, parts manuals, system passwords, and warranty documentation to the Department representative.	

Checklist 731-6-6 Engine Generator and Automatic Transfer Switch		Pass or Fail
1.	Open the circuit breaker(s) that serves the engine generator block heater and the battery charger. Verify these items are de-energized. Verify the panelboard directory card description is accurate. Close the circuit breaker(s) that serves the block heater and battery charger.	
2.	Review the configuration settings that are programmed into the generator control panel. Verify the settings agree with those provided by Department during equipment start-up.	
3.	The Department representative will change the default generator controller password.	
4.	Review the configuration settings that are programmed into the Automatic Transfer Switch control panel. Verify the settings agree with those provided by Department during equipment start-up.	
5.	The Department representative will change the default Automatic Transfer Switch control panel password.	
6.	Verify the generator controller start/stop switch is in the AUTO REMOTE position. Open the toll equipment building main circuit breaker to simulate a utility power outage. Record the elapsed time between the power outage and power being restored by the generator set & ATS. The maximum acceptable elapsed time is 10 seconds to restore power.	_____ Seconds
7.	The Department representative will telephone Sunwatch and verify the "Building on Backup Power" alarm is active.	
8.	While the building is being powered from the generator set, verify the UPS is on line, providing power to Panel C, and the UPS has no active alarms showing on the operator interface.	

	Checklist 731-6-6 Engine Generator and Automatic Transfer Switch	Pass or Fail
9.	Close the toll equipment building main circuit breaker to simulate a return of utility power. Record the elapsed time between the power restoration and the ATS operating to restore normal utility power to the building. The maximum acceptable elapsed time for the ATS to switch back to Utility power is 15 minutes.	_____ Minutes
10.	With the generator running, the UPS on-line, and the normal utility power restored, operate the generator Emergency Power Off (EPO) station. Ensure the generator shuts down immediately by emergency stop. All other equipment should remain operational.	
11.	Reset the generator emergency stop alarm and place the generator control panel Off/Run/Auto switch in the AUTO position.	
12.	Turn over the generator and ATS operator manuals, parts manuals, service manuals, and warranty documents to the Department representative.	

Complete all items on the Operational Testing Walk-through punch lists. Touch-up and otherwise repair and restore marred exposed finishes on the interior of the building. Complete all touch-up painting in the interior. Touch-up and otherwise repair and restore marred exposed finishes on outdoor equipment.

Correct deficiencies identified by the Department.

Upon successful completion of the Operational Testing Walk-Through, make final change-over of permanent locks and transmit keys to the Engineer.

T731-6.2.1 Equipment Demonstrations for Maintenance Personnel.

Provide a competent and experienced person (or persons) thoroughly familiar with the Work to demonstrate to, and instruct the Department's personnel in operation, adjustment and maintenance of products, equipment and systems. This instruction shall include normal start-up, run, stop, and emergency operations, location and operation of all controls, alarms and alarm systems, etc. The instruction shall include tracing the system in the field and on the diagrams in the instruction booklets so that the Department's operating personnel will be thoroughly familiar with both the system and the data supplied. Provide instruction at mutually agreed upon times.

Use operation and maintenance manuals for each piece of equipment or system as the basis of instruction. Review contents in detail to explain all aspects of operation and maintenance. For equipment that requires seasonal operation, provide similar instruction during other seasons.

If installers and/or Contractor's personnel are not experienced in operational procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following: (Items listed are examples only and not all inclusive)

1. Maintenance manuals.
2. Record documents.
3. Spare parts and materials.
4. Tools.
5. Lubricants.

6. Fuels.
7. Identification systems.
8. Control sequences.
9. Hazards.
10. Cleaning.
11. Warranties and bonds.
12. Maintenance agreements and similar continuing commitments.

As part of instruction for operating equipment, demonstrate the following procedures: (Items listed are examples only and not all inclusive)

1. Start-up.
2. Shut down.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

Contractor access is prohibited into the tolling site after the TEC has started installation of the tolling equipment.

T731-7 Prerequisites for Toll Site Final Acceptance

Review maintenance and operations in relation with applicable warranties, agreements to maintain, bonds, and similar continuing commitments.

Obtain concurrence from Engineer that the following items have been completed:

1. All additional spare parts as specified in the Contract Documents have been provided to the Department.
2. All special tools for items such as louver vanes, adjustable dampers, thermostats, allen-head locking devices, as specified in the Contract have been provided to the Department.
3. Record documentation has been provided to the Department in accordance Section T731-2
4. As-Built documentation for the toll facility has been provided to the Department in accordance Section T731-3
5. Manufacturer and supplier warranties have been provided to the Department in accordance Section T731-4.

T731-8 Toll Site Final Acceptance

Toll site Final Acceptance must be scheduled after the TEC commissioning has been completed. Toll site Final Acceptance includes completion of the following items:

1. Remove temporary facilities from the site, including portable toilets, construction tools, equipment, and any debris.
2. Inspect the toll site in the presence of Engineer and obtain concurrence from Engineer.

T731-9 Basis of Payment

The work specified in this Section will not be paid for directly but will be considered as incidental work.

SECTION 735
TOLL GANTRIES

735-1 Description.

Furnish and erect toll gantries at the locations identified in accordance with the Plans.

The Department designates a toll gantry with a walkway as an accessible toll gantry.

The Department designates a toll gantry without a walkway as a non-accessible toll gantry and may further classify it as a cantilever or span structure.

Meet the requirements shown in the following Standard Plan Indices:

Non-Accessible Cantilever Toll Gantry……. Standard Plans Index 700-040
Non-Accessible Span Toll Gantry.……. Standard Plans Index 700-041
Accessible Span Toll Gantry…….……. Standard Plans Index 700-041

735-1.1 Supporting Hardware: Include the following as shown on the Plans:

1. Submit a Non-accessible gantry supporting hardware.
   a. W-Sections
   b. Horizontal support pipes
   c. Attachment hardware for connection J-arms, W-Sections and horizontal support pipes
2. Accessible gantry supporting hardware, including associated mounting hardware.
   a. Swing gate assemblies
   b. Walkway system
   c. Fall arrest system
   d. Access stair assembly
   e. Equipment retraction assemblies including toll equipment support systems

735-2 Materials:

735-2.1 General Requirements: Meet the general material requirements of Section 700-2.1 and the Overhead Signs material requirements of Section 700-2.4.3 unless otherwise noted in Section 735-2.2. Hot-dip galvanize steel, in accordance with Section 962-11.

735-2.2 Supporting Hardware: Meet the requirements of Section 962-11 when galvanizing for fittings and appurtenances for all structural steel, fasteners, and hardware.

All aluminum materials must meet the requirements of Section 965. Weld aluminum structures in accordance with Section 965.

Metallic mounting assemblies must meet ASTM B117 for corrosion resistance.

Provide supporting hardware meeting the requirements of this Section and Table 735-1.

TABLE 735-1 MATERIALS FOR SUPPORT HARDWARE AND FITTINGS ITEM	MATERIALS
Steel U-Bolts	ASTM A449 or ASTM 193 B7 with minimum yield strength of 55,000 psi and a minimum ultimate strength of 90,000 psi
Aluminum bars, plates, stiffeners backing ring, shims and shapes Bar, Rod, and Shapes	Alloy 6061-T6 per ASTM B308
Stainless Steel Plates	Type 304L per ASTM A240
Stainless Steel Structural Shapes, Bars, and U-Bolt	Type 316L per ASTM A276
Stainless Steel screws, bolts, washers, and nuts	18-8 Stainless Steel unless otherwise noted
SEMS Machine Screws with washers and nuts for Upper Platform End Panel and Swing Gates	18-8 Stainless Steel with Phillips Pan Head with internal tooth-lock washer #10-32 threading
1" Fiberglass Grating for Upper Grating and Lower Grating	Fiberglass grating, pultruded, I-bar, SPF polyester resin, gray, 1.000" height x 0.600" top flange width I-bar bearing bars, spaced 1.500" on center with 0.900" clear space between bearing bar top flanges, anti-skid surface and full sealed, bearing bars run parallel to length of panel, gray cross-rods spaced 6" on center, 60% open area, flame retardant to UL94V0 and ASTM E84 Class 1 or Class A compliant
Stainless Steel Wire Mesh (above lower grating and inside fall restraint assembly)	Wire mesh, square weave, stainless steel Type 316 woven construction, mill finish, 6x6 square mesh, 0.1317" x 0.1317" opening, 0.0350"wire
Stair Treads	Welded bar grating, hot-dipped galvanized, stair tread, 19-W-4 spacing, minimum 1-1/4" height x 3/16" thick rectangular bearing bars, serrated, run parallel to length of stair tread; with checkered plate 90 degree nosing ; load capacity 400 lbs.
Upper Stair Landing and Access Platform Lower Landing Grating	Welded bar grating, hot-dipped galvanized, GW-150 smooth, welded fabrication, 19-W-4 spacing, 1-1/2” x 3/16” bearing bars, 77% open area, spaced 1-3/16” on centers, cross bars, 4" on centers; grating must support a uniform load of 500 lbs. over a clear span of 48" with a deflection of less than 0.2"
Access Platform Grating	Welded bar grating, hot-dipped galvanized, GW-150 smooth, welded fabrication, 19-W-4 spacing, 1-1/2” x 3/16” bearing bars, 77% open area, spaced 1-3/16” on center, regular cross bars, 4" on center, width 36"; grating must support a minimum uniform load of 237 lbs. over a clear span of 72" with a deflection of less than 0.45"
Self-Closing Hinge for Access Platform Gate	Stainless Steel Type 304, self-closing full mortise-mount spring hinge, with adjustable tension, rounded corners, 1-3/4" thickness, 4-1/2" x 4" overall dimensions with 2 leaves

TABLE 735-1 MATERIALS FOR SUPPORT HARDWARE AND FITTINGS ITEM	MATERIALS
Aluminum Screening	Wire mesh, square, aluminum alloy, mill finish, woven-intercrimp weave, 2” x 2” mesh (square), 0.4370" x 0.4370" opening (square), 0.063" thick (16 gauge) wire diameter, 76% open area
Full Mortise Pin & Barrel, Continuous hinge for Swing Gate	Stainless Steel Type 304, full mortise pin and barrel continuous hinge, supporting a minimum door weight of 300 lbs.
Rivet Nut for Swing Gate Latch assembly	Aluminum twist resistant locking rivet nut
Hex Head Screw for Gate Latch Post Connection Plate	Galvanized Flanged Hex Head Screws Medium-Strength
Retaining Rings for Gear Box Output Shaft	Stainless Steel
Fasteners for Swing Gate Hinge	Stainless steel – size and type per hinge manufacturer
PTFE Tape (polytetrafluoroethylene) For fall arrest system	Slippery PTFE Bar, with a slippery surface on one side and an etched texture on one side. The etched texture is scuffed to readily accept adhesive. Chemical Resistant, Impact Resistant, Low Water Absorption, Slippery, Wear Resistant, Weather Resistant. Use outdoor rated silicone adhesive made for attaching PTFE to stainless steel
Bushing for Gear Box Output Shaft	HDPE
Bushing for Gear Box Bushing Plate	Slip fit acetal plastic flanged sleeve bearing
Silicone Rubber adhesive Latch plate and Stop Plate	High-Temperature Silicone Rubber Strip with Adhesive-Back, Outdoor rated, Tensile Strength Min. 700 psi
Brass Keys for Output Shaft and Gear Box Input Adapter	Marine Grade Brass 485 meeting ASTM B21 or approved alloy: Corrosion resistant brass alloy appropriate for industrial applications and rated for deployment in an outdoor marine environment -
Input Adapter for AUMA Gearbox	Input adapter shall be brass and machined to match input of AUMA gearbox. Input shall be configured to accept a standard ½” square socket wrench with appropriate tolerances.

Conform to AGMA-9002 Bores and Keyways for Flexible Couplings (Inch Series) for sizes and tolerances of keys, keyways, key seats, key shafts, and key hubs/bores.

All flanged hex head screws must be serrated.

735-2.3 Toll Gantry Foundations, Fabrication, Installation, and Erection: Meet the requirements of Section 700.3.3**.**

735-3 Toll Equipment Attachment Infrastructure:

735-3.1 Toll Equipment J-Arms: Furnish and install J-Arms and all associated hardware in accordance with the Plans.

J-Arms must be fabricated within the following tolerance limits:

1. Outside diameter of 2.875 inches with an ovality tolerance of +/- 0.015 inch along the straight sections of the arm. (ANSI H35.2)

2. The minimum and maximum outside diameter within the curved section of the J-Arm must be 2.790" and 2.904" respectively.

3. J-Arm pipe bending must be in accordance with the requirements specified in Pipe Fabrication Institute Standard ES-24, Pipe Bending Methods, Tolerances, Process and Material Requirements.

4. Equipment retraction assembly for accessible toll gantries.

Furnish and install equipment retraction assemblies and all associated hardware in accordance with the Plans and Specifications.

735-3.2 J-Arm Fasteners and Attachment Hardware: All U-bolts must be furnished with double nuts and a saddle. Weld aluminum structures in accordance with Section 965. Install bolt, nut, and washer assemblies in accordance 460-5.

J-arm attachment for gantries includes non-accessible gantry hardware and accessible gantry hardware as shown in the Plans and Specifications.

735-3.3 Sampling and Testing: Test J-Arm roundness, yield, and tensile strength at the fabrication facility before shipping to the jobsite in accordance with the Producer's Quality Control Plan.

Provide a sample J-Arm from each J-Arm fabricator for testing and acceptance by the Engineer, prior to fabricating any J-Arms for the project. Sample J-Arm(s) that meet criteria may be used as production J-Arms.

735-3.4 Installation of Supporting Hardware: Furnish and install supporting hardware in accordance with the Plans and Specifications.

735-3.5 Delivery of Spare Equipment: Toll facilities gantry subcomponent plans will provide the quantity of spare equipment required. Deliver spare equipment to the Department's Central Repair Depot at Florida's Turnpike Milepost 99. Provide two weeks advance notice prior to delivering the spare items. Deliver the equipment in the original manufacturer's storage packaging. If the manufacturer does not use packaging for storage, wrap in heavy duty industrial grade clear plastic and label. Place hardware in boxes and label.

735-4 Toll Gantry Electrical Infrastructure:

Toll gantry electrical infrastructure includes the following as shown on the Plans and Specifications:

1. Raceways (including conduits, wireways, and cable trays) for power, E6, data and CCTV, associated fittings and accessories located on the toll gantry, the pull ropes, grounding wire, strut channel frames and all associated attachment hardware.

2. Fixtures, raceway, and conductors for lighting, lighting control, wiring devices, strut channel frames, and all associated attachment hardware.

3. E6 Reader frames as well as all wire troughs and associated strut channel frames, at the base of the toll gantry.

4. Lightning protection at the toll site, except for the toll equipment building lightning protection and the generator equipotential bonding.

5. Handhole enclosures (Cantilever Gantry Pencil Pull Boxes) shall be sized 5 inches wide by 5 inches deep x 36 inches long, NEMA 4X with threaded hubs.

All toll gantry electrical infrastructure must be rated NEMA 3R or NEMA 4.

735-5 Shop Drawings and Certifications:

Submit shop drawings in accordance with Section 5. Include fabrication and connection details including field splice locations and material certifications. Prior to the submittal of the shop drawings, determine the actual in-place dimensions for all toll gantry structures on the basis of existing field conditions and include on the shop drawings.

Include the following as-built information on the shop drawings:

1. Station and offsets of the center of the anchor bolt circle(s)
2. Orientation of the anchor bolt circle(s)
3. Elevation(s) of the top of foundation(s)
4. Any other as-built requirements identified in Standard Plans 700-041.

Each J-Arm fabricator must be an approved fabricator of aluminum products per FDOT Specification Sections 105-3. Provide a letter from each J-Arm fabricator to the Department stating that the fabricator is currently equipped/capable of fabricating the J-Arms. This letter must be provided at least one month in advance of providing the sample J-Arm.

735-6 Method of Measurement:

Contract unit price for each toll gantry, furnished and installed, will include furnishing the truss, uprights, columns, foundation(s), support hardware, toll gantry electrical infrastructure, accessible gantry gear boxes, and all equipment, labor, and materials necessary for a complete and accepted installation.

735-7 Basis of Payment:

Price and payment will be full compensation for furnishing all materials and completing all work described in the Plans and Specifications.

Payment will be made under:

Item No. 735-1- Toll Gantry - Each.

TECHNICAL SPECIAL PROVISION

FOR

_____

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T737
TOLL SITE DRY WELL AND ACCESSORIES

T737-1 Description.

Furnish and install the condensate drainage and refrigerant piping systems complete with all supports, hangers, specialties, and accessories as shown on Plans and herein specified.

T737-2 Materials.

Provide new materials free from defects and of American manufacture, and clearly marked with manufacturer's name and weight, classification, or working pressure of pipe and fitting.

T737-2.1 Pipe:

The following schedule covers the materials which shall be furnished and installed unless otherwise specified under the system section:

Materials	Service
PVC non-pressure pipe in accordance with Section 948	Condensate Piping
Precast Concrete Pipe Class IV in accordance with Section 449	Precast Concrete Pipe (for Dry Well)

T737-2.2 Pipe Fittings:

1. All PVC socket type connections shall be made with PVC solvent cement complying with ASTM D 2564.

2. Air Gap Fitting: Coated cast iron air gap fitting with integral cast air ports, female threaded inlet and outlet.

T737-2.3 Pipe Hangers and Supports

Provide hangers and supports for the different applications as follows:

1. Plumber's strap shall not be used.

2. Pipe Saddles: 18 gauge galvanized iron, 12 inches long (min.) installed at all points where insulated lines bear on hangers.

3. Supports shall be generally capable of maintaining the installed load plus 500 lb. Support copper tubing at 6-foot (max.) intervals horizontally. Support PVC piping every 4 feet.

T737-2.4 Pipe Sleeves for Toll Equipment Buildings

1. Interior: Galvanized sheet metal, 22 gauge. Provide for pipe passing through walls or floors before pouring concrete. Plastic sleeves are permitted.

2. All sleeves shall be large enough to allow full thickness of insulation through sleeves for insulated piping, and for two layers of 30 lb. felt wrapping around un-insulated piping.

T737-2.5 Condensate Dry Well

Provide precast concrete pipe for dry well, with the bell end supporting a H-20 traffic rated manhole cover and frame as shown on the Plans.

T737-3 Submittals and Shop Drawings.

Submit manufacturer's technical data sheets and shop drawings for approval on all pipe, fittings, valves, hangers and supports, sleeves and specialties as listed in this Technical Special Provision before any work is commenced. Submit plumbing and piping erection drawings.

T737-4 Construction Requirements.

T737-4.1 General

The Plans are generally diagrammatic. They do not show every bend, offset, elbow or other fittings which may be required in the piping for installation in the space allotted. Careful coordination of the work of this Technical Special Provision with that of other Divisions is necessary to avoid conflicts.

Line and Grade: Install gravity lines at uniform grade to low point after field verification of low point invert.

T737-4.2 Delivery, Storage, and Handling

1. Provide factory-applied plastic endcaps on each length of pipe and tube. Maintain endcaps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

2. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

3. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

T737-4.3 Pipe Sleeves

1. Place all sleeves for piping prior to the pouring of concrete or in time to set in place as masonry walls are erected.

2. After piping is installed through the sleeves, complete with insulation or wrapping, the sleeves shall be sealed water-tight with an approved mastic or caulking compound.

T737-4.4 Jointing Pipe

1. Provide nipples of same material and weight as pipe used. Part of standard weight nipples is less than 1-1/2 inches.

2. Provide reducing fittings where changes in pipe sizes occur.

3. Provide unions or flanges in all service lines at each piece of equipment, specialty, valves or at other locations required for ready disconnect.

4. Provide all necessary drain piping from the low point of each of the systems, and other miscellaneous piping required by the various systems to make a complete installation. Drains shall not be smaller than connection at equipment and no drain shall be smaller than 3/4 inch.

T737-4.5 PVC Pipe:

1. Remove all burrs from cut ends of PVC piping with knife, deburring tool or file.

2. Visually inspect the inside of pipe and fitting sockets and remove all dirt, grease or moisture with chemical cleaner and wipe clean with cloth prior to application of solvent.

3. All thermoplastic pipe installed underground shall be installed in accordance with ASTM D 2321.

T737-4.6 Pipe Hangers and Supports

1. Provide brackets, rolls, clamps and supplementary steel as required for proper support of pipelines. Design hangers to allow for expansion and contraction of pipelines and of adequate size to permit covering to run continuously through hangers. Support piping at equipment independently so that no weight will be supported by equipment. Coordinate location of hangers with light fixtures. Wire brush all steel or iron supports and prepare surfaces under this Technical Special Provision for painting.

2. Special Supports: All clamps, hangers and supports required by equipment manufacturers, shall be furnished and installed as per their recommendations.

3. Plumber's tape, straps, chain, wire hangers, or perforated bar must not be allowed as a means for hanging pipe.

T737-4.7 Equipment Connections

1. Make connections between equipment and the piping systems as shown and specified.

2. Make connections between any piece of equipment and any piping system by means of unions, flange joints or other fittings which permit equipment to be disconnected and removed for maintenance.

T737-4.8 Condensate Dry Well

1. Field coordinate with civil site and grading plans, utility plans, and all other trades for the exact location of the condensate dry well.

2. Do not locate dry well in the direct path of the site conduits.

T737-5 Method of Measurement.

The Contract unit price for each toll site dry well and associated condensate piping will include furnishing, placement, and testing of all materials, equipment, and for all tools, labor, equipment, hardware, supplies, parts, support, shop drawings, manuals, warranty documentation, and demonstrations. Also include all acceptance procedures and incidentals necessary to complete the work.

T737-6 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 737- 1- Toll Site Dry Well and Accessories - Each

TECHNICAL SPECIAL PROVISION

FOR

_____

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T738
FIRE EXTINGUISHERS AND ACCESSORIES

T738-1 Description.

Furnish all labor, materials, services, testing, and equipment necessary to provide and install fire extinguishers with associated mounting accessories at Toll Facilities in accordance with the Plans and Specifications.

T738-2 Materials.

T738-2.1 Standards: Fire extinguishers and accessories must meet the following applicable industry standards:

1. National Fire Protection Association (NFPA): NFPA 10 - Portable Fire Extinguishers.
2. All fire extinguishers shall be Underwriters' Laboratories (UL) approved and labeled or by other National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7 to provide procurement flexibility.

T738-2.2 Furnish and install a multi-purpose, dry chemical stored pressure type UL listed fire extinguisher with the following material characteristics:

1. Corrosion-resistant, powder coated, metal cylinder with metal valve and siphon tube.
2. Rated 4A:80B:C with nominal capacity of 10 lbs.
3. Cabinet or wall mountable as indicated on the Plans.
4. Visual pressure gauge, stainless steel pull pin, handles.
5. Squeeze type valve, handle.
6. Operating temperature range from -20°F to +120°F.

T738-2.3 Furnish and install wall bracket-mounted fire extinguishers where indicated on the Plans. Furnish and install weatherproof surface mounted fire extinguisher cabinets at locations indicated on the Plans in accordance with the following:

1. Size: To suit type of unit being housed.
2. Frame Finish: Metal trim.
3. Door: Metal trim with 1/4-inch clear acrylic or tempered safety glass.
4. Signage: Identify extinguisher cabinets with manufacturer's standard red lettering applied to cabinet door, spelling "FIRE EXTINGUISHER".

T738-3 Submittals and Shop Drawings.

Submit manufacturer's technical data indicating compliance with the requirements and installation instructions for fire extinguishers, weatherproof cabinets, and accessories. Submit attachment details for exterior wall mounted, interior wall mounted and power distribution frame mounted fire extinguishers.

T738-4 Quality Assurance.

Provide new UL-listed fire extinguishers bearing UL "Listing Mark" for type, rating, and classification of extinguishers indicated. Provide fire extinguishers, cabinets, and accessories by single manufacturer.

T738-5 Construction Requirements.

Verify servicing, charging, and tagging of all fire extinguishers. Install the fire extinguishers and mounting accessories in strict accordance with the original design, approved

shop drawings, NFPA 10, and requirements of agencies having jurisdiction, anchoring all components firmly into position.

T738-6 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

TECHNICAL SPECIAL PROVISION

FOR

GENERAL REQUIREMENTS FOR TOLL SITE ELECTRICAL INFRASTRUCTURE

FINANCIAL PROJECT NO.: 442764-1-52-01

This item has been digitally signed and sealed by Stephen J Conway on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date:	October 5, 2021
Fla. License No.:	53532
Firm Name:	RS&H
Firm Address:	10748 Deerwood Park Blvd. South
City, State, Zip Code:	Jacksonville, FL, 32256

SECTION T740
GENERAL REQUIREMENTS FOR
TOLL SITE ELECTRICAL INFRASTRUCTURE

T740-1 Common Work Results for Electrical

T740-1.1 Description.

This section includes general electrical requirements specifically applicable to toll site infrastructure.

T740-1.2 Materials

1. All electrical equipment and materials used on this project shall be fully rated and new (not used or reconditioned). Electrical equipment and machinery shall be of the most current designs and models.

2. Unless otherwise noted, all material shall be listed / labeled by UL or another National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7.

3. Where multiple items of the same equipment or materials are required, furnish and install products of the same Manufacturer.

4. Material and equipment shall be provided complete and shall function up to the specified capacity or function. Should any material or equipment, as a part or as a whole, fail to meet the performance requirements, the material or equipment shall be replaced or repaired to bring the performance up to the specified requirements. Damages to the finish or the paint by such replacements, alterations, or repairs shall be restored to prior conditions, at no additional cost to the Department.

5. Where tamper proof screws are specified or required, Phillips head or Allen head screws are not acceptable as tamperproof. For each size or type used, provide the Department with three tools. If existing tamper proof equipment exists on the job site, the screw heads shall match the existing.

T740-1.2.1 Standards: Systems, equipment, materials, and accessories that are assembled or installed in a toll equipment building (TEB) shall comply with the following:

1. Florida Building Code, Current Edition in effect.
2. Florida Fire Prevention Code and the publications as referenced in NFPA 1 – Uniform Fire Code (the Current Edition in effect) and NFPA 101 – Life Safety Code (the Current Edition in effect).

T740-1.3 Submittals and Shop Drawings

1. Submit specific shop drawings which indicate the fabrication, assembly, installation, and erection of systems' components. Drawings that are part of the Plans shall not be considered a substitute for required shop drawings.

2. The Plans describe specific sizes for the electrical systems' basis of design. These sizes are based on specific items of power consuming equipment (lights, motors for fans, etc.). Coordinate the requirements of each load with each load's actual nameplate data and manufacturer's published electrical criteria.

3. Coordinate with the approved shop drawings from all required disciplines and verify final electrical characteristics before roughing in the power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in the Plans, make adjustments to the wiring, disconnects, and branch circuit protection to match the installed equipment's requirements.

4. Submit a detailed site conduit drawing at a scale of 1” = 20’ prior to the start of Work. Prepare a separate set of drawings for each toll site and show the site-specific name in the title block. Show routing of each conduit from origin to termination point. Coordinate the exact location of conduit stub-ups within the available working spaces.

5. Provide the following when TEBs are depicted on the toll facility plans:

a. Submit detailed interior TEB elevation drawings at a scale of 1/2” = 1’ prior to the start of Work. Prepare a separate set of drawings for each TEB and show the site-specific name in the title block. Provide a drawing for each wall in each of the TEBs in the project. Show the actual physical dimensions required for the installation to assure proper integration of the equipment with other TEB systems while maintaining NEC required clearances. Show locations of conduits, racking, junction boxes, panelboards, safety switches, receptacles, light switches, control panels, UPS units, bypass switches, surge protection devices, wall cabinets, telephone boards, thermostats, and all wall mounted equipment.

b. Submit detailed conduit routing drawings at a scale of 1/4” = 1’ for the enlarged site plan at the TEB prior to the start of Work. Prepare a separate set of drawings for each toll site and show the site-specific name in the title block. Show conduit stub-ups in the TEB floor slab and penetrations through the TEB walls. Show routing of each conduit from origin to termination point. Coordinate the exact location of conduit stub-ups with the available working spaces.

c. Submit an arc flash hazard analysis, in accordance with the latest version of the Standard for Electrical Safety in the Workplace, NFPA 70E. An arc flash hazard analysis determines the arc flash protection boundary and the personal protection equipment (PPE) that people within the arc flash boundary must use. Field install arc flash and shock warning labels on each piece of new electrical distribution equipment such as panelboards, safety switches, motor control centers, and automatic transfer switches. The labels must indicate the flash hazard boundary, the flash hazard at 18 inches, the PPE level requirements, and the approach restrictions.

T740-1.3.1 As-Built Documents:

In the As-Built documents, show all components including but not limited to:

1. Raceways 3/4" and above, cable tray systems, and grouped raceway racking as installed, including dimensions from fixed lines such as slab edges
2. Site underground raceways and duct banks
3. Pull boxes and manholes including elevations
4. Lighting
5. Junction boxes 6”x6” and larger must be shown in exact location.
6. Any combining of circuits (which is only allowed by specific permission) or change in homerun outlet box must be indicated
7. Circuit number changes
8. Conductors and cables, cable sizes, raceway sizes, etc.
9. Panelboard changes, including load changes
10. Access panels
11. Location of lighting control devices such as photocell controls, switches, etc.
12. Wireway and cable tray systems
13. Exact location of driven grounding electrodes
14. Locations of grounding and lightning protection ground loops

15. SCADA system control panels and associated electrical devices, connections, and power supplies as depicted on the toll facility plans

16. Riser diagrams exactly as installed

17. Panelboards, equipment racks, disconnects, and switches and surge-protective devices

18. Update the toll facility plan notes to match with items actually furnished, actual installation methods, etc.

T740-1.4 Warranty

1. The warranty will cover the materials and workmanship required to complete the project. The warranty shall be provided by the Contractor to the Department and shall include labor and materials for a minimum period of one year from date of Final Acceptance of the total Contract unless extended by the Contractor's proposal.

2. Where extended warranties or guarantees are called for herein, furnish three copies to be inserted in the Operation and Maintenance Manuals.

3. All preventative maintenance and normal service will be performed by the Department's maintenance personnel after Final Acceptance. This shall not alter the Contractor's one year warranty or the manufacturer's warranty of the installed equipment.

T740-1.5 Construction Requirements.

T740-1.5.1 General:

1. Wiring arrangements for equipment shown on the drawings are intended to be diagrammatic and do not show all required conductors and functional connections. Provide all items to form a complete and operating system.

2. Electrical distribution systems for toll facilities must be selectively coordinated systems. The protective features of the electrical distribution system will automatically and selectively isolate a faulted or overloaded circuit from the remainder of the electrical system. Only the closest protective device to the fault will operate to isolate the fault without affecting other parts of the system.

3. Obtain all new physical addresses that may be required for the initiation of new electric and/or communication services and pay any required costs and fees. Coordinate and verify power and telephone company service requirements prior to material procurement and installation of service equipment.

4. Occupied buildings must remain in operation while the new work is being performed. Schedule work for a minimum outage to the Department. Reroute existing conduit and wiring in areas under construction such that the building systems remain active and useable for the building occupants. Notify the Engineer and facility manager 48 hours before any shut-down of existing systems.

5. Coordinate with the Contractor for construction phasing. Renovation projects require the existing electrical systems to remain operational while the renovation work takes place.

6. Verify that the physical dimensions of the equipment will allow for proper installation in the space allotted on the drawings and with NEC working clearances.

7. Verify finish dimensions at the project site in preference to using dimensions noted on the Plans.

8. Electrical equipment shall be protected from the weather during shipment, storage, and construction per the manufacturer's recommendations. Should any

equipment be subjected to damage by water, it shall be replaced without additional cost to the Department.

9. Inspect all electrical equipment and materials prior to installation. Damaged equipment and materials shall not be installed or placed in service. Replace or repair the damaged equipment (in compliance with industry standards) at no additional cost to the Department. Any equipment and/or testing required for the repairs shall be provided by the Contractor.

T740-1.5.2 Supervision of the Work:

1. A qualified and experienced electrical superintendent shall be in charge of the work in progress at all times. If, in the judgment of the Department's representative, the electrical superintendent is not performing duties satisfactorily, the General Contractor shall immediately replace him upon receipt of a letter of request from the Department. Once a satisfactory electrical superintendent has been assigned to the work, he shall not be withdrawn by the Electrical Contractor without the written consent from the Department.

2. Provide field superintendent(s) who have a minimum of four years previous successful experience on projects of comparable sizes and complexity. Superintendent shall be present at all times that work under this Division is being installed or affected.

T740-1.5.3 Coordination:

Provide the labor and materials required to electrically connect all the items and equipment served by the power distribution systems in the toll facilities and tolling gantries that are identified in the contract documents. Include all required coordination and supervision where work connects to or is affected by the work of others.

T740-1.5.4 Provision for Openings: Perform the following for all toll equipment buildings depicted on the Toll Facility Plans.

1. Locate openings required for work. Provide sleeves, guards or other approved methods to allow passage of items installed.

2. Coordinate with roofing Contractor on installation of electrical items which penetrate the roof or are mounted on the roof. Roof penetrations shall be installed so as to not void the roof warranty.

3. Where work pierces any waterproofing, it shall maintain the integrity of the waterproofing. Coordinate the work which pierces the waterproof barrier with the General Contractor.

4. Coordinate with Fabricated Structures Manufacturer on installation of electrical items which penetrate the Toll Equipment Building floor, walls and ceiling.

5. Field verify all conduits installation penetrating the foundation to ensure that conduit layout is completed prior to the foundation pour.

T740-1.5.5 Concrete Pads: Furnish and install reinforced concrete pads for transformers. Unless otherwise noted, pads shall be four (4) inches high and shall exceed the dimensions of the equipment being set on them, including future sections, by six (6) inches on each side. The concrete pads will be reinforced with 6x6-W1.4xW1.4 welded wire mesh. Trowel all surfaces smooth.

T740-1.5.6 Cutting and Patching:

1. Provide cutting and patching necessary for the installation of electrical infrastructure.

2. Materials impacted by cutting and patching must be refinished to match specified finish.

3. Schedule work to avoid as much cutting and patching as practical.

T740-1.5.7 Trenching and Backfilling:

1. Place backfill at new grades to match adjacent undisturbed surface.

2. See Section 120 for trenching, backfilling, and compaction requirements.

3. Comply with OSHA Standard 29 C.F.R.s. 1926. 650 Subpart P for trench excavation.

T740-1.5.8 Delivery, Handling, Protection of Materials, and Storage:

1. Ship, deliver, and store products in the manufacturer's protective packing to prevent damage.

2. Handle equipment carefully to prevent damage to components, breakage and denting or scoring of surfaces and finishes.

3. Store all equipment and products in clean, dry spaces. Protect all equipment from dirt, fumes, water, chemicals, construction debris and physical damage. Any equipment exposed directly to moisture will not be acceptable and shall be replaced.

4. Replace damaged products and equipment. Repair and repaint marred and damaged finishes to original factory finish as directed by manufacturer and as specified.

5. Keep all conduits and other openings protected against entry of foreign matter.

T740-1.5.9 Installation: Install / use in accordance with any instructions included in the listing or labeling. Furnish and install supports and anchorage of electrical equipment.

T740-1.5.10 Waste Materials Disposal: Comply fully with Florida Statute 403.7186 regarding mercury containing devices and lamps. Lamps, ballasts and other materials shall be transported and disposed of in accordance with all DEP and EPA guidelines applicable at time of disposal.

T740-2 Shop Drawings Processes

T740-2.1 Description.

T740-2.1.1 Shop drawing submittals - Include:
List the project title and the contractor information on the first sheet of each shop drawing. Include the site-specific name of the building or site, the subcontractors, engineers, contact names, and telephone numbers.

1. Submit a shop drawing that includes specification sheets, catalog sheets, schematics, manuals, etc. for each separately numbered specification section in the Index of the Technical Special Provisions (TSP). If the project will not use any products from a TSP section, then submit the shop drawing with a note indicating "No products or materials from this TSP section will be installed on this project."

2. The following shop drawing sections must be compatible and operate together as a system when depicted on the Toll Facility plans:

a. Dual AC Control System and Sequence of Operation
b. Ductless Split System Air Conditioners
c. Fuel Oil Piping for TEB sites only
d. Concrete Protected Above Ground Fuel Storage Tank for TEB sites only
e. Supervisory Control and Data Acquisition
f. Panelboards
g. Engine Generator

h. Static Uninterruptible Power Supply

i. Automatic Transfer Switch

j. Service Entrance Automatic Transfer Switch for RTC sites with on-site-power

3. The following shop drawing sections must be compatible and must be coordinated for installation of the electrical conduits entering toll equipment buildings when depicted on the Toll Facility plans:

a. Fabricated Structures

b. Common Work Results for Electrical

4. Submittal product data shall be presented in a clear and thorough manner. Clearly mark each sheet to identify pertinent products or models applicable to this project. Indicate all optional equipment and delete or cross out non-pertinent data. Markings shall be made with arrows, circles or underlining. Highlighting is not acceptable.

5. Partial shop drawings for a TSP specification section are not acceptable and will not be reviewed. Ensure each shop drawing submittal is complete and includes all the products, materials, manuals, etc. specified in the particular TSP section.

6. Drawings, riser diagrams, wiring diagrams, and schematic diagrams shall include identification of the project name, and the specific site name when multiple sites are included in the same project.

7. Product Data: Technical product data is required for all items as called for in the specifications regardless if item furnished is as specified.

a. Submit technical data verifying that the item submitted complies with the requirements of the specifications. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate all optional equipment and changes from the standard item as called for in the specifications. Furnish drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.

b. In order to facilitate review of product data, they shall be clearly annotated, indicating by cross reference the contract drawings, note, and/or specification paragraph numbers where and/or what item(s) are used for and where item(s) occur in the contract documents. Identify product data as to the item and/or location (i.e. "surge suppression switchboard MDP").

c. See specific sections of the specifications for further requirements.

d. Re-Submit any technical data or shop drawing rejected by the Engineer of Record or the Department.

T740-3 Substitutions

T740-3.1 Description.

General, administrative and procedural requirements for substitutions of products specified in the toll site electrical, communications, and safety and security infrastructure TSP sections including toll equipment building TSP subsections where applicable.

T740-3.1.1 Definitions.

Substitutions: Products, materials, equipment, finishes, and methods of construction are considered substitutions if they meet any one of the following conditions:

1. Is not the specified manufacturer and/or model.

2. Accomplishes the same result as the specified product / basis of design product but requires more space and / or power.

3. Requires changes in other elements of the work such as (but not limited to) architectural, mechanical, structural, or other electrical work.

4. Affects the project schedule or cost.

T740-3.1.2 Permitted Substitute Equipment or Products (with "or equal")

Substitutions are permitted for manufactured items or equipment identified by part numbers or catalog numbers items specifically identified with the tag "or equal". Substitutions must conform to the following:

1. Substituted item is equal or superior to specified product in all aspects.

2. Substitutions will be provided at no additional cost to the Department.

3. Warranties for the substitution must be equal to or greater than the warranties specified.

4. Submit shop drawings and applicable calculations for the substituted item and all system and layout impacts, to the Engineer of Record for review. The shop drawings and applicable calculations must be signed and sealed by the Specialty Engineer or the Contractor's Engineer of Record. Submit in accordance with the requirements of 5-1.4.1 through 5-1.4.3, as appropriate.

5. Provide substituted item, equipment, product etc. and all changes to product, design, layout including the effort required to develop shop drawings and calculations at no additional cost to the Department.

6. Warranties for the substitution must be equal to or better than the warranties specified.

7. Substitutions must have the same space/layout profile and must not require changes to other design systems and / or their functionality. When the substituted item does not meet this criterion, the substitution will need to conform to the additional requirements below.

T740-3.1.3 Permitted Substitute Equipment or Products (without "or equal")

Substitutes proposed for an item, equipment, product, etc. that has not been identified with a tag "or equal" must at a minimum conform to the following additional criteria:

1. Substituted item must be equal or superior to specified product in all aspects.

2. Provide analysis of systems and layouts that may be affected by the substitution. Provide shop drawings, manufacturer's catalog cuts and operating instructions, calculations to demonstrate that the toll site and all associated systems continue to function at or a better level compared to the basis of design.

If a new request for substitution is submitted for an item that impacts previously approved requests for submission for any reason, the Department will require that the new and/or previously approved requests / documentation be re-submitted.

T740-3.2 Request for Substitution

T740-3.2.1 Representation: In submitting a substitute item, equipment, product, etc. that has not been listed on contract drawings, in contract documents or in an addendum, verify / perform the following:

1. Substituted item is equal or superior to specified product in all aspects.

2. Coordinate installation of accepted substitution into work, making changes as may be required to complete work in all aspects.

3. Waive all Claims for additional costs related to substitution which may subsequently become apparent.

4. Provide the same warranties for the substitution as for the product specified.

5. Absorb all costs incurred by the substitution when affecting other trades including but not limited to electrical, mechanical, structural, architectural, civil, etc.

6. Absorb any cost incurred by the Engineer in review of the substituted product if the acceptance of the substituted item creates the need for system modification and/or redesign, or if the substituting contractor exhibits negligence in his substituting procedure thus submitting inferior, misapplied or mis-sized equipment. In the event of additional engineering costs the billing structure shall be agreed upon prior to review by all involved parties.

7. Absorb any costs related to impacts to the project schedule or cost as a result of the use of the substituted item.

T740-3.2.2 Submittals: Submit separate requests for substitutions for each individual product, material, equipment, etc. that is defined as a substitution.

The submittal must consist of a dated written request for substitution as required below. The request must be very specific as to what specified item the request for substitution is submitted for.

Include the following in each request for substitution submittal:

1. Name of product, material, equipment, process etc. to be substituted.

2. Drawings, product data, calculations signed and sealed by a professional engineer licensed in the State of Florida, performance data and/or other information necessary for the Engineer to determine that the equipment meets all specifications and requirements.

3. Compliance statement. Each request for substitution shall include the following compliance statement typed on letterhead of submitting company:

a. Submittal complies with all aspects/requirements of contract documents: (Yes/No) If No, state deviances.

b. Submittal complies with all applicable codes: (Yes/No) If No, state deviances.

c. Submittal does not require change to any other element of the work: (Yes/No) If No, state required change.

d. Meets or exceeds the performance of specified product: (Yes/No) If No, state required change.

e. Affects project schedule: (Yes/No) If Yes, quantify impact.

T740-3.3 Consideration and Acceptance

T740-3.3.1 The Engineer's decision on acceptance or rejection of substitutions will be final.

T740-3.3.2 Substitutions will be considered on basis of design, concept of work, and overall conformance with information given in Contract Documents, including but not limited to:

1. Design criteria, which shall be equal or superior to the specified item.

2. Finishes, which shall be identical or superior to finishes of specified product.

3. Lenses or louvers, which shall be identical size, thickness and type material specified.

4. Physical size and dimension which are identical or within design criteria limitations.

5. Photometric data, which shall be identical or superior in quantity and quality.

6. Trim detail, electrical, and mechanical qualities, shall be identical or within design criteria limitations as determined by the Engineer.

T740-3.3.3 Approval of a substituted item or listing a substituted item as an approved substitution does not modify or act as a waiver in any way, of the requirements of the contract documents.

TECHNICAL SPECIAL PROVISION

FOR

_____

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T741
TOLL SITE ELECTRICAL
CONDUCTORS, CABLING, AND SUPPORTS

T741-1 Low Voltage Electrical Power Conductors and Cables

T741-1.1 Description. Includes conductors (wire), cable, wiring connectors, and connections.

T741-1.1.1 Submittals for Review:

1. Submit data sheets and catalog sheets describing each type of conductor, connector, splicing material, and terminal lug that will be installed on the project.
2. Include descriptive names for the conductors that indicate the system or equipment they serve. i.e. “generator feeders”, “service entrance conductors”.

T741-1.1.2 Qualifications

Manufacturer must specialize in manufacturing products specified in this Section with minimum five years’ experience.

T741-1.1.3 Toll Site Project Conditions

1. Conductor sizes on the Plans are based on copper.
2. Electrical power conductors 10 AWG and smaller may be spliced in order to construct longer circuits. Electrical power conductors 8 AWG and larger may not be spliced.
3. The current carrying capacity of electrical power conductors shall be determined using the tables in NEC Article 310. Calculating the current carrying capacity of conductors by assuming a lower ambient temperature than the one shown in the header of the Ampacity table(s) in Article 310 is not permissible, unless the lower ambient temperature is written and described in the Contract Documents.
4. Aluminum wiring is not permitted.
5. Ensure all sizes are given in American Wire Gauge (AWG) or in thousand circular mils (kcmil).
6. Conductors shall be marked with color codes as described in this Section.

T741-1.1.4 Coordination

1. Coordinate Work with other trades.
2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
3. Determine required separation between cable and other work.
4. Determine cable routing to avoid interference with other work.

T741-1.2 Materials.

T741-1.2.1 Conductors

1. Install THHN/THWN insulated copper conductors rated for 600 Volts, with PVC insulation, and a nylon thermoplastic outer jacket. Ensure the solid or stranded conductors are made of annealed copper and rated for 90°C in dry locations, and 75°C for wet or below grade locations. Ensure the conductors are UL 83 Listed and are suitable for use in residential, commercial, and industrial environments. All systems and low voltage conductors shall be stranded conductors.
2. Install XHHW or XHHW-2 insulated copper conductors rated 600 Volts, with XLPE insulation to protect the conductor against high temperatures and wet locations. Ensure the solid or stranded conductors are made of annealed copper and rated for

90°C in dry locations, and 75°C for wet or below grade locations. Ensure the conductors are UL 44 Listed and are suitable for use in residential, commercial, and industrial environments.

3. Type TC Multiconductor Power and Control Tray Cable.

a. The individual conductors shall be stranded copper with XHHW-2 insulation.

b. The overall cable jacket will consist of a flame retardant, moisture resistant, and sunlight resistant PVC covering.

c. The cable shall be listed for installation indoors, outdoors, in cable trays, raceways, and for direct burial in the ground.

d. Type TC cable may be installed as open wiring in lengths not to exceed fifty feet between the cable tray and the device or equipment served. Open wiring shall be secured and supported at intervals less than six feet.

e. Type TC Cables with three individual conductors sized between 12 AWG and 10 AWG shall be constructed with a green colored grounding conductor, a white neutral conductor, and a black phase conductor.

f. Type TC Cables with four individual conductors sized between 12 AWG and 10 AWG shall be constructed with a green colored grounding conductor, a white neutral conductor, a black phase conductor, and a red phase conductor.

T741-1.2.2 Wiring Connectors

1. Install fully insulated mechanical connectors, UL 486B Listed, and rated for 600 Volts maximum for 8 AWG and larger conductors in dry locations.

2. Install PVC insulated spring pressure cable connectors (wire nuts), UL 486C Listed, and rated 600 Volts maximum for 10 AWG and smaller conductors in dry locations.

3. Electrical conductor splices and/or taps below grade level are not acceptable for non-emergencies. For emergency conductor repairs below grade, install wrap-around UF splice kits with splice closure sleeves filled with sealing gel that entirely encapsulates the mechanical connector to seal out moisture. The underground splice kit shall be qualified to ANSI C119.1 for underground splicing and shall be rated for use on 600 Volt connections.

4. Communications cables, coaxial cables, and Ethernet cables shall be installed in continuous lengths and shall not be spliced in the field.

T741-1.3 Construction Requirements.

T741-1.3.1 Examination

1. Coordination and Meetings: Verify the existing conditions before starting work.

2. Verify that interior of any buildings are protected from weather.

3. Verify that mechanical work likely to damage wire and cable has been completed.

4. Verify that raceway installation is complete and supported.

5. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final approved submittal for equipment to assure proper number and size of the conductors. (As for multiple speed motors, different motor starter arrangements, etc.).

T741-1.3.2 Preparation

Completely and thoroughly swab raceway before installing wire.

T741-1.3.3 General

1. Install products in accordance with manufacturer's instructions.
2. Route wire and cable as required to meet the Project Conditions.
3. Install cable in accordance with the NECA "Standard of Installation".
4. Use solid conductor wire for feeders and branch circuits 10 AWG and smaller and use stranded conductors for #8 AWG and larger. Bonding grounding conductor can be solid copper. All systems and low voltage conductors shall be stranded conductors.
5. Use conductors 12 AWG or larger for power and lighting circuits.
6. Increase branch conductor sizes as required to maintain a branch circuit voltage drop of less than 3% to the load served when the branch circuit is operating at full rated load.
7. Ensure all 120V, 20A circuit homeruns over 50ft. are #10 cu. minimum unless noted otherwise.
8. Ensure all 120V, 20A circuit homeruns over 150ft. are #8 cu. minimum, unless noted otherwise.
9. Pull all conductors into the raceway at the same time. Do not exceed the manufacturer's recommended pulling tensions.
    a. Do not pull wire until the conduit system is complete from pull point to pull point and major equipment terminating conduits have been fixed in position.
    b. Ensure the minimum bending radius of insulated wires or cables is not less than the minimum recommended by the manufacturer or the NEC.
    c. Where coaxial or fiber optic conductors are installed, special requirements apply as outlined under that specific system detail specifications.
10. Use suitable wire pulling lubricant for wire. Ensure compound or lubricant does not cause the conductor or insulation to deteriorate.
11. Neatly train and lace wiring inside boxes, equipment, and panel boards.
12. Ensure conductor sizes indicated on circuit homeruns or in schedules are installed over the entire length of the circuit unless noted otherwise on the drawings or in these specifications.

T741-1.3.4 Vertical Risers

Provide vertical cable riser supports that are spaced per NEC 300.

T741-1.3.5 Control and Signal Circuits

1. For control and signal circuits above 50 VAC, conductors shall be #14 AWG minimum size, THWN/THHN.
2. For control and signal circuits 50 VAC and below, conductors, at the Contractor's option, may be #16 AWG, 300 volt rated, PVC insulated, except where specifically noted otherwise in the contract documents.
3. All control and signal circuit conductors shall be stranded copper conductors.

T741-1.3.6 Taps/Splices/Connectors/Terminations.

1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wire ways, junction boxes, outlet boxes, or

equipment enclosures where sufficient additional room is provided for all splices. No splices shall be made in in-ground pull boxes (without written approval of engineer).

4. Allow adequate conductor lengths in all junction boxes, pull boxes and terminal cabinets. All termination of conductors in which conductor is in tension will be rejected and shall be replaced with conductors of adequate length. This requirement shall include the providing by the Contractor of sleeve type vertical cable supports in vertical raceway installations provided in pull boxes at proper vertical spacing.

5. A calibrated torque wrench shall be used for all bolt tightening.

6. Clean conductor surfaces with a wire brush before installing lugs and connectors.

7. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

T741-1.3.7 Field Quality Control

1. Perform inspections and tests listed in the NETA ATS, Section 7.3

2. Perform an Insulation Resistance test – documenting the results using the Conductor Insulation Resistance template on all power system conductors larger than 10 AWG. Turn over written test results to the CEI within 48 hours of completing the test. Turn over written test results to the CEI within 48 hours of completing the test. A copy of the Conductor Insulation Resistance template may be obtained from the Engineer at the pre-construction conference

T741-1.4 Color Coding

1. All feeders and branch circuits No. 6 and smaller shall be wired with color-coded wire with the same color used for the system throughout the toll site. Feeders above No. 6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape or paint in all junction boxes and panels. Tape or paint shall completely cover the full length of conductor insulation within the box or panel.

2. Unless otherwise approved, or to match the existing, the color-codes must be as follows:

T741-1.4.1 Utility or Generator Power

1. 120/240 Volt, 1 phase, 3 wire
   a. Line 1 = black
   b. Line 2 = red
   c. Neutral = white
   d. Equip Ground = green

T741-1.4.2 UPS Power / Clean Power

1. 120/240 Volt, 1 phase, 3 wire
   a. Line 1 = black
   b. Line 2 = red
   c. Neutral = white with yellow stripe
   d. Equip ground = green with yellow stripe

T741-1.5 Method of Measurement.

The quantity to be paid for will be the plan quantity of each conductor and cable, in feet, completed and accepted. Measurement will be based on the overall length of each conductor between pull boxes, toll equipment, toll equipment buildings, and terminal devices. Add 10 feet of slack for each pull point and terminal device.

Do not include length of conductors or cables on the toll gantry; they are incidental to the gantry.

Do not include length of conductors or cables inside a toll equipment building; they are incidental to the toll equipment building.

T741-1.6 Basis of Payment.

Prices and payments will be full compensation for all work specified in this Section, including all materials, equipment and tests.

Payment will be made under:

Item No. 741- 1- Toll Site Conductors and Cables_____LF

T741-2 Grounding and Bonding for Electrical Systems

T741-2.1 Description. Furnish all labor, materials, services, testing, and equipment necessary to provide and install Grounding and Bonding for Electrical Systems at each toll site including the following elements:

1. Grounding electrodes and grounding electrode conductors
2. Inspection wells
3. Equipment grounding conductors
4. Supplemental Equipment Ground Bar installed below the service entrance main disconnect.

T741-2.1.1 Grounding System Description.

1. Bond together the following items to form the grounding system for the power distribution system.

a. Metal underground water pipe – if available

b. Metal frame of a TEB - if available

c. Concrete-encased electrode consisting of 20 feet of 2/0 AWG minimum size, bare copper conductor imbedded in a building footer or equipment slab and clamped to the rebar. Extend the conductor to the Neutral bar of the service entrance. Ensure this grounding electrode conductor is not spliced and not connected to the supplemental equipment ground bar.

d. Rod electrodes – Copper clad steel rods, 5/8-inch diameter, and UL Listed. A minimum of two rods are required for each electrical service.

e. Couplings or connectors used to join multiple ground rods together shall be of the threaded type.

f. Supplemental equipment ground bar located below or adjacent to the service entrance main disconnect.

g. The lightning protection system ground ring in accordance with NFPA 780.

2. If the Uninterruptible power supply (UPS) contains an isolation transformer and is considered a separately derived system, then the neutral point of the transformer will be grounded as follows:

a. One grounding electrode conductor will be extended to one of the ground rods installed at the service entrance.

b. One grounding electrode conductor will be extended to a concrete-encased electrode consisting of 20 feet of #4 AWG minimum size, bare copper conductor embedded in the building footer or equipment slab and clamped to the rebar.

3. Inside a TEB: Install a separate equipment grounding conductor to serve each computer equipment rack that will be installed. Some of the racks may be installed in

the future. For future equipment racks, coil 10 feet of #4 AWG stranded grounding conductor, colored green, above or below the rack location for future connection. Install a name tag that describes the purpose of the conductor. i.e. Toll Equipment Grounding Conductor.

4. Ground all raised metal frames that support toll equipment cabinets at two locations. Connect each end of the metal frame to the concrete encased electrode. The bonding jumper between the metal frame and the concrete encased electrode shall not be smaller than # 2/0 AWG bare Copper. Ensure the lugs connected to the metal frame are rated for aluminum and/or copper.

T741-2.1.2 Performance Requirements

1. Grounding Rod Resistance: Use the fall of potential three-point method and test each ground rod individually before connecting it to the system. Ensure the maximum resistance to ground (earth) does not exceed 25 Ohms. If a ground rod measures greater than 25 Ohms to ground then a second ground rod should be installed nearby, but not closer than the depth of the 1st rod, and then bond the two rods together with a direct buried conductor. Turn over the test reports to the Engineer within 1 week of performing the test.

2. The resistance to ground should be consistent between the ground rods. Any rod that measures more than 20% different than the surrounding rods should be investigated.

3. After bonding all the power system grounding components together, use the "Clamp on Method" to measure the resistance to ground of the completed system. Ensure the maximum resistance to ground (earth) does not exceed 5 Ohms. Drive additional ground rods if necessary to meet the requirements. Promptly turn over the test reports to the Engineer.

T741-2.1.3 Submittals for Review

1. Product Data: Submit data sheets for all grounding electrodes, clamps, bonding straps, ground bars, exothermic welding products, and inspection wells.

2. Submit a site specific One-Line Grounding Plan that indicates all grounding electrode conductor connection points and grounding conductor sizes at the service disconnect, automatic transfer switch (ATS), back-up generator, and the uninterruptable power supply (UPS) when depicted on the Toll Facility component plans.

3. Show the locations of the grounding system inspection wells on the Electrical Site Plan. Inspection wells in paved areas will be "traffic rated" H-20.

T741-2.1.4 Qualifications

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years of experience.

T741-2.2 Materials.

T741-2.2.1 Rod Electrodes

1. Material: Copper-clad steel, sectional with threaded couplings
2. Diameter: 5/8 inch
3. Length: 20 feet total length.

T741-2.2.2 Exothermic Connections

Use exothermic welding to bond the grounding conductors to the ground rods.

T741-2.2.3 Grounding Conductors

1. Material: Stranded or solid copper
2. Grounding Electrode Conductor: Sized to meet NFPA 70 requirements.

T741-2.2.4 Grounding Inspection Wells

1. Within non-paved areas, install non-traffic rated ground access wells that are manufactured from 20,000 PSI high density polymer concrete and meet ASTM C-857 specifications with a minimum size of 12" x 12" x 12". Install a high-density polymer concrete cover for each access well.

2. Install traffic rated ground access wells in paved areas and on roads or shoulders. The access wells shall be traffic rated H-20 with 10 inch diameter cast iron top and cast iron cover, with 12 inch minimum cast iron riser.

T741-2.2.5 Supplemental Equipment Ground Bar in TEB

1. Provide supplemental ground bars when depicted inside the TEBs on the Toll Facility component plans.

2. Install the supplemental equipment ground bar on the wall adjacent to, or under MDP. Use Red, 1 inch hex shaped standoff insulators, rated for 600 Volts to separate the bar from the wall. Install a grounding electrode conductor between the supplemental bar and the equipment ground bar, inside the service disconnect enclosure.

3. The equipment ground bar will Manufactured from electrolytic tough pitch 110 alloy copper bar with dimensions of approximately ¼ inch thick, 2 inches high, and 12 inches long.

T741-2.3 Construction Requirements.

T741-2.3.1 Examination

1. Verify existing conditions prior to beginning the work.

2. Verify that final backfill and compaction has been completed before driving rod electrodes.

T741-2.3.2 Installation

1. Install rod electrodes at locations indicated on the plans. The service entrance ground rod electrodes shall consist of two 20 ft driven rods spaced 20 feet apart or more.

2. Provide a grounding inspection well at each driven rod location in the power distribution system (not for lightning protection system). The top of the inspection well will be flush with the finished grade.

3. A main bonding jumper shall connect the neutral bus to the ground bus at the first service disconnect.

4. The main grounding electrode conductor shall be installed in one continuous length and shall not be spliced or broken at any point until it terminates at the neutral bus within the first service disconnecting means.

5. Provide bonding to meet NFPA 70 and Regulatory Requirements (i.e., metal duct work, metal piping, gas piping etc.).

6. Bond together metal siding not attached to a grounded structure and bond to ground.

7. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Ground the metal wall studs when conductors are installed through holes in the studs.

T741-2.3.3 Field Quality Control

Measure the continuity of each grounding electrode conductor after it is installed and prior to connecting it to the system. The maximum acceptable continuity resistance is 0.02 Ohms.

T741-2.4 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T741-3 Hangers and Supports for Electrical Systems

T741-3.1 Description. Furnish of all labor, materials, services, testing, and equipment necessary to provide and install hangers and supports for electrical systems at each toll site including the following:

1. Hardware for the support of conduit, tubing, and cable
2. Wireway supports and wire trough supports
3. Anchors and fasteners

T741-3.1.1 Submittals and Shop Drawings

1. Product Data: Provide manufacturer's catalog data for hangers, supports, and fastening systems.

2. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.

3. Submit strut channel frame support material certifications and scaled drawings ½" = 1' showing the support frame design.

T741-3.1.2 Regulatory Requirements

1. Conform to requirements of NFPA 70, the National Electrical Code.

2. Furnish products listed and classified by Underwriters Laboratories, Inc. and acceptable to the Department as suitable for purpose specified and shown.

3. ASTM A123 - Specifications for Zinc Coatings on Iron and Steel products.

T741-3.2 Materials.

T741-3.2.1 Product Requirements

1. Materials and Finishes: Provide products with adequate corrosion resistance based on the environment where the products are installed. All steel products must be hot-dipped galvanized except for stainless steel products.

2. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of the supported equipment and the conduit. Consider the weight of the wires in the conduit when selecting products.

3. Anchors and Fasteners:

a. Concrete surfaces and structural elements: Use expansion anchors, preset inserts, and self-drilling anchors.

b. Steel Structural Elements: Use beam clamps that will not damage the protective zinc coating of galvanized steel.

c. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.

d. Solid Masonry Walls: Use expansion anchors, preset inserts, and self-drilling anchors.

e. Sheet Metal: Use galvanized sheet metal screws.

f. Wood Elements: Use galvanized wood screws.

T741-3.2.2 Steel Strut Channel

1. The cross-sectional width dimension of the steel strut channel (channel) must be a minimum of 1-1/2". The depth will be as required to satisfy the load requirements. Channel with 1-1/2" depth or greater must be rolled from 12-gauge steel.

2. Attachment holes, when required, must be factory punched on hole centers equal to the channel cross sectional width dimension and must be a maximum of 9/16" diameter.

3. Channel attachment nuts must be designed to pre-locate in the strut channel and provide a bearing surface on the turned down lips while making positive contact with the side walls of the channel.

4. Steel channel sections must be rolled from AISI C1018 commercial grade steel and be in conformance with ASTM A569.

5. 4. Stainless steel channel sections must be available in either 304 or 316 stainless steel.

6. Steel channel used for modular metal framing and conduit supports must be in compliance with the Federal Specification W-C-582 and Federal Specification WW-H-171.

7. Install steel strut channel in straight sections only and do not be bent in the field.

8. Install hot dipped galvanized after fabrication channel or stainless steel channel for exterior applications. Install painted steel or hot dipped galvanized channel for indoor applications. Steel channel that is hot dipped galvanized after fabrication must have a minimum Zinc thickness of 1.5 ounces per square foot on each surface according to ASTM A123 - Specifications for Zinc Coatings on Iron and Steel products.

9. Install bolt nut and washer assemblies in accordance 460-5.

10. Repair damaged zinc finish on field cut and field drilled galvanized steel strut channel by using cold galvanizing methods. The cold galvanizing compound must be pre-mixed and composed of a liquid organic zinc compound. After application, the dried zinc compound film must be 95% metallic zinc.

11. Provide protective end caps on channel ends. The protective caps must be made of soft PVC and manufactured by the same company that manufactured the channel.

T741-3.2.3 Conduit Supports and Fasteners

1. Support conduit securely and fasten to the structure it is installed upon. The conduit mounting hardware must be manufactured by the same company that manufactured the channel for the environment they were designed.

a. Hangers, clamps, straps, and hardware for supporting conduit must be listed in accordance with UL 2239 – Hardware for the Support of Conduit Tubing, and Cable by UL or other National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7.

b. Hardware for supporting boxes must be UL 514A listed by UL or other NRTL.

c. Cable ties or Ty-wraps must not be used to support conduit or junction boxes.

2. Conduit supports and support fasteners and bolts used outdoors or in wet locations must be manufactured from carbon steel and must be hot dipped galvanized after fabrication and according to ASTM A123.

T741-3.3 Shop Drawings and Submittals

Provide catalog sheets showing fastening details as applicable. Provide steel strut channel product data including strut channel frame support material, attachment details for attaching to the concrete pad and attachment details for attaching equipment to the strut channel frame. Provide mounting details for raceways and boxes, fire extinguisher cabinets and accessories mounted to the frames.

Provide manufacturer's installation instructions including application conditions and limitations of use stipulated by Product testing agency specified under Standards. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

T741-3.4 Construction Requirements.

T741-3.4.1 Installation

1. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".

2. Do not use powder-actuated anchors to secure electrical equipment.

3. Obtain permission from Engineer before drilling or cutting structural members or galvanized metal.

4. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

5. Install Power Distribution Frame and E6 Mounting Frame in accordance with the following:

a. Attachment holes, when required, must be factory punched on hole centers equal to the channel cross sectional width dimension and must be a maximum of 9/16" diameter.

b. Channel attachment nuts must be designed to pre-locate in the channel and provide a bearing surface on the turned down lips while making positive contact with the side walls of the channel.

c. Steel channel must be installed in straight sections only and must not be bent in the field.

d. Install protective end caps on channel ends.

6. Install surface-mounted cabinets and panelboards with minimum of four anchors.

7. In TEBs, interior items must be supported directly from structural portion of the building. All ceiling mounted items must be supported directly from the building superstructure. Provide with supplemental threaded rod hangers from super structure as specified elsewhere. No sagging of the ceiling will be permitted. Adjust supplemental supports accordingly.

8. The use of perforated iron straps for supporting conduits will not be permitted. The required strength of the supporting equipment and size and type of anchors must be based on the combined weight of conduit, hanger, and cables.

9. Group together parallel groups of conduit or conduit runs in a similar direction and support by means of 1½" x 1½", 12-gauge, pre-galvanized zinc coated conduit strut

channel trapeze hanger system (racking) consisting of concrete inserts, threaded rods, washers, nuts, locknut washers, etc. Individually fasten galvanized angle iron to cross members with malleable iron hangars listed and approved for use on angle iron, bolted with proper size cadmium machine bolts, washers and nuts. Individually fasten conduits supported by strut channel with two-piece strut channel straps with bolts and nuts listed and approved for such use. Beam clamps must be malleable iron.

10. Hangers for PVC coated conduit must be PVC coated and galvanized.

11. On concrete, install insert anchors with round head galvanized machine screws. In wood construction, provide round head screws. An electric or hand drill must be used for drilling holes for all inserts in concrete or similar construction. Fabricate all screws, bolts, washers, etc., used for supporting conduit or outlets from rust-resisting metal.

12. Threaded rod hangers must be galvanized continuous thread type, minimum 3/8" diameter. Increase size as required to support assembly. Bending of rod hangars is not permitted.

13. Conduit support racks must be minimum of 24", increase, distance as required for quantity of conduits and spare capacity) provide space on each rack for 25 percent additional conduits. Group conduits on channel racking adjacent to each other at sides, allowing all remaining unused space at center as spare capacity. Do not exceed 1” spacing between conduits.

14. In TEBs, provide a minimum of two (2) all-thread rod hangers for each rack located at the ends of the channel. Increase number of hangars as required to support assembly.

15. In general conduit supporting devices such as spring type conduit clips are not acceptable. Conduit clips with snap close strap are acceptable for use in dry interior concealed locations only. Back-to-back arrangement or attachment to other raceways, piping, etc. is not permitted.

16. All hangers, clips and accessories for supporting must be listed by UL or other NRTL.

17. Support systems must meet requirements for seismic loads. Refer to general Conditions of the specifications.

18. Materials installed in environmental air plenum must be UL Plenum listed by UL or other NRTL and bear the appropriate markings.

19. Support conductors not in raceways directly from the structure with devices listed by UL or other NRTL as intended for such use. Cable ties used with listed support devices within plenum air environments must be plenum rated by UL or other NRTL.

T741-3.5 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T741-4 Surface Raceways and Wire Troughs

T741-4.1 Description. Furnish of all labor, materials, services, testing, and equipment necessary to provide and install surface raceways and wire troughs at each toll site.

T741-4.1.1 Submittals and Shop Drawings

1. Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, finishes, and accessories.

2. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.

Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

T741-4.1.2 Quality Assurance

1. Perform Work in accordance with NECA Standard of Installation.
2. Maintain one copy of document on site.

T741-4.1.3 Qualifications

Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years of experience.

T741-4.2 Materials.

T741-4.2.1 Wireways Installed Outdoors:

1. Wireways installed vertically or horizontally on toll equipment gantry structures shall be the Feed-Through type with a minimum cross section of 6 inches by 6 inches.
2. Wireways installed outdoors shall be manufactured from temperature and chemically resistant fiberglass material and shall be rated NEMA 3R, and NEMA 12, and IP55.
3. Vertically mounted wireways shall be listed for vertical installation and the removable covers shall be equipped with captivated monel cover screws and oil resistant gaskets.
4. Wireways shall be fastened in place using the manufacturers brackets or hangers and in accordance with the manufacturer's installation instructions.

T741-4.2.2 Wire Troughs

1. Wire troughs installed indoors in dry locations shall have a minimum cross section of 12 inches by 12 inches and be manufactured from 14-gauge steel and then phosphatized before painting inside and outside with ANSI 61 gray colored polyester paint.
   a. Indoor wire troughs shall be equipped with slip-on removable covers and embossed mounting holes on the back of the enclosure.
   b. Do not field drill mounting holes in the enclosure. Use the embossed mounting holes provided by the manufacturer.
2. Wire troughs installed outdoors or in wet locations shall have a minimum cross section of 12 inches by 12 inches and shall be manufactured from 14-gauge galvanized steel and then phosphatized before painting inside and outside with ANSI 61 gray colored polyester paint.
   a. Outdoor wire troughs shall include an integral drip-shield along the top, and seam free sides, front, and back.
   b. The removable front cover shall be a "slip on" type metal cover with corrosion resistant fasteners along the bottom of the cover. The fasteners shall be captive and held to the cover. The removable cover shall include provisions for padlocking.
   c. Factory provided mounting holes on the back of the wire troughs shall be embossed. Field drilled mounting holes are not acceptable.
   d. The wire troughs shall be UL 870 listed, and rated NEMA 3R or NEMA 4X.

T741-4.3 Construction Requirements.

T741-4.3.1 Installation

1. Install products in accordance with manufacturer's instructions.
2. Wireways and wire troughs shall be mounted plumb and level.

3. Wireways shall be secured to the structure using the original equipment manufacturer's brackets and/or hangers.

4. The ends of all wireways shall be closed using the original equipment manufacturers fittings.

5. Field drilling for mounting galvanized metal enclosures, or wire troughs is not acceptable. Use factory provided mounting holes only.

6. Do not terminate conduits and wireways into the top of a wire trough where installed outdoors.

T741-4.4 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T741-5 Cable Trays

T741-5.1 Description. Furnish of all labor, materials, services, testing, and equipment necessary to provide and install Cable Trays at each toll site including the following:

1. Aluminum cable trays and accessories.
2. Cable trays for use within toll equipment buildings.
3. Cable trays for use on outdoor gantries.

T741-5.1.1 Submittals for Review

1. Product Data: Provide data for fittings and accessories.
2. Shop Drawings: Indicate tray type, metal type, rung spacing, loading depth in accordance with NEMA VE 1, dimensions, support types, support points, accessories, and finishes.

T741-5.1.2 Submittals for Information

1. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

T741-5.1.3 Qualifications

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years of experience, and with service facilities within 100 miles of Project.

T741-5.1.4 Field Measurements

1. Verify that field measurements are as indicated on shop drawings, instructed by manufacturer.

T741-5.2 Materials.

T741-5.2.1 Ladder-Type Cable Tray Requirements for Toll Equipment Buildings

1. Loading depth: 4-inch NEMA VE 1 loading depth with 5-inch total side rail height.

2. The aluminum cable tray side rails will be manufactured from aluminum alloy extrusions that meet the material specifications of the Aluminum Association Alloy #6063-T6.

3. Ensure the cable tray system is designed to safely support a uniformly distributed load of 100 pounds per foot with 8-foot support spans. When loaded at 100 pounds per foot, the maximum deflection of the cable tray shall not exceed ½ inch at any point.

4. The UL cross sectional area of each side rail shall be 1 square inch or larger.

5. Finish: Aluminum – non painted

6. Inside Width: 24 inches minimum

7. Inside Depth: 4 inches minimum

8. The cable tray shall be equipped with a 4-inch center divider to separate the power cables from the data cables.

9. Straight Section Rung Spacing: 6 inches on center. Each rung must be capable of supporting a 200-pound concentrated load at the center of the cable tray over and above the cable load with a safety factor of 1.5.

10. Minimum Radius of any Fittings: 12 inches

11. Provide drop out fittings and drop out bushings above the tolling communications cabinet.

12. Provide manufacturer's standard clamps, hangers, brackets, splice plates, expansion joints, reducer plates, blind ends, barrier strips, connectors, conduit to tray adaptors, ladder drop-out fittings, and grounding straps.

13. Support the cable tray inside a toll equipment building at 8-foot intervals from the ceiling using factory provided Trapeze Support Kits consisting of pre-galvanized steel channel with zinc plated hardware, hold down guide clamps, square washers, head cap screws and channel nuts.

T741-5.2.2 Cable Tray Requirements for Outdoor Gantries

1. Longitudinal Ladder Style Cable Tray

a. Loading depth: 4” NEMA VE 1 with 5” total rail height.

a. The aluminum cable tray side rails will be manufactured from aluminum alloy extrusions that meet the material specifications of the Aluminum Association Alloy #6063-T6.

b. Ensure the cable tray system is designed to safely support a uniformly distributed load of 100 pounds per foot with 6-foot support spans. When loaded at 100 pounds per foot, the maximum deflection of the cable tray shall not exceed ½ inch at any point

c. The UL cross sectional area of each side rail shall be 1 square inches minimum.

d. Finish: Aluminum, non-painted.

e. Inside width for Accessible Gantries: 24” for Data; 6” for Power.

f. Inside width for Non-Accessible Gantries: See Plans.

g. Accessible Gantries: The DATA cable tray must be equipped with a center divider to separate the future tolling data cables from the E6 coaxial cables.

h. Non-Accessible Gantries: The cable tray must be equipped with two dividers to separate the future tolling data cables, E6 coaxial cables, and power cables.

i. Straight Section Rung Spacing: 6 inches on center.

j. Provide manufacturer's standard clamps, hangers, brackets, splice plates, expansion joints, reducer plates, blind ends, barrier strips, connectors, conduit to tray adaptors, ladder drop-out fittings, and grounding straps.

2. Transverse & Equipment Ventilated Channel Style Cable Tray

a. Loading depth: 1-3/4” height.

b. The aluminum cable tray will be manufactured from aluminum alloy that meets the material specifications of the Aluminum Association Alloy #6063-T6.

c. Ensure the cable tray system is designed to safely support a uniformly distributed load of 30 pounds per foot with 6-foot support spans.

d. The UL cross sectional area of each side rail shall be 0.4 square inches minimum.

e. Finish: Aluminum, non-painted.

f. Inside width: 4".

g. Provide manufacturer's standard clamps, hangers, brackets, splice plates, expansion joints, blind ends, barrier strips, connectors, grommets, conduit to tray adaptors, drop-out fittings, and grounding straps.

T741-5.2.3 Warning Signs

1. Engraved Nameplates: 1/2-inch black letters on yellow laminated plastic nameplate, engraved with the following wording:

2. WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

T741-5.3 Construction Requirements.

Install metallic cable tray in accordance with NEMA VE 1. Provide supports at each connection point, at the end of each run, at other points to maintain spacing between supports of 8 ft maximum, and as required by the manufacturer. Use expansion connectors where required where joints are crossed.

At toll equipment buildings, provide UL or other NRTL Listed fire stopping to sustain the wall fire ratings when passing cable tray through fire-rated elements and partitions.

Ground and bond cable tray. Provide electrical continuity between all tray components. For ladder type cable tray: Install a 10 AWG copper equipment grounding conductor from the service entrance ground bus to the cable tray. Use Cu/Al rated mechanical lugs at the end of the grounding conductor to bond it to the cable tray. For ladder type cable tray at outdoor gantries: Bond the cable tray and each metal conduit with grounding bushings and a #10 AWG, minimum bare copper equipment grounding conductor. Bond all metallic conduits terminating at the tray by using bonding type bushings. Install to create a continuous, low-resistance, electrical ground return path in accordance with the requirements of the NEC.

Use anti-oxidant compound to prepare aluminum contact surfaces before assembly. Electrical connections to the cable tray shall be made with Cu/Al rated lugs. Carefully coordinate the cable tray installation with other trades to avoid interferences and maintain proper NEC clearances. Install the cable tray at plan locations and heights and as required by field connections. Cable tray wire shall not be spliced at the tray or inside the tray. Cable tray installed outside will utilize screw on covers to protect the cables from the elements.

T741-5.4 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T741-6 Identification for Electrical Systems

T741-6.1 Description.

Furnish and install the following:

1. Nameplates and labels
2. Wire and cable markers

3. Conduit markers

T741-6.1.1 Submittals and Shop Drawings

1. Product Data: Provide catalog data for nameplates, labels, and markers.

2. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

T741-6.1.2 Regulatory Requirements

1. Conform to requirements of ANSI/NFPA 70.

2. Furnish products listed and classified by Underwriters Laboratories, Inc., and acceptable to authority having jurisdiction as suitable for purpose specified and shown.

T741-1.1 Materials.

T741-6.1.3 Nameplates

1. Nameplates for normal power: Laminated phenolic plastic, chamfer edges, red (and black version) front white core, with lettering etched through the outer covering. White engraved letters on red (and black version) background.

2. Nameplates for emergency power (where applicable): Laminated phenolic plastic. Red front, with white core, with lettering etched through outer covering, white engraved letters on red background.

3. Letter Size:

a. Use 1/4-inch-high letters for identifying individual equipment and loads.

b. Use 1/2-inch-high letters for identifying grouped equipment and loads.

c. Use 1-inch-high letters for identifying Service Disconnecting means.

4. Provide nameplates that adequately describe the function of the particular equipment involved. Where nameplates are detailed on the drawings, inscription and size of letters shall be as shown and shop drawing submitted for approval. Nameplates for panelboards must include the panel designation, voltage and phase of the supply. For example, “Panel A, 120/208V, 3-phase, 4-wire”. In addition, provide phenolic label in panel to describe where the panel is fed from. For example, “Fed from MDP-1:3:5”. The name of the machine on the nameplates for a particular machine shall be the same as the names used on all motor starters, and disconnect switches for that machine.

5. Equip the following items with nameplates: Wire troughs, and conduits at the base of the gantry. All motors, motor starters, push button stations, control panels, time switches, disconnect switches, transformers, panelboards, all circuit breakers in panelboards greater than 400 Amps, contactors or relays in separate enclosures, power receptacles where the nominal voltage between any pair of contacts is greater than 150V, wall switches controlling outlets that are not located within sight of the controlling switch, high voltage boxes and cabinets, large electrical systems junction and pull boxes (larger than 4 11/16”), terminal cabinets, terminal boards, and equipment racks. Describe the associated panel and circuit number on the nameplate.

6. Field install Arc Flash and Shock Warning labels on each piece of new electrical distribution equipment such as panelboards, safety switches, and automatic transfer

switches. The labels will indicate the flash hazard boundary, the flash hazard at 18 inches, the PPE level requirements, and the approach restrictions.

7. Provide adhesion labels on inside door of each fused switch indicating NEMA fuse classification and the size fuse installed.

T741-6.1.4 Wire Markers

1. Description: Cloth, tape, split sleeve, or tubing type wire markers.

2. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

3. Legend:

a. Power and Lighting Circuits at both ends of each conductor. Branch circuit numbers or feeder numbers as indicated on the construction plans. Including the neutral conductor. i.e. The conductor connected to circuit breaker #2 will be labeled with a wire marker showing "2". The neutral associated with this circuit will also be labeled with a wire marker showing "2".

b. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on shop drawings.

T741-6.1.5 Conduit/Junction Box Color Code

1. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

Color Code for Junction Boxes	Krylon Paint #
System Emergency 120/208 volt	Light Red 2110
Fire Alarm	Popsicle Orange 2410
Normal Power 120/240 volt	Glossy Black 1601
Fiber Optics	Plum Purple 1929
Sound System	Daisy Yellow 1813
Intercom	True Blue 1910
Computer/Data	Gold 1701
BAS	Light Beige 2502
FIDS / BIDS	Beige 2504
Security/CCTV	Moss Green 2004
Telephone	Light Green 2011
Grounding	Fluorescent Green #3106

2. Conduits (not subject to public view) longer than 20 feet shall be painted with above color paint band 20 ft. on center. Paint band shall be 4" in length. Where conduit is parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be neatly applied and uniformed. Paint boxes and raceways prior to installation or tape conduits and surrounding surfaces to avoid overspray. Paint overspray shall be removed.

3. Junction boxes and conduit located in public areas (i.e. areas that can be seen by the public) shall be painted to match surface attached to.

T741-6.1.6 Conduit/Junction Box Marker

1. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately describe it's associated panel and circuit reference number(s) within, (i.e. ELRW-2, 4, 6) or systems within (i.e. fire alarm, SCADA, etc.). Identification shall be by means of black permanent marker. (Paint 1/2 cover plate with appropriate color as noted above, and mark other 1/2 with associated panel/circuit or system description as described).

2. Identify conduit not installed in public areas with circuit numbers as described above. Spacing: 20 ft. on center, adjacent to color identification bands.

T741-6.1.7 Device Cover Plate Identification

1. Self-adhesive clear printed labels with Black typed letters (pre-printed, dot matrix, or laser). Labels printed with Ink Jet printers are not acceptable.

2. Locations:

a. Each new switch and receptacle cover plate.

b. Each existing switch and receptacle cover plate in areas of remodel/renovation.

c. Each new communications cover plate.

d. Each existing communications cover plate in areas of remodel/renovation.

3. Legend:

a. Receptacle plates adequately describe its associated panelboard and circuit reference (i.e., L1A-3).

b. System plates adequately describe its terminal board, or terminal cabinet, termination cable identifier, and assigned user code number, (i.e., TTB-LS2-***).

T741-6.1.8 Underground Warning Tape

4-inch-wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

T741-6.1.9 Signage

1. Description: Laminated phenolic plastic, chamfer edges, white core, face color as specified elsewhere, with lettering etched through the outer covering, 1" lettering.

2. Locations:

a. More than one service per NEC (if applicable).

b. Emergency Generator Systems per NEC (if applicable).

T741-6.2 Construction Requirements.

T741-6.2.1 Preparation

Degrease and clean surfaces to receive nameplates.

T741-6.2.2 Application

1. Install nameplate parallel to equipment lines.

2. Secure nameplate to equipment front using stainless steel pop rivets.

3. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

4. Paint colored band on each conduit longer than 6 feet (2 m).

5. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

6. Identify junction boxes and outlet boxes.

7. Nameplates installed inside on dead front cover shall be self-adhesive tape. (Do not drill or install screws in dead front unless prior approval is granted by equipment manufacturer).

8. Exterior nameplates installed on wire troughs and all outdoor electrical equipment must be provided with an epoxy-based adhesive.

9. Install wire markers at all connections and terminations.

T741-6.3 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T741-7 Lightning Protection System

T741-7.1 Description. Provide a Class I lightning protection system as described in NFPA 780, LPI 175, UL 96A, NEC, and the Plans and Specifications to protect toll equipment building (TEB), the toll equipment gantry(ies), the fuel tank, generator set, outdoor metal enclosures, outdoor equipment racks and any outdoor equipment that extends higher than 10 feet above grade level.

T741-7.2 Materials.

T741-7.2.1 Conductors

1. Grounding ring electrode conductors and underground conductors must be copper and the minimum acceptable size is 98,600 circular mils, with 24 strands.

2. TEB Roof conductors must consist of copper or aluminum conductors complying with the weight and construction requirements of the Code. Roof conductors will be chemically compatible with the roofing components and metal flashing. The angle of any turn shall not exceed 90° and shall provide an approximately horizontal or downward course.

3. Down conductors must be copper.

4. Air Terminals: Aluminum or copper with a threaded 5/8-inch diameter base and pointed at the tip. Air terminals will be solid and not hollow.

T741-1.1.1 TEB Through Roof Fittings: Through roof fittings must be compatible with the roofing system and will not affect the roof warranty.

T741-7.2.2 Fasteners: Conductor fasteners must be of the same material as the conductor, having ample strength to support conductor.

T741-7.2.3 Ground Rods: Lightning protection system ground rods will be sectional, 5/8" diameter, copper clad steel ground rods. The copper cladding must be a minimum of 0.010 inch thick.

T741-7.3 Submittals and Shop Drawings.

1. Submit shop drawings for review before site work begins. Include drawings of the entire site that shows the location of all site components and interconnections between each component and each piece of equipment bonded to the system. Include locations of air terminals, cabling, ground rings, ground rods, down conductors. For TEBs, submit an enlarged cross-sectional detail of the through roof fittings properly installed in the roof.

2. Submit product data sheets on air terminals, cabling, ground rings, ground rods, down conductors, through roof fittings, fasteners, cable connectors and exothermic welding products.

T741-7.3.1 Qualifications: Submit written evidence showing manufacturer and installer's qualification to the Department prior to beginning work.

1. Manufacturers: Firms regularly engaged in manufacture of lightning protection systems, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Installer: Firms holding an EC License in the State of Florida with at least five (5) years of successful installation experience on projects with electrical installation work similar to that required for the project.

T741-7.4 Construction Requirements.

The system will be installed by experienced installers in compliance with NFPA 780, the Lightning Protection Institute Standard of Practice 175, and Underwriters' Laboratories.

1. All equipment to protect the toll site against damage by lightning must be included whether or not specifically called for herein.

2. Install a 98,600 circular mil, 24 strand, bare copper lightning protection grounding electrode conductor around each toll structure extending out to each piece of equipment on the site. Install the conductor in direct contact with the earth and a minimum of 30 inches below grade.

3. Ground each metal support column on toll equipment structures (i.e. gantries) at two separate points near the base of the columns. Each grounding point must have a grounding pad and a separate down conductor and separate ground rod. The ground rods must be bonded together below grade.

4. The grounding lugs at the base of the gantry columns must be installed by the gantry fabricator. Field welding to galvanized metal gantries is not acceptable.

5. The ground rods will extend into the earth vertically not less than 20 feet.

6. Install in an inconspicuous manner with conductors coursed to be concealed as much as possible.

7. All metallic equipment within 6 feet of any lightning conductor shall be bonded to conductor.

8. Install lightning protection conductors that require physical protection in schedule 80 PVC conduit.

9. Conceal down conductors in TEBs within the walls. Down conductors concealed within walls shall be installed in PVC conduit. The radius of any bend shall not be less than 8 inches. “Through Roof” devices will be installed when penetrating a roof.

10. Ensure “Through Roof” devices are compatible with the roofing materials. The Through Roof devices will be turned over to the roofing contractor for installation.

11. Install all air terminals vertically. Install swivel type air terminal bases on angled surfaces and roofs.

a. Glue may not be used to secure an air terminal to a vertical surface such as a parapet.

b. Air terminals are not required on electrically continuous metallic toll equipment gantries.

c. Air terminals are not required on metallic outdoor generator set enclosures.

12. The following lightning protection systems at each site will be bonded together by a 98,600 circular mil, 24 strand, direct buried copper conductor.

a. TEBs within 500 feet of each other.

b. Toll gantry columns

c. Engine generator, enclosure, and fuel tank with any metal piping

d. Metal enclosures and wireways

13. The completed system will be inspected by an independent 3rd party and must receive a UL Master Label or The Lightning Protection Institute Inspection Program (LPI-IP) Certificate.

T741-7.4.2 Conductor Connections and Splices

1. Connections above grade level will be made with mechanically bolted fittings of aluminum, copper, or tin-plated bronze.

2. Connections below grade will be made by welding.

T741-7.4.3 Testing

1. Use the fall of potential three-point method and test each ground rod individually before connecting it to the system. Ensure the maximum resistance to ground (earth) does not exceed 25 Ohms. If a ground rod measures greater than 25 Ohms to ground then a second ground rod should be installed nearby, but not closer than the depth of the 1st rod, and then bond the two rods together with a direct buried conductor. Turn over the test reports to the Engineer within 1 week of performing the test.

2. The resistance to ground should be consistent between the ground rods. Any rod that measures more than 20% different than the surrounding rods should be investigated.

3. After bonding all the lightning protection system ground rods together and connecting the ground rings, use the "Clamp on Method" to measure the resistance to ground of the completed lightning protection ground rod system. Ensure the maximum resistance to ground (earth) does not exceed 5 Ohms. Drive additional ground rods if necessary to obtain a resistance to ground reading of 5 Ohms or less. Turn over the test reports to the Department within 1 week of performing the test.

T741-7.5 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

TECHNICAL SPECIAL PROVISION

FOR

_____

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T742
TOLL FACILITY ELECTRICAL EQUIPMENT

T742-1 General

Furnish all labor, materials, services, testing, and equipment necessary to provide and install toll facility electrical equipment for Roadside Tolling Cabinet (RTC) sites and Toll Equipment Building (TEB) sites in accordance with the Plans and Specifications.

T742-2 Panelboards

T742-2.1 Description.

Furnish and install Emergency Panelboards (EDP and EP1), Power Distribution Frame (PDF) including accessories as shown in the Plans and all associated electrical conduit and cabling.

T742-2.2 Materials.

T742-2.2.1 Standards: Panelboards must meet the following applicable industry standards:

1. NECA Standard of Installation (published by the National Electrical Contractors Association)
2. NEMA AB1 - Molded Case Circuit Breakers
3. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies
4. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
5. NEMA PB 1 - Panelboards
6. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
7. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association)
8. NFPA 70 - National Electrical Code
9. UL requirements throughout document include UL or other National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor,
10. Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7.

T742-2.2.2 Qualifications: Manufacturer must be a company specializing in manufacturing the products specified in this sub-section with minimum three years' experience.

T742-2.2.3 Maintenance Materials: Meet the requirements of Acceptance Procedures for Toll Facilities. Furnish two keys for each panelboard.

T742-2.2.4 Panelboards: Provide EDP and EP1 panelboards as follows:

1. Manufacturers: EDP and EP1 panelboards must meet the requirements of the contract documents and must be from one of the following manufacturers or an approved equal:
    a. Schneider/Square D Co.
    b. ABB/General Electric
    c. Eaton/Cutler-Hammer
2. Description: NEMA PB 1, circuit breaker type panelboard with a vertically mounted main circuit breaker, a minimum of 18 one pole branch breaker spaces,.
3. Panelboard Bus: Copper, ratings as indicated. Provide an equipment ground bus in each panelboard.

4. Integrated Short Circuit Rating: All panelboards, bussing and breakers must be fully-rated, selectively coordinated to safely interrupt available short circuit currents. The AIC ratings shown on the drawings are the minimum ratings that can be provided.

5. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL or other NRTL listed as Type HACR for air conditioning equipment branch circuits.

6. Main Circuit Breaker Accessories: The vertically mounted main circuit breaker will be equipped with auxiliary contacts, 1a/1b, rated 6 Amps at 24 VDC.

7. Enclosure:

a. Interior Dry Locations: NEMA 1

b. Exterior and Wet Locations: NEMA 3R or 4X stainless steel where shown on the plans.

8. Cabinet Front: Flush or Surface type as indicated, fastened with concealed trim clamps, hinged door with flush lock, hinged cover, welded metal directory frame, finished in manufacturer's standard gray enamel.

9. The number of utilized breaker spaces must not exceed 80% of the full breaker space capacity. 20% of the breaker spaces must remain empty..

10. Use bolt-on type circuit breakers securely fastened to the bus bars using bolts. Plug-on type or clip-on type circuit breakers are not acceptable.

11. Provide a typed circuit directory card that accurately identifies each circuit and a spare unused directory card for future use. Provide directory cards from the same manufacturer as the panelboard. Place the spare directory card behind the typed directory card in the welded metal directory card holder.

12. For nameplates of normal power, provide laminated phenolic plastic, chamfer edges, black front white core, with lettering etched through the outer covering. White engraved letters on black background.

13. For nameplates of emergency power, provide laminated phenolic plastic, chamfer edges, red front white core, with lettering etched through the outer covering. White engraved letters on red background.

T742-2.3 Submittals and Shop Drawings

T742-2.3.1 Shop Drawings: Submit shop drawings in accordance with Section 5, General Requirements for Toll Site Electrical Infrastructure and the following:

1. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, withstand ratings, dimensions, and enclosure details as applicable for the following:

a. Power Distribution Frame product data including strut channel frame support material, attachment details for attaching to the concrete pad and attachment details for attaching equipment to the PDF.

b. Panelboard, circuit breakers, panel components, etc.

c. Light fixture

d. Raceway and boxes mounted to the frame

e. Fire extinguishers, cabinets, and accessories

2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Standards. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

3. Shop Drawings: Submit scaled drawings ½" = 1' showing the physical location of each panelboard. Indicate panelboard outline and support point dimensions, support frame design, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes. Include conduit routing and actual circuiting arrangements.

T742-2.3.2 Documentation Requirements. Provide record documents in accordance with Acceptance Procedures for Toll Facilities and the following:

1. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

2. If installed circuit breakers differ from the basis of design in the plans, perform a final coordination study, using a recognized software program to confirm that the installed equipment meets the coordination study requirements.

T742-2.4 Warranty: The panelboards under this specification section will be warranted by the manufacturer against defects in material and workmanship for a period of 1 year from the date of acceptance. The warranty will include parts, shipping costs, rigging costs, labor, and travel expenses, to replace the equipment or repair the equipment in place, in accordance with the manufacturers published service manuals. Provide warranty documentation in accordance with Acceptance Procedures for Toll Facilities.

T742-2.5 Construction Requirements

T742-2.5.1 Panelboards: Furnish and install panelboards in accordance with NEMA PB 1.1 and the NECA "Standard of Installation" and the following:

1. Install panelboards plumb.

2. Provide filler plates for unused spaces in panelboards.

3. Provide typed or neatly handwritten circuit directory for each branch circuit panelboard. Revise the directory to reflect any circuiting changes required to balance the phase loads. Provide (1) additional blank circuit directory for each branch circuit panelboard.

4. Circuit breakers must be molded case type unless noted otherwise on the plans.

5. Install the panelboards at the location and elevation depicted on the plans.

6. Panelboard Identification - Provide engraved plastic nameplates in accordance with the Specifications.

T742-2.5.2 Field Quality Control

Prior to energizing the installed panelboard perform the following:

1. Clean the interior of the enclosure and remove all dirt and debris.

2. Perform an insulation resistance test using a MegaOhm Meter between each phase bus and ground. Investigate any reading of less than 1 MegaOhm.

T742-2.5.3 Adjusting: Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

T742-2.5.4 Cleaning. Clean installed work in accordance with Acceptance Procedures for Toll Facilities and the following:

1. Clean electrical parts to remove conductive and deleterious materials.

2. Remove dirt and debris from inside the enclosures.

3. Clean finishes and touch up damaged paint.

T742-2.6 Method of Measurement

The Contract unit price per toll site for RTC toll site panelboards includes panelboards, grounding and bonding, associated surge suppression devices, and power distribution strut channel frame with lighting, furnished and installed, and will include furnishing all materials and hardware, all incidental work, and all labor, equipment, and miscellaneous materials necessary for a fully assembled complete and accepted installation.

The work specified in this Section for TEB toll sites including all incidental work identified in Acceptance Procedures for Toll Site, will not be paid for directly but will be considered as incidental work.

T742-2.7 Basis of Payment

Price and payment will be full compensation for all work specified in this subsection, including all materials, equipment, and accessories.

Payment will be made under:

Item No. 742-1- RTC Toll Site Panelboards and Power Distribution Frame - Each

T742-3 Electricity Metering and Utility Service Entrance

T742-3.1 Description.

Furnish all labor, materials, services, testing, and equipment necessary to provide and install Electric Metering and Utility Service Entrance Equipment at each Toll Facility which includes:

1. Service racks
2. Metering transformer cabinets
3. Meter bases

T742-3.2 Materials.

T742-3.2.1 Standards: Electric Metering and Utility Service Entrance Equipment must meet the following applicable industry standards:

1. NECA Standard of Installation (National Electrical Contractors Association)
2. NFPA 70 - National Electrical Code
3. Listed and classified by Underwriters Laboratories, Inc. and acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

T742-3.2.2 System Description: 240/120 Volts, 200 Amp, 1 phase, 3 wire, 60 Hertz, with grounded neutral, or as shown on the plans.

T742-3.2.3 Meter Bases: Furnish meter bases as follows:

1. Meter bases shall be fabricated from aluminum and then painted by the manufacturer.
2. The meter base shall contain in integral bypass that allows the meter to be removed and replaced without interrupting power to the building.
3. Neutral lugs must be sized to accommodate grounding conductors.

T742-3.2.4 Pad for Utility Transformer: Furnish and install the utility transformer pad sized and configured as required by the Utility.

T742-3.2.5 Secondary Connection Cabinet: If the quantity of underground service entrance conductors is greater than the utility pad mounted transformer lugs can accept, provide a secondary connection cabinet installed by the Electrical Contractor between the utility transformer and the service entrance point on the building. Ensure the customer's service

entrance conductors and the utilities service entrance conductors are properly joined inside this enclosure. Contact the utility company for the specifications and requirements of this cabinet.

T742-3.2.6 Service Disconnect: The service disconnect must comply with the following:

1. Vertically mounted main circuit breaker within an ATS, panelboard or as depicted in the plans.
2. Fuses must not be used as overcurrent protection for the power distribution system.
3. Contain a set of auxiliary contacts. The contacts will be open when the service disconnect is open and closed when the service disconnect is closed.
4. The service entrance feeder conduits must utilize rigid metal conduit elbows coated with PVC or Bitumen.

T742-3.2.7 Quality: Perform Work in accordance with Utility Company written requirements. Maintain one copy of each document on site.

T742-3.3 Submittals and Shop Drawings

T742-3.3.1 Shop Drawings: Submit shop drawings in accordance with Section 5, and General Requirements for Toll Site Electrical Infrastructure.

Provide ratings and dimensions of transformer cabinets and meter bases. Include the Utility contact information, the electric meter base configuration and the utility transformer pad details in the engineering submittals.

T742-3.4 Construction Requirements:

T742-3.4.1 Pre-Installation Meeting: A pre-installation meeting must be scheduled with the Engineer and the Utility Company representative.

Review service entrance requirements and details with Utility Company representative at the pre-installation meeting.

T742-3.4.2 Field Measurements: Verify that field measurements are as indicated on Utility Company drawings.

T742-3.4.3 Installation: Install transformer pad, metering transformer cabinets, and meter base as required by the local Utility Company.

Service entrance conductors between the utility transformer and the toll facility must be continuous and must not be spliced or tapped.

Toll sites must have dedicated secondaries from the utility transformer to the utility power meter and must not be shared with non-tolling electrical loads.

T742-3.5 Method of Measurement

The quantity paid will be the plan quantity for Electric Metering and Utility Service Entrance furnished, installed, and accepted at each toll facility.

T742-3.6 Basis of Payment

Price and payment will be full compensation for all work specified in this Subsection.

Payment will be made under:

Item No. 639-7-122 Electrical Power Service,
Toll Site Electric Metering and Utility Service Entrance.....Each

T742-4 Wiring Devices

Furnish and install wiring devices as shown in the Plans. Wiring devices include:

1. Wall switches / Snap switches
2. Receptacles
3. Twist-Locking receptacles
4. Device plates and box covers

T742-4.1 Materials.

T742-4.1.1 Standards: Wiring devices must meet the following applicable industry standards

1. NECA - Standard of Installation
2. NEMA WD 1 - General Requirements for Wiring Devices
3. NEMA WD 6 - Wiring Device -- Dimensional Requirements
4. NFPA 70 - National Electrical Code

T742-4.1.2 Qualifications: Manufacturer must be a company specializing in manufacturing the Products specified in this section with minimum three years' experience.

T742-4.1.3 Wall Switches / Snap Switches: Provide products that comply with NEMA WD 1, and are commercial specification grade, UL 20 Listed, and rated for AC only general-use.

1. Configuration:
   a. Single pole single throw or 3 ways.
   b. Switches shall be connected to the conductors using screw type mechanical pressure connectors. Spring type pressure connections are not acceptable.
   c. Provide same series switch for other configurations.
2. Ratings:
   a. Voltage: 120-277 volts, AC
   b. Dielectric voltage test: Withstands 1500 Volts for 1 minute.
   c. Temperature rise: The maximum temperature rise shall not exceed 30 degrees C.
   d. Flammability: Rated V-2 per UL 94.
   e. Current: 20 Amps continuous current unless indicated otherwise on the plans.

T742-4.1.4 Lighting Timer Switches: Provide 125V, 20A 4-hour twist type time delay switch in metal weatherproof box.

T742-4.1.5 Straight Blade Receptacles: Provide products that comply with NEMA WD 1, and are UL 498 Listed, commercial specification grade

1. Features and benefits:
   a. Shall be corrosion-resistant, with plated steel strap locked into the face and back body to resist pulling away from face/body assembly.
   b. The brass power contacts shall be 0.032 inch thick, and utilize triple-wipe action.
   c. Easily accessible break-off, line-contact connecting tab for fast, easy split-circuit wiring.
   d. Impact-resistant nylon face and thermoplastic back body.
   e. Accepts #14 - #10 AWG solid or stranded copper or copper-clad wire.
   f. The terminal compartments shall be isolated from each other for positive conductor containment.

g. Shall be equipped with an auto-ground clip to assure positive grounding.

2. Configuration:

a. Simplex (single) or duplex outlets.

b. Receptacles installed outdoors shall be rated Weather Resistant and shall be of the ground fault circuit interrupter type.

c. Receptacles shall be connected to the conductors using screw type mechanical pressure connectors. Spring type pressure connections are not acceptable.

3. Ratings: Receptacles shall be rated as follows:

a. 20 Amp, 125 Volt, NEMA 5-20R

b. Receptacles shall meet UL 94 Flammability requirements.

c. Receptacles shall have a dielectric voltage withstand rating of 2000 Volts

d. Temperature rise of 30 degrees C after 100 cycles of overload at 150% of rated current.

T742-4.1.6 Twist-Lock Receptacles: Provide products that comply with NEMA WD 1, and are UL 498 Listed, commercial specification grade, meets federal specification W-C-596, and have the following features and benefits:

1. Configuration:

a. Simplex (single)

b. Twist lock receptacles shall be connected to the conductors using screw type mechanical pressure connectors. Spring type pressure connections are not acceptable.

2. Ratings:

a. 20 Amp, 125 Volt, 2 horsepower, NEMA L5-20R with dielectric voltage withstand rating of 2000 Volts and temperature rise of 30 degrees C after 100 cycles of overload at 150% of rated current.

b. 30 Amp, 250 Volt, 2 horsepower, NEMA L6-30R with dielectric voltage withstand rating of 2000 Volts, and temperature rise of 30 degrees C after 100 cycles of overload at 150% of rated current.

c. Receptacles shall meet UL 94 Flammability requirements of HB or better

T742-4.1.7 Wall Plates / Cover Plates

1. Cover Plates: Smooth thermoset plastic plates.

2. Provide labels on each wall plate and receptacle plate that show the branch circuit numbers and panelboard that serves them.

3. Weatherproof Cover Plate: Cast zinc cover plate with a “While-In-Use” cast zinc hinged weather proof and padlockable door.

T742-4.1.8 Wiring Device Color: Device colors shall be ivory when served by normal power, red when served by generator power, and orange when served by the critical power system.

T742-4.2 Submittals and Shop Drawings

T742-4.2.1 Shop Drawings: Submit shop drawings in accordance with Section 5, General Requirements for Toll Site Electrical Infrastructure, and the following.

1. Shop Drawings: Call out the use or location for each device, such as “Receptacles above tolling cabinets”, “general use receptacles in toll building”, “twist-locking receptacle” etc on each shop drawing.

2. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations and ratings. Provide specification sheets for each type of wiring device.

3. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product

T742-4.3 Warranty

The wiring devices under this specification section will be warranted by the manufacturer against defects in material and workmanship for a period of 1 year from the date of acceptance. The warranty will include parts, shipping costs, labor, and travel expenses, to replace the equipment or repair the equipment in place, in accordance with the manufacturers published service manuals.

T742-4.4 Construction Requirements.

T742-4.4.1 Examination

1. Verify that outlet boxes are installed at proper height. Coordinate outlet heights with interior elevations.

2. Verify that wall openings are neatly cut and will be completely covered by wall plates.

3. Verify that floor boxes are adjusted properly.

4. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

5. Verify that openings in access floor are in proper locations.

T742-4.4.2 Preparation

1. Provide extension rings to bring recessed outlet boxes flush with finished surface.

2. Clean debris from outlet boxes.

T742-4.4.3 Installation

1. Install in accordance with NECA "Standard of Installation".

2. Install devices plumb and level.

3. Install switches with OFF position down.

4. Install receptacles with the grounding pole on the bottom.

5. Connect wiring device grounding terminal to outlet box and branch circuit equipment grounding conductor.

6. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

7. Connect wiring devices by wrapping the solid conductor around the screw terminal and tightening the screw snugly. Back wiring/back stabbing is not acceptable. Stranded conductors shall be terminated with compression style lugs.

8. Install cast iron plates on outlet boxes and junction boxes in unfinished areas and on surface mounted outlets.

9. Install wiring devices as indicated on the Drawings, and as called for below.

10. Switches and receptacles shall be installed and located as follows, unless noted otherwise on Drawings.

11. Switches: Centerline 46" above finished floors.

12. Receptacles: Centerline 18" above finished floors generally; Verify and coordinate exact height and locations with plans and elevations.

13. Where light switches are located adjacent to doors, they shall be installed on "knob" side of door. Field-verify door swings.

14. Provide identification in accordance with the Specifications.

T742-4.4.4 Field Quality Control

1. Inspect each wiring device for defects.

2. Operate each wall switch with circuit energized and verify proper operation.

3. Verify that each receptacle device is energized.

4. Test each receptacle device for proper polarity.

5. Test each GFCI receptacle device for proper operation.

T742-4.4.5 Adjusting: Adjust devices and wall plates to be flush and level.

T742-4.4.6 Cleaning: Clean exposed surfaces to remove splatters and restore finish.

T742-4.5 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T742-5 Toll Site Engine Generator

Furnish and install emergency backup generator as shown on the Plans.

T742-5.1 Materials

T742-5.1.1 Standards: Emergency backup generator must meet the following applicable industry standards:

1. UL 489 Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures. UL requirements throughout document include UL or other National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7.

2. NEMA MG1 Motors and Generators

3. NFPA 30 - Flammable and Combustible Liquids Code

4. NFPA 70 National Electrical Code

5. NFPA 110 - Emergency and Standby Power Systems

T742-5.1.2 Qualifications: The company selling the products specified herein must be an authorized distributor for the original equipment manufacturer. The distributor must be factory authorized to supply parts, perform field services, and perform factory warranty work on the engine generator and associated products specified herein. The distributor must maintain a parts inventory for the equipment provided and stock 50% of all parts for the engine, generator, and automatic transfer switch at their service facility within 100 miles of the project job site. The company selling the products specified herein must operate a public parts counter or parts warehouse that is open to the public, 5 days per week, Monday through Friday. The Department may inspect the service facility to verify the parts stock.

T742-5.1.3 Delivery Storage and Handling: Inspect the equipment for damages immediately upon delivery and contact the distributor or manufacturer before accepting a

product that was damaged during shipping. Take photos of any damaged equipment before removing it from the truck. Make specific notes on the receiving ticket to describe the extent of any damage.

Protect equipment from dirt and moisture by securely wrapping in heavy plastic until it is installed.

When lifting the engine generator with a crane, use spreader bars to prevent bending the weather protective enclosure

T742-5.1.4 Maintenance Parts: Provide the following additional maintenance parts for each engine generator:

1. One air filter
2. One oil filter
3. One fuel filter
4. One water separator clear bowl
5. One radiator fan belt.

The parts will be new and must match the part numbers shown in the manufacturer's parts manual. Highlight these part numbers with a yellow highlighter in the paper parts manual. Parts that are not new OEM parts, or do not match the parts shown in the manufacturer's parts manual will be rejected.

T742-5.1.5 Packaged Engine Generator Set: Classify the Emergency Power Supply System (EPSS) in accordance with NFPA 110 as Level 2, Type 10.

System Standby Rating: As shown on Plans for each toll facility, while operating inside a weather protective enclosure, and at an ambient temperature of 110 degrees Fahrenheit, and at an elevation of 100 feet above sea level. The engine generator will use an engine mounted radiator with a pusher type radiator fan. The full standby rated output will be available with varying loads for the duration of the interruption of the normal source power. The average power output must not exceed 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year. The Standby power rating will be in accordance with ISO3046/1.

Generator (alternator) output voltage dip and frequency dip requirements: Upon application of 100% rated (full) load at 0.8 pf, in a single step, the instantaneous voltage dip at the output of the alternator shall not exceed 20% and the instantaneous frequency dip will not exceed 20%.

T742-5.1.6 Engine (Packaged Engine Generator Set): Acceptable original equipment manufacturers include:

4. No substitutions

Provide a water cooled inline or V type, four stroke cycle, compression ignition diesel internal combustion engine with the following requirements:

1. Fuel: No. 2 fuel oil, ultra-low sulfur, not to exceed 15 ppm sulfur.
2. Engine speed: Rated for 1800 rpm.
3. Governor: Electronic isochronous governor. Random frequency variation shall not exceed ±0.25%.

4. Safety Devices: Pre-alarms and Engine shutdowns with alarms for high engine temperature, low oil pressure, overspeed, and emergency stop. Limits as selected by the manufacturer. Also provide overcrank / failure to start lock out and alarm.

5. Engine Starting: Positive engagement, cycle crank type, DC starting system with the number of starter motors in accordance with manufacturer's instructions. Include remote “two wire” starting controls.

6. Engine Jacket Coolant Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C) under all site conditions, and suitable for operation on 208 or 240 volts AC. Also provide isolation valves on the coolant supply and return hoses to facilitate maintenance on the heater.

7. Radiator: High ambient radiator using propylene glycol based coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F (43 degrees C) when the engine generator is installed within the weather protective enclosure and running at 100% rated (full) load. Radiator air flow restriction 0.5 inches of water (1.25 Pa) maximum. Provide a metal radiator guard and provide an accessible coolant drain valve on the bottom of the radiator. If the weather protective enclosure makes the drain valve not accessible, then extend a permanent drain hose from the drain valve to the outside of the enclosure. The radiator shall also include low coolant alarm contacts.

8. Engine Accessories: Aftercooler, intake air filter(s) with differential pressure service indicators, spin on lube oil filters, lube oil cooler, gear driven water pump, battery charging alternator, and crank case fumes disposal tube(s) routed outside. Also provide an oil drain valve on the bottom of the engine oil pan. If the weather protective enclosure makes the drain valve not accessible, then extend a permanent drain hose from the drain valve to the outside of the enclosure.

9. Engine Fuel System: Primary spin on fuel filter(s) with separate fuel/water separator with metal housing and see-through containment bowl, fuel transfer pump with a suction head of 9 feet minimum, a hand operated fuel priming pump with an analog fuel pressure gauge mounted next to the hand prime pump. A factory installed fuel oil cooler shall be mounted on the radiator to keep the return fuel temperature below 85 degrees F.

a. For TEB toll sites, submit fuel piping head loss calculations to the Engineer for the piping that serves above ground storage tanks. The calculations will show that the engine generator fuel pump is capable of operating properly with the proposed fuel pipes, and fuel pipe accessories such as foot valves, check valves, anti-siphon valves, pipe elbows, etc.

10. Mounting: Provide unit with suitable spring type vibration isolators mounted under the structural steel base or steel tank. If the engine and the alternator are isolated from the structural steel base or tank by rubber snubbers/mounts, then vibration pads may be utilized under the structural steel base.

11. Paint. The engine and the engine accessories shall be painted by the original manufacturer. Additional painting of the engine and engine accessories are not acceptable to the Department. The engine may not be repainted to change the color. Belts and hoses shall not be painted. The OEM part numbers must remain visible on all belts, hoses, and filters.

T742-5.1.7 .10 Generator (Packaged Engine Generator Set): Provide a NEMA MG1, single phase, four pole rotors, brushless synchronous generator with a brushless permanent magnet exciter with the following requirements:

1. Insulation Class: H.
2. Temperature Rise: 130 degrees C
3. Enclosure: NEMA MG1, drip proof, IP 22 guarded.
4. Voltage Regulation: Include generator mounted volts per hertz exciter regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Include manual controls to adjust voltage drop, voltage level (plus or minus 25 percent) and voltage gain.

The manual voltage adjustment will be used to adjust the output voltage up to 120% of nominal to test over voltage protective device. The manual voltage adjustment will also be used to adjust the output voltage down to 80% of nominal to test under voltage protective device.

T742-5.1.8 Accessories (Packaged Engine Generator Set): Provide the following accessories:

1. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless-steel exhaust fitting assembly, sized in accordance with engine manufacturer's instructions. Also provide an outlet elbow and a rain cap. If the exhaust piping penetrates the top of the outdoor enclosure, a rain collar shall be installed around the exhaust piping to minimize water entering the weatherproof enclosure.
2. Removable Insulation Blankets: If the exhaust silencer is mounted inside the weather protective enclosure then the silencer and stainless-steel flex will be covered with removable insulation blankets. The insulation blankets will be minimum one inch thick with three layers. The outer layer will be silicone impregnated fiberglass. The middle layer will be fiberglass. The innermost layer will be stainless steel mesh.
3. Batteries: Heavy duty, high output, diesel engine starting type, vibration resistant, lead acid storage batteries. The advertised Cold Cranking Amps shall be at 0 ºF. Ensure the batteries will withstand extreme vibration and sample batteries have been tested in accordance with IEC 61056-1. The prototype batteries shall pass a 50-hour vibration resistance test. Match the battery voltage to the engine starting system. Include copper battery cables and a key operated battery disconnect switch. Submit data sheet to the engineer on the battery switch. Calculate the voltage drop in the battery cables with full load cranking amps. Provide this calculation with the shop drawing submittals.
4. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
5. Battery Charger for TEB Sites: Magnetic amplifier design, 10 Amps DC output with current limiting at 140%. Automatic float/equalize mode designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell and rated for use at ambient temperatures up to 120 ºF. Accessories shall include: Analog DC Voltmeter and Ammeter, alarms for low DC volts, high DC volts, and charger failure. Provide a wall mounted enclosure to meet NEMA 250, Type 1 requirements. The manufacturer shall provide a 10-year standard warranty on the charger. Battery charger must be wall-mounted inside the TEB.
6. Battery Charger for RTC Sites: The battery charger must be enclosed, automatic, dual-rate, solid-state, constant-voltage type having ac voltage compensation, dc voltage regulation, and must be current limiting. The battery charger must be located in the

control panel or otherwise integrally mounted on the engine-generator set. The battery charger must employ transistor-controlled magnetic amplifier circuits to provide continuous taper charging. The battery charger must have two ranges, float and equalize, with a 0 to 24 hour equalizer timer, a dc cranking relay, silicon diode full-wave rectifiers, automatic surge suppressers, a dc ammeter, a dc voltmeter, and fused inputs and outputs. The battery charger must have a continuous rated output of not less than 10 amperes. The battery charger must conform to UL 1236.

7. Line Circuit Breaker: NEMA AB 1, molded case circuit breaker, generator mounted in a NEMA 1 enclosure. The circuit breaker enclosure shall provide adequate space for the Electrical Contractor to bend the generator feeder conductors in accordance with the NEC. The circuit breaker protective trip unit shall include integral thermal and instantaneous magnetic trips in each pole, sized in accordance with NFPA 70. Include a set of auxiliary contacts on the generator circuit breaker. The contacts will be open when the circuit breaker is open and closed when the circuit breaker is closed. These contacts will be monitored by the SCADA system.

8. Engine Generator Control Panel: NEMA 1, IP22 generator mounted control panel made of heavy-duty sheet steel and vibration isolated from the engine generator set. The control panel shall house the engine and generator controls, gauges and indicators. Also provide a hinged vandal door over the face of the control panel with provisions for a padlock. The control panel shall include the following equipment and features:

a. Frequency Meter: 45 - 65 Hz. range

b. AC Output Voltmeter with true RMS sensing, 1/2 percent accuracy with phase selector switch.

c. AC Output Ammeter with true RMS sensing, 1/2 percent accuracy with phase selector switch.

d. Output voltage adjustment.

e. Push to test indicator lamps, for low oil pressure, high water temperature, overspeed, and overcrank shutdowns.

f. Engine Off/Auto/Start/Stop selector switch.

g. Engine running time meter.

h. Oil pressure gauge.

i. Fuel pressure gauge

j. Water temperature gauge.

k. Emergency stop button

l. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.

m. Additional visual indicators and alarms as required by the Safety Indication and Shutdown table below.

n. Remote Alarm Contacts: Pre-wire SPDT contacts to a terminal strip for remote alarm functions required by NFPA 110.

o. Provide over voltage protection (ANSI #59) and under voltage protection (ANSI #27) to protect the generator and/or building distribution system from a voltage regulator malfunction. Over voltage relay settings shall be adjustable from 100% to 125% of nominal voltage. Under voltage relay settings shall be adjustable from 75% to 100% of nominal voltage. The pickup and dropout times will be adjustable from 1 to 10 seconds. When the generator set is producing power, an over voltage or under voltage condition shall cause the

engine generator to automatically shut down on a fault. The engine shall not attempt to restart until the fault is acknowledged and the fault reset button is depressed. When the engine generator shuts down normally and stops producing power, this shall not be considered a fault and the under-voltage relay shall not initiate an under-voltage fault.

p. The generator control panel shall include a factory installed Modbus RTU communication port that will be connected to SCADA system control panel.

q. The alarms indicated below will be transmitted to the SCADA system by the generator control panel Modbus RTU interface for use as Remote Audible (R.A.) alarms at Sunwatch.

Safety Indication and Shutdowns

Indicator Function	Level 1				Level 2		
	C.V.	**S**	**R.A.**		**C.V.**	**S**	**R.A.**
Overcrank	x	x	x		x	x	x
Low water temp 70 degrees F	x		x		x		x
High engine temperature prealarm	x		x		o		x
High engine temperature	x	x	x		x	x	x
Low lube oil pressure prealarm	x		x		o		o
Low lube oil pressure shutdown	x	x	x		x	x	x
Overspeed	x	x	x		x	x	x
Low level radiator fluid	x		x		x		x
Low fuel level – main tank	x		x		x		x
Low fuel level – day tank	x		x		x		x
EPS supplying load	x		x		x		x
Generator control switch not in auto	x		x		x		x
High battery voltage	x		x		o		o
Low battery voltage	x		x		x		x
Battery charger AC failure	x		x		x		x
Remote emergency stop	x	x	x		x		x
Over Voltage		x				x	x
Under Voltage	x	x	x		x	x	x
Lamp / horn test switch	x		x		x		x
Audible alarm silencing switch	x		x		x		x
Generator breaker open	x		x		x		x
Emergency Power Off Initiated	x		x		x		x

CV; control panel visual indication. S: Shutdown of the EPSS. RA: Remote audible.
x = Required. o = Optional

T742-5.1.9 Other Requirements (Packaged Engine Generator Set): Additional requirements are as follows:

1. Weather Protective Generator Set Enclosure: Manufactured with 14-gauge aluminum prepainted panels with interlocking seams, stainless steel mechanical fasteners, stainless steel hinges, and door holder latches. The doors will be strategically located to allow access for maintenance and visibility of the instruments on the face of the control panel. The doors must have gaskets and must be key lockable. The engine radiator fan will draw air into the

enclosure through a fixed aluminum intake louver and discharge the air through a gravity-open type aluminum discharge damper.

2. To prevent rodents and birds from entering the enclosure all openings in the enclosure will be covered from the inside with heavy aluminum wire mesh with 0.2 inch square holes. The wire diameter must be 0.047 inch or greater.

3. The engine generator must operate properly inside the enclosure at rated (full) load with the outdoor ambient temperature up to 110 degrees Fahrenheit. The enclosure will be wind rated in "miles per hour" by the manufacturer in accordance with the Wind-Borne Debris Region map published in the current Florida Building Code.

4. Provide a factory installed sound attenuated aluminum enclosure. The enclosure shall be factory certified for the sound level not to exceed 72 db (A) when measured 7 meters from the engine generator when the engine generator is operating at 100% rated load.

T742-5.1.10 Integrated Base Fuel Tank (Packaged Engine Generator Set for RTC Sites): Provide a base tank as follows:

1. Provide a dual wall secondary containment, closed top, base fuel tank.

2. Tank Capacity: The minimum fuel tank capacity must be designed for the engine generator to run for 72 hours at design demand load, while providing power to the toll site(s) during a normal power outage.

3. The base fuel tank system shall be listed under UL 142, subsection entitled Special Purpose Tanks EFVT category, and will bear their mark of UL Approval according to their particular classification.

4. The above ground base fuel tank with secondary containment basin must be installed in accordance with the Flammable and Combustible Liquids Code—NFPA 30, the Standard for Installation and Use of Stationary Combustible Engine and Gas Turbines—NFPA 37, and Emergency and Standby Power Systems—NFPA 110.

5. The primary tank shall be rectangular in shape and constructed in clam shell fashion to ensure maximum structural integrity and allow the use of a full throat fillet weld.

6. Interior of the primary tank will be coated with a solvent-based film rust preventative coating.

7. Steel Channel Support System: Reinforced steel box channel for generator support, with a load rating not less than the weight of the packaged generator.

8. Exterior Finish: The base tank exterior finish shall be Power Armor Plus™, a polyurea-textured rubberized coating.

9. Normal venting shall be sized in accordance with the American Petroleum Institute Standard No 2000, Venting Atmospheric and Low Pressure Storage Tanks not less than 1-1/4" (3 cm.) nominal inside diameter.

10. The emergency vent opening shall be sized to accommodate the total capacity of both normal and emergency venting and shall be not less than that derived from NFPA 30, table 2-8, and based on the wetted surface area of the tank. The wetted area of the tank shall be calculated on the basis of 100 percent of the primary tank. The vent is to be spring pressure operated: opening pressure is 0.5/psig and full opening pressure is 2.5 psig. The emergency relief vent is to be sized to accommodate the total venting capacity of both normal and emergency vents.

11. Provide a 2" NPT opening within the primary tank and lockable manual fill cap.

12. Provide a direct reading, UL listed, magnetic fuel level gauge with a hermetically sealed, vacuum tested dial, to eliminate fogging.

13. Provide a float switch for remote or local annunciation of a (50% standard) low fuel level condition.

14. Fuel in basin switch: A float switch will be installed into the containment basin of the fuel tank. This switch will close a set of contacts if fuel leaks from the main tank and into the containment basin.

15. Ball valve: A ball valve will be installed in the fuel supply line to the generator. The operator will be manually able to shutoff fuel to the generator supply line.

16. Engine fluid containment: The top of the fuel tank will be equipped a fluid containment area to catch engine fluids that may leak.

17. Decal: The fuel tank must be equipped with the following permanent signs:

a. NFPA 704 "Fire Diamond"

b. "No Smoking: Flammable Diesel"

c. "XXX Gallons"

18. High fuel level switch: A fuel level switch will be installed in the tank and the contacts will close when the fuel level reaches 90%.

19. Install generator cabling and conduit connections to the Automatic Transfer Switch and the SCADA monitoring system as shown in the Plans and Specifications.

T742-5.2 Shop Drawings and Submittals

T742-5.2.1 Documentation: Provide service and repair manual and the parts manual for each generator as follows:

1. Provide one digital copy and one paper book copy of the engine generator manufacturer's parts manual for each engine generator provided under this contract. The parts manual must show the original equipment manufacturers part numbers for all parts and accessories on the engine, radiator, main alternator, starter, charging alternator, and generator control panel.

2. Provide one digital copy and one paper book copy of the engine generator manufacturer's service and repair manual and include the following.

a. Include the manufacturer's suggested preventive maintenance service activities, suggested intervals between each service, and the required parts and tools to perform the service.

b. Include separate chapters on each subsystem or major component that make up the engine generator package. Each chapter will provide exploded view diagrams, required tools, and step by step procedures to repair or replace each component in the subsystem.

3. If the manuals are incomplete, are lacking in meaningful parts information or step by step repair instructions, or do not cover the model or type of equipment being provided, then the manuals will be rejected and require re-submission.

T742-5.2.2 Shop Drawings: Submit shop drawings in accordance with Section 5 Acceptance Procedures for Toll Facilities, and the following:

1. Sizing Program Results. Provide printouts in the shop drawings from the engine generator manufacturer's sizing and simulation program. The sizing program printouts must show the following items or information:

a. Simulation #1. The program will show the selected engine generator installed inside the weather protective enclosure while running at full (100% rated) load with the ambient temperature at 110 degrees Fahrenheit and the unit is installed at 100 feet above sea level. The printout will show the air flow in cubic feet per minute that is passing through the weather protective enclosure and the pressure drop across the selected radiator. Ensure the printout shows the selected engine model number, radiator model number or part number, alternator size, and weather protective enclosure part number. The printout will also show the instantaneous voltage and frequency dips upon a 100% rated load (block load) application at 0.8 power factor.

b. Simulation #2. Run a second simulation that lists the name and Watt rating of each electrical load that the engine generator will serve. Use the construction plans to determine the site specific electrical loads and the sequence that the loads will be applied to the engine generator. The printouts will show the voltage and frequency dips for each set of loads that are applied to the engine generator. The power distribution system, including the backup generator, shall be designed to operate normally when the UPS units are operating at 100% full (rated) load.

2. Shop Drawings will include plan and elevation views with dimensions of the selected engine generator with the exhaust system in place, and base fuel tank when applicable. Also show plan and elevation views with dimensions of the weather protective enclosure. Include specific dimensions for interconnection points such as:

a. Fuel piping connections
b. Exhaust outlet sizes and locations
c. Oil valve location
d. Radiator drain valve location
e. Spring isolator mounting points
f. Conduit stub up locations for the main generator feeder, jacket water heater circuit, and battery charger circuit.

3. Provide engine generator fuel consumption rate curves at various loads.

4. Provide a manufacturers engine generator data sheet that shows the EPA Tier Rating of the engine generator package. The engine generator must meet or exceed the current EPA tier rating requirements for stationary and off-road diesel engines. The engine generator model number shown on the EPA documentation must match the engine generator model number being submitted for review.

5. Provide calculations that show the ventilation rate of the cooling air flowing through the weather protective enclosure. Also show the pressure drops across the louvers and across the engine radiator.

6. Provide a site specific, point to point interconnection diagram on 11 x 17-inch paper. The site specific drawing will show the exact connection points for the Modbus RTU communications cables, remote EPO station, battery charger alarms, main fuel tank alarms, engine start contacts in the automatic transfer switch, ATS auxiliary contacts to indicate the position of the ATS, engine running auxiliary contacts, etc. Submittals will not be reviewed without this site-specific diagram showing the name of the tolling site.

7. Provide an electronic copy of the operation and maintenance manuals.

T742-5.2.3 Product Data: Provide data sheets that show the dimensions, weights, ratings, interconnection points, features, ratings, and internal wiring diagrams if applicable, for the following items:

1. Engine
2. Alternator
3. Radiator and radiator fan size
4. Radiator drain valve and extension hose
5. Antifreeze
6. Engine oil
7. Engine crankcase fumes disposal tube
8. Fuel filter
9. Diesel Fuel Additives for increasing Cetane # and fuel stabilizer.
10. Water separator
11. Fuel prime pump – hand operated
12. Analog fuel pressure gauge
13. Fuel pump suction pressure data and maximum external restriction data.
14. Head loss calculations for the proposed fuel piping and accessories
15. Flexible fuel lines
16. Jacket coolant heater and hose isolation valves
17. Oil drain valve and extension hose
18. Air cleaner and differential pressure indicator
19. Engine Generator Control Panel
20. Modbus RTU communication card with wiring diagrams and a Modbus register map for the engine generator controller.
21. Main Circuit Breaker and trip unit
22. Engine cranking battery
23. Battery cable size and lengths. Show the cable Voltage Drop during engine cranking.
24. Battery rack
25. Battery charger
26. Exhaust silencer, elbow, and rain cap.
27. Exhaust system stainless steel flexible connector
28. Thermal blankets for silencer
29. Vibration isolators
30. Weather protective enclosure
31. Base fuel tank, if applicable
32. Warranty statement
33. The distributor will provide a written statement concerning the availability of repair parts and the physical address of the parts counter or parts warehouse that is open to the public, 5 days per week, Monday through Friday.

Provide Operation Manual and Installation Manual as follows:

34. Provide one paper book copy and one electronic copy of the Manufacturer's Operation Manual and the Installation Manual for the engine generator and automatic transfer switch at each Toll Building. Provide a set of manuals for each engine generator provided under this contract. Deliver the manuals to the Engineer at the same time the manuals are electronically submitted.

35. If the manuals are incomplete, or are lacking in meaningful operational or installation instructions, or do not cover the model or type of equipment being provided, then

the Department may REJECT the manuals and indicate on the shop drawing review forms the nature of the deficiencies. The contractor will then collect the deficient materials from the Engineer, correct the deficiencies, and then re-submit the materials for another review.

36. If the manuals are incomplete, or are lacking in meaningful operational or installation instructions, or do not cover the model or type of equipment being provided, the submission will be rejected.

T742-5.3 Warranty

The packaged engine generator system must be warranted by the manufacturer against defects in material and workmanship for a period of 1 year from the date of system start-up. The warranty will include parts, shipping costs, rigging costs, engine fluids, labor, and travel expenses, to replace the equipment or repair the equipment in place, in accordance with the manufacturers published service manuals.

Regular and scheduled maintenance will be performed by the Department's maintenance contractor. Requirements for consumables such as oil and filters to be original equipment manufacturer brands are not acceptable and must not void the manufacturer's warranty of the equipment.

T742-5.4 Quality.

1. The engine generator must be a standard product of the original equipment manufacturer. The vendor that provides the engine generator package must be an authorized manufacturer's representative for the brand of engine generator that is provided.

2. Perform an operational test on the engine generator and automatic transfer switch before the site is turned over to the Department. After all the site systems and equipment have been installed, placed into service, and individually commissioned by the appropriate party, provide functional testing with all the systems and equipment running simultaneously to verify that the normal operation of any one system or piece of equipment does not interfere or aggravate the normal operation of any other system or equipment. Perform the operational testing with a Department representative present to observe the process.

T742-5.5 Construction Requirements.

1. Install in accordance with manufacturer's written instructions.

2. The original equipment manufacturers field service personnel will perform the initial start-up of the engine generator and place the unit in service. The warranty document will show the Florida Turnpike Enterprise as the owner.

3. Install concrete protected above ground fuel storage tank and associated fuel oil piping for TEB Toll sites.

4. Install integral base fuel tank for RTC Toll sites.

5. Diesel Fuel. Deliver and install #2 diesel fuel oil with less than 15 ppm of sulfur to fill the diesel fuel tank 90% full. Include fuel additives in proper quantities to increase the Cetane number to 50 minimum, increase the lubricity, and stabilize the fuel. Also add biocide to prevent bacteria and fungi from growing within the fuel tank. After testing the engine generator, refill the tank to 90 % full.

6. Identification - Provide engraved plastic nameplates in accordance with the Specifications.

7. Provide equipotential bonding to the nearest counterpoise loop per the Specifications.

T742-5.5.2 Field Quality Control: Provide field inspection and testing as follows:

1. Over voltage and Under voltage operational test. The original equipment manufacturers field service personnel will perform the following operational test. Open the generator main circuit breaker before performing the over voltage and under voltage tests.

a. The manual voltage adjustment on the generator control panel will be used to adjust the generator output voltage up to 120% of nominal voltage to test the over voltage protective device. When the output voltage reaches 120% of nominal for 1 second, the engine generator shall automatically shut down and the Over Voltage Alarm on the control panel shall initiate. Reset the fault and verify the alarm clears

b. The manual voltage adjustment on the generator control panel will be used to adjust the generator output voltage down to 80% of nominal voltage to test the under voltage protective device. When the output voltage reaches 80% of nominal for 1 second, the engine generator shall automatically shut down and the Under Voltage Alarm on the control panel shall initiate. Reset the fault and verify the alarm clears

c. Return the manual voltage adjustment on the generator control panel to 100% of nominal output voltage after the testing is complete.

2. Load Bank Tests:

a. A 4-hour continuous load bank test will be performed after the unit is placed into service and all accessories are installed and the permanent fuel system is installed. The test shall be performed with resistive load banks, in the presence of the engineer and if required, the local fire marshal. The test shall be performed during regular business hours only - Monday - Friday, 8:00 AM to 5:00 PM. Run the engine generator at the following % loads and time periods.

1. 0.5 hour at 50% load
2. 0.5 hour at 75% load
3. 3 hours at 100%
4. Block load at 100% load and verify voltage & frequency dip.
5. 0% load for 10 minutes to cool down.

b. During test a written log shall be maintained at 15-minute intervals with the following:

1. Ambient Air Temperature
2. Amperes
3. Hertz
4. Oil Pressure and temperature
5. Water Temperature
6. Battery Charging DC voltage and Amps
7. Exhaust Stack Temperature
8. Noise Level in dba (each side)
9. Differential pressure across the radiator

3. Test the alarm and shutdown circuits by simulating the faults, temperatures, and liquid levels. Verifying the alarm lights energize and the alarm horn sounds. Also verify the alarm silence feature works properly.

4. After testing the engine generator, refill the tank to 90 % full.

T742-5.5.3 Manufacturer's Field Services: The manufacturers field service representative shall visit the job site a minimum of three times (sign in each time) after construction begins to coordinate the installation with the Contractor. Provide assistance with

concrete pad sizes and shapes, routing and connection points for the control wiring, and proper silencer installation methods.

T742-5.5.4 Adjusting and Cleaning: Adjust the generator output voltage and engine speed. Record for future use.

Touch up paint any scratches on the enclosures or housings in accordance with the manufacturer's instructions. Clean the engine and generator surfaces of grease and oil.

T742-5.5.5 Demonstration: Provide systems demonstration in accordance with Acceptance Procedures for Toll Facilities.

Simulate a utility power outage by interrupting normal power and demonstrate that the system operates automatically to provide standby power to the building. Also simulate a generator over voltage fault condition and observe the engine shutting down, the generator breaker tripping open, and the OV fault lamp illuminated. Clear the faults, close the generator main circuit breaker and restore the engine generator to the automatic operating mode.

T742-5.6 Method of Measurement.

The Contract unit price for each toll site engine generator will include furnishing, placement, testing and commissioning of all equipment. Also includes providing all tools, labor, equipment, hardware, operational software packages and firmware, supplies, fuel, parts, support, shop drawings, manuals, warranty documentation, and demonstrations, also including all acceptance procedures and incidentals necessary to complete the work. The cost of the fuel tank, fuel, Automatic Transfer Switch and fire extinguishers at each toll site location will also be included in the cost of the toll site engine generator.

T742-5.7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section.

Payment will be made under:

Item No. 639-5- Emergency Generator – Permanent - Each

T742-6 Automatic Transfer Switch

Furnish and install automatic transfer switch as shown in the Plans.

T742-6.1 Materials.

T742-6.1.1 Standards. Automatic Transfer switches must meet the following applicable industry standards:

1. NFPA 70 - National Electrical Code
2. NEMA ICS 1 General Standards for Industrial Control and Systems
3. NEMA ICS 2 Standards for Industrial Control Devices, Controllers, and Assemblies
4. NEMA ICS 6 Enclosures for Industrial Controls and Systems
5. U.L. – 1008, 7th Edition. UL requirements throughout document include UL or other National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7.
6. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
7. NFPA 101 – Life Safety Code
8. NFPA 110 – Emergency and Standby Power Systems
9. Furnish products listed and classified by UL or other NRTL

T742-6.1.2 Qualifications.

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years' experience, and with service facilities within 100 miles of Project.

2. Supplier: Authorized distributor with a minimum of five years' experience.

T742-6.1.3 Quality Assurance.

1. Perform Work in accordance with NFPA 110.

2. The Automatic Transfer Switch must be a standard product of the original equipment manufacturer. The vendor that provides the Automatic Transfer Switch must be an Automatic Switch Company authorized manufacturer's representative. The Automatic Transfer Switch and the engine generator shall be provided by the same vendor.

T742-6.1.4 Manufacturers. Provide an ATS as manufactured by Automatic Switch Company.

T742-6.1.5 Automatic Transfer Switch(es)

1. Provide with fully rated overlapping neutral transfer contacts. The neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts shall not overlap for a period greater than 100 milliseconds. Neutral switching contacts which do not overlap are not acceptable.

2. Provide service entrance rating when supporting roadside tolling cabinets. Include integral overcurrent protection and a disconnecting means for the utility service entrance conductors. Service entrance rated transfer switches shall operate as delayed transition when transferring between power sources, with an adjustable time delay in the neutral position. Include a molded case circuit breaker with a thermal magnetic trip unit in line with the utility power source.

3. Equip with a microprocessor-based control system to provide all the operational functions. Include a real-time clock with battery back-up.

4. Include a controller with a 20-character, LCD display, with keypad, which allows access to the system. Provide password protection functionality.

5. Provide with an equipment grounding bar sized to accept the conductors as shown on the electrical drawings.

6. Factory test to ensure proper operation and compliance with the specification requirements.

7. Provide as double-throw, actuated by electrical operators momentarily energized. The transfer switch must be capable of transferring successfully in either direction.

8. Provide normal and emergency contacts that are positively interlocked mechanically and electrically to prevent simultaneous closing. Provide main contacts that are mechanically locked in both the normal and emergency positions without the use of hooks, latches, or magnets.

9. Provide such that control components and wiring are accessible from the front.

10. Provide 600-Volts SIS switchboard type for all control wires. Identify all control wire terminations with tubular, sleeve-type markers.

11. Equip each transfer switch with copper/aluminum solderless bolted pressure-type lugs rated for 90 degrees C.

12. Provide Belleville compression-type washers for bolted connections.

13. Terminate control wires with locking spade-type connectors.

14. Provide solid-state components with an operating range of -20°C to +55°C and meet IEEE Standard 472-1974.

15. Withstand Ratings

a. Switch(es) shall be listed by Underwriters' Laboratories, Inc. or other NRTL, Standard UL-1008, 7th Edition with 3-cycle short circuit closing and withstand values for specific manufacturers breaker as follows:

RMS Symmetrical Amperes at 480 VAC

Switch Rating in Amperes	Closing and Withstand Ratings
100 - 400	22,000
600 - 800	65,000
1000 - 1200	85,000

b. During the 3-cycle closing and withstand tests, there must be no contact welding or damage, and there must be contact continuity across all phases after completion of testing. The 3-cycle tests shall be performed without the use of current limiting fuses. Use test procedures in accordance with UL-1008, and certified by Underwriters' Laboratories, Inc. or other NRTL.

T742-6.1.6 Enclosures: Provide enclosure that meets or exceeds UL-1008 minimum wire bending space and supplied with three-point door latches. Furnish NEMA Type 1 enclosures for all enclosures inside of the building and NEMA Type 4X enclosures for exterior applications. Equip with a door-mounted pocket, housing an operations and maintenance manual. Enclosure finish with manufacturer's standard gray enamel paint.

T742-6.1.7 SCADA Components to be Installed within the ATS Enclosure

1. Monitor the incoming utility power feeder on the line side of the main circuit breaker by a power meter located remotely on the SCADA control panel. Mount the following accessories inside the ATS:

a. Current transformers (CT's) for each incoming feeder (Utility service entrance feeder, and the backup generator feeder). Provide solid core CT's, wound type current transformers, with a 5 Amp secondary rating, accuracy class 0.5%, with a minimum burden of 10 VA.

b. CT shorting type terminal block for use with the current transformers.

c. A fused voltage disconnect with 2 amp fuses to sense the utility voltage on the line side of the main circuit breaker.

2. SCADA components that are factory installed in the ATS and that will be monitored by the SCADA system:

a. Auxiliary contacts on the main circuit breaker to detect the breaker position.

b. Auxiliary contacts on the ATS to detect the position of the ATS by the SCADA system.

T742-6.1.8 Product Options and Features

1. Adjustable, 1-phase sensing of the normal source and emergency source. Factory set to pick up at 90% and drop out at 80% of rated voltage. The adjustable frequency picks up at 95% and dropout at 93% of rated frequency. The switch shall also include phase sequence monitoring on the normal and emergency source.

2. Time delay to override momentary normal source power outages. This will delay the engine start signal and transfer switch operation. Adjustable 0 - 999 seconds. Field adjusted to 1 second during start-up.

3. Time delay on transfer to emergency. Adjustable 1-300 seconds. Field adjusted to 1 second during start-up.

4. Time delay to control contact transition time on transfer to either source. Adjustable 1-120 seconds. (Delayed Transition Only) Field adjusted to 2 seconds.

5. Time delay on retransfer to normal, adjustable 0-9999 seconds, with engine overrun to provide adjustable 0–9999 second unloaded engine operation after retransfer to normal. Field adjust the retransfer to normal time delay to 900 seconds. Field adjust the unloaded engine cool down time delay to 300 seconds.

6. "Load Test Switch" to simulate a normal power failure. (Maintained type)

7. Contact to close on failure of normal source to initiate engine starting or other customer functions.

8. Contact to open on failure of normal source to initiate engine starting or other customer functions.

9. Green pilot light to indicate switch in normal position.

10. Red pilot light to indicate switch in emergency position.

11. Plant exerciser with (10) 7-day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise the generating plant. Adjustable type with minimum of 1-minute increments and battery back-up. Also include selection of either "no load" (ATS will not transfer during exercise period) or "load" (ATS will transfer during exercise period). Field adjust to 'LOAD" such that the ATS will transfer to emergency during the plant exercise period.

12. An LCD display, with 1% accuracy, shall show all three separate phase to phase voltages simultaneously, for both the normal and emergency source. A digital LCD frequency readout shall display frequency for both the normal and emergency source.

13. (2) Auxiliary contacts rated 10 Amp, 120 volts AC closed when the ATS is in the normal position. Wired to a terminal strip.

14. (2) Auxiliary contacts rated 10 Amp, 120 volts AC, closed when the ATS is in the emergency position. Wired to a terminal strip.

15. Adjustable relay to prevent transfer to emergency until voltage and frequency of generating plant have reached acceptable limits. Factory set at 90% of rated value.

16. Automatic synchronizing check relay to prevent retransfer from emergency to normal until the normal and emergency sources are within acceptable limits.

T742-6.1.9 Automatic Sequence of Operation

1. Provide the following sequence of operation:

a. Should the voltage of the normal source drop below a preset value (adjustable 70-100%) set at 80% on any phase after a time delay (adjustable 0.5-6 seconds) set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant.

b. The transfer switch shall transfer to emergency when the generating plant has reached a preset value (adjustable 90-100%) set at 90% of rated voltage and frequency.

c. After restoration of normal power on all phases to a preset value (adjustable 70-100%) set at 90% of rated voltage, an adjustable time delay period of 0-31 minutes (factory set at 5 minutes) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source.

d. After retransfer to normal, the engine generator shall be allowed to operate at no load for a 5-minute period before shutting down.

2. Transfer switches shall transfer to emergency within the time limits as required by the National Electrical Code for each branch of emergency power system.

3. When more than one Automatic Transfer Switch is connected to an emergency generator, each ATS shall be programmed to switch from normal power to emergency power sequentially. The Normal to Emergency time delay shall be adjustable 1-300 seconds and shall be adjusted as shown below:

a. The Normal to Emergency time delay shall be set to 1 second for an ATS serving a critical power system.

b. The Normal to Emergency time delay shall be set to 11 seconds for an ATS serving a non-critical power system.

T742-6.1.10 Surge Suppression Field install a UL-1449 third edition listed surge suppression device for each incoming feeder (Utility service entrance feeder, and backup generator feeder(serving the transfer switch. Install the SPDs on the outside of the ATS nearest the equipment ground bar inside the ATS. The SPD will protect the emergency generator feeder where it enters the ATS enclosure. Connect the SPD leads to the conductors by tapping the feeder conductors with insulation piercing connectors similar to TTD 0810F. The SPD leads shall be gently braided or twisted and shall not exceed 12 inches in length. The SPD enclosure shall include an integral disconnect switch to de-energize the SPD for maintenance. Refer to section T742-7 for surge suppressor requirements.

T742-6.1.11 Documentation and Maintenance Materials: Submit the following documentation:

1. Operation Data: Include instructions for operating the equipment. Include instructions for operating equipment under emergency conditions when the engine generator is running.

2. Maintenance Data: Include routine preventative maintenance instructions and a lubrication schedule. Provide a list of special tools, maintenance materials, and replacement parts that should be stocked.

3. Maintenance Materials

a. Provide maintenance materials and operators manuals.

b. Provide two of each special tool required for maintenance or manual operation.

4. Maintenance Service: Furnish service and maintenance of each transfer switch for one year from the date of Substantial Completion.

T742-6.2 Shop Drawings and Submittals

Submit shop drawings and include the following:

1. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, withstand ratings, dimensions, and enclosure details.

2. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

T742-6.3 Warranty

1. The complete system provided under this specification section will be warranted by the manufacturer against defects in material and workmanship for a period of 1 year from the date of system start-up. The warranty will include parts, shipping costs, rigging costs, labor, and travel expenses, to replace the equipment or repair the equipment in place, in accordance with the manufacturers published service manuals.

2. Regular and scheduled maintenance will be performed by the Department's maintenance contractor. Maintenance work by the maintenance contractor shall not void the manufacturer's warranty of the equipment. Requirements for consumables such as filters to be original equipment manufacturer brands are not acceptable and shall not void the manufacturer's warranty of the equipment.

T742-6.4 Construction Requirements.

T742-6.4.1 Delivery, Storage, And Handling

1. Deliver, store, protect and handle products to site in accordance with General Requirements for Toll Site Electrical Infrastructure .

2. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

3. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to internal components, enclosure and finish.

T742-6.4.2 Examination'

1. Verify site conditions are suitable for the ATS.

2. Verify that surface is suitable for transfer switch installation.

T742-6.4.3 Installation. Install transfer switches in accordance with manufacturer's instructions.

1. Provide all associate control wiring to the generator as required.

2. Identification - Provide engraved plastic nameplates in accordance with the Specifications.

3. Provide all interface control wiring and conduit as required to provide require emergency operation of equipment on project as applicable, i.e. elevators, building automation system, fire alarm control panel, smoke control system, etc.

T742-6.4.4 Manufacturer's Field Services.

1. The manufacturers field service representative shall visit the job site a minimum of three times (sign in each time) after construction begins to coordinate the installation with the E.C and G.C. Provide assistance with concrete pad sizes and shapes, proper mounting instructions for each ATS and the quantity and routing of ATS control wiring.

2. Program each ATS with settings as provided by the Department.

T742-6.4.5 Demonstration.

1. Provide systems demonstration under provisions of the Specifications.

2. Demonstrate the proper operation of each transfer switch in normal and emergency modes. Operate each ATS manually in the presence of the Department's representative.

T742-6.5 Basis of Payment.

The work specified in this Section for TEB and RTC sites will not be paid for directly but will be considered as incidental work.

T742-7 Surge-Protective Devices, 1KV or Less

Furnish and install Surge Protection Devices (SPDs) to protect the normal electrical distribution system, the emergency electrical distribution system, the critical power electrical distribution system, and end-use electrical equipment from the effects of transient voltage surges. Install the surge protection devices as shown on the plans or specified in this section.

T742-7.1 Materials

T742-7.1.1 Standards: SPDs must meet the following applicable industry standards:

1. UL 1449 3rd Edition, Standard for Surge Protective Devices
2. UL 1283, Standard for Electromagnetic Interference Filters
3. UL 96A Installation Requirements for Lightning Protection Systems
4. ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002
5. IEEE Std. 1100-2005 Section 8.6.1
6. ANSI C84.1, American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hertz).
7. NFPA 780 - Lightning Protection Code, latest edition.
8. NFPA 70 - National Electrical Code (NEC), current adopted year. Article 285
9. American National Standards Institute (ANSI) approved ANSI/NETA Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems, 2009 edition (ANSI/NETA Acceptance Testing Specifications -2009).
10. UL 497, Standard for Protectors for Paired-Conductor Communications Circuits
11. UL 497A, Standard for Secondary Protectors for Communications Circuits
12. UL 497B, Standard for Protectors for Data Communications and Fire-Alarm Circuits
13. UL 497C, Standard for Protectors for Coaxial Communications Circuits
14. UL requirements throughout document include UL or other National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7.

T742-7.1.2 Definitions. The following definitions are used in this section:

ATS .....Acceptance Testing Specifications

In: Nominal discharge current rating as required by UL 1449, 3rd Edition

MCOV .....Maximum Continuous Operating Voltage

VPR.....Voltage Protection Rating (Clamping voltage)

SCCR .....Short Circuit Current Rating

SPD .....Surge Protective Device

T742-7.1.3 System Description. Provide surge protective devices (SPDs) for the following systems and equipment:

1. Each main electrical service panel and MDP as shown on the drawings. Include branch circuit breakers in the main service panel to disconnect and protect the surge protective device and its connecting conductors.
2. Each emergency electrical distribution panel (EDP).
3. Each distribution and branch panel as shown on the drawings. Include branch circuit breakers in the distribution and branch panels to disconnect and protect the Surge Protective Device and its connecting conductors.
4. Electronic equipment installed as identified in the Contract Documents, including electronic time clocks, controls systems, access control system, telephone, CCTV, etc. Communications and signaling circuits that travel outdoors will be protected with low voltage, fast acting, surge protection devices.
5. Site lighting circuits.
6. Additional locations as required by NFPA 780.
7. On each emergency power feeder entering the enclosures and before the emergency feeder is connected to Automatic Transfer Switch.
8. On all telephone lines, DSL lines, T1 lines where they enter the enclosure or at the telephone board.
9. Existing SPDs shown on the drawings shall remain active unless noted for replacement.

Provide the best type of SPD that matches these specifications and matches the equipment being protected.

Install SPDs on the outside of control panels and electrical equipment.

Do not install SPD's inside of electrical panels or control panels.

T742-7.1.4 Quality.

1. All SPDs shall be manufactured by a company normally engaged in the design, development, and manufacture of such devices for electrical and electronics systems equipment for a minimum of five years.
2. Manufacturing facility shall operate a Quality System Certified as ISO 9001:2008 (or latest version) Compliant.
3. The SPD manufacturer shall provide requested technical assistance through support (including on-site as needed) by a factory-trained representative.
4. Source Limitations: Obtain SPDs and accessories for like applications through one source from a single manufacturer located in the United States.
5. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of SPDs and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
6. 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.

T742-7.1.5 Surge Protective Devices. Furnish SPDs manufactured by one of the following:

1. Advanced Protection Technologies
2. Emmerson/Liebert

3. L.E.A. International

4. Approved equal - Any product that meets or exceeds the performance of the above manufacturers will be considered.

Furnish SPDs rated for continuous operation under the following conditions, unless otherwise indicated:

5. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.

6. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

7. Humidity: 0 to 85 percent, no condensing.

8. Altitude: Less than 20,000 feet (6090 m) above sea level

T742-7.1.6 Service Entrance Surge Protective Device. Furnish surge protective device with the following minimum features and accessories:

1. Each SPD shall be UL 1449 third edition listed and labeled as a Type 1 suppressor intended for use without the need for external or supplemental overcurrent protection.

2. Each SPD shall be labeled with 20kA I-nominal (In) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.

3. Each SPD shall be of modular construction such that each of the SPD modules may be field replaced without the need to remove the entire SPD enclosure.

4. Install the SPD externally to the distribution equipment with the leads as short and straight as possible. Gently twist the conductors together. Installer may reasonably rearrange breaker locations to ensure short and straightest possible leads to the SPD. If any lead lengths exceed 24", the Contractor responsible for installation must contact the specifying electrical engineer for additional installation instructions.

5. Each SPD shall be installed with a branch circuit breaker as a disconnecting means or provide an integral factory installed disconnect switch as a disconnecting means.

6. Each SPD will have the following modes of protection: Line to Line, Line to Neutral, Line to Ground, and Neutral to Ground.

7. The SPD shall include visual LED indicator lights for power and protection integrity.

8. Each SPD shall contain one set of form C contacts that change state when the SPD requires service.

9. Minimum Surge Current Capability: 200 kA per phase with less than 1 nanosecond response time.

10. Connection Means: Permanently wired, connected on the load side of the service entrance overcurrent protection, and meet the SPD manufacturer's instructions for overcurrent protection (breaker or fuse size).

11. Protection modes and UL 1449 3rd Edition VPRs for circuits with voltages of 120/240V, 1-Phase, 3-Wire shall not exceed:

a. Line to Neutral: 700V for 120/240V, 1PH, 3W
b. Line to Ground: 700V for 120/240V, 1PH, 3W
c. Neutral to Ground: 700V for 120/240V, 1PH, 3W
d. Line to Line: 1200V for 120/240V, 1PH, 3W

T742-7.1.7 Surge-Protective Device for Distribution Panelboards. Furnish surge protective device with the following minimum features and accessories:

1. UL 1283 listed as an Electromagnetic Interference Filter

2. SPD shall be UL 1449 Third Edition, labeled as Type 1 intended for use without need for external or supplemental overcurrent controls or labeled as Type 2 with manufacturer approved over current protection.

3. SPD shall be UL 1449 Third Edition labeled with 20kA nominal discharge current (In) (verifiable at UL.com) for compliance to UL 96A Lightning Protection Master Label and NFPA 780.

4. Install the SPD externally to the distribution equipment with the leads as short and straight as possible. Gently twist conductors together. Installer may reasonably rearrange breaker locations to ensure short and straightest possible leads to the SPD. If any lead lengths exceed 24", the Contractor responsible for installation must contact the specifying electrical engineer and the surge protective device manufacturer or distributor for installation assistance.

5. SPD marked with a 200kA short-circuit current rating (SCCR).

6. Modes of Protection: Line to Neutral, Line to Ground, Line to Line, and Neutral to Ground

7. The SPD shall include visual LED indicator lights for power and protection integrity.

8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

9. Each SPD shall contain one set of form C contacts that change state when the SPD requires service.

10. Minimum Surge Current Capability: 150 kA per phase

11. Protection modes and UL 1449 3rd Edition VPRs for circuits with voltages of 120/240V, 1-Phase, 3-Wire shall not exceed:

a. Line to Neutral: 700V for 120/240V, 1PH, 3W
b. Line to Ground: 700V for 120/240V, 1PH, 3W
c. Neutral to Ground: 700V for 120/240V, 1PH, 3W
d. Line to Line: 1200V for 120/240V, 1PH, 3W

T742-7.1.8 Surge-Protective Device Direct Wired (120 VAC). Furnish surge protective device with the following minimum features and accessories:

1. SPD shall be UL 1449 3rd Edition listed/recognized.

2. 15 & 30 Amp, 120 V rated. All continuous current bearing components must be either 15 or 30 Amp rated, minimum; depending on Location Load usage.

3. SPDs shall provide three suppression modes: Line-to-neutral, line-to-ground, and neutral-to-ground.

4. SPD shall provide a pulse life rating of 3,000 amperes (8/20µs waveform) every thirty (30) seconds for 2,000 occurrences.

5. Peak Single-Impulse Surge Current Rating: 20kA per mode, 60kA per protected circuit

6. SPD shall include visual LED diagnostic indicator for power and protection integrity.

7. SPD shall allow for chase nipple or DIN RAIL mounting.

T742-7.1.9 Data Line, Ethernet, RS 422, and RS-232 Surge-Protective Device. Furnish surge protective device with modular DIN RAIL design and the following minimum features and accessories:

1. Listed and meets the requirements of UL 497A, UL 497B, or UL 497C as applicable.

2. Plug-in replaceable DIN RAIL modules

3. Employs hybrid circuitry that combines metal oxide varisters with silicon avalanche diodes.

4. Let through voltages for SPD's protecting the following circuits shall not exceed the following:

a. Ethernet – 10 Volts
b. Power over Ethernet – 75 Volts
c. RS 485 – 10 Volts
d. RS 232 – 27 Volts
e. Coaxial – 90 Volts
f. 4 – 20 milliAmp – 30 Volts

5. Peak Single-Impulse Surge Current Rating: 10 kA per mode.

6. Subject to compliance with requirements, provide products by one of the following for data line SPDs:

a. Advanced Protection Technologies/Surgeassure
b. Superior Electric/Stabiline
c. Circa Telecom
d. Emerson Network Power
e. Scientific Atlantic
f. Surge Suppression Incorporated

T742-7.1.10 Telephone Line Surge-Protective Device. Furnish surge protective device with modular design and the following minimum features and accessories:

1. Listed and meets the requirements of UL 497A, UL 497B, or UL 497C as applicable.

2. Plug-in replaceable modules design to fit on standard M1-50, 66 connecting block

3. Must be installed with matching ground rail or external ground post for extending metallic frame to building ground.

4. Provide applicable breakdown voltages of either 270V, 200V, or 65V

5. Peak Single-Impulse Surge Current Rating (8x20 □s): 250A Tip and Ring to Ground

6. Subject to compliance with requirements, provide products by one of the following for telephone line SPDs:

a. Advanced Protection Technologies/Surgeassure
b. Superior Electric/Stabiline
c. Circa Telecom
d. Emerson Network Power
e. Scientific Atlantic
f. Surge Suppression Incorporated

T742-7.1.11 Enclosures. Furnish NEMA Type 1 enclosures for all enclosures inside of the building and NEMA Type 4X enclosures for exterior applications.

T742-7.2 Submittals and Shop Drawings

Submit in accordance with Section 5, General Requirements for Toll Site Electrical Infrastructure, and the following:

1. Product Data: For each type of product indicated. Include rated capacities, bill of materials of number of MOVs installed per phase with MOV part number and surge current rating, operating weights, operating characteristics, furnished specialties, and accessories.

2. Product Certificates: SPD submittals shall include Listing documentation, signed by product manufacturer certifying compliance with the following standards:

a. UL 1283 compliance verified information is posted at www.UL.com, under Certifications, searching using UL Category Code: FOKY.

b. UL 1449 3rd Edition certification listing and classification page, VPR, MCOV, In, and Type 1 information is posted at www.UL.com, under Certifications, searching using UL Category Code: VZCA. SCCRs are posted in manufacturer's UL docs.

c. UL 497, UL 497A, UL 497B, UL 497C as applicable.

3. Field quality-control test reports, including the following:

a. Test procedures used.

b. Measure the continuity of each conductor between the equipment being protected and the SPD. The maximum resistance is 1 milliohm.

c. Failed test results and corrective action taken to achieve requirements.

4. Operation and Maintenance Data: For Surge protective Devices to include in emergency, operation, and maintenance manuals.

5. Warranties specified in this Section.

T742-7.2.1 Operation and Maintenance Data. 1. Submit operation and maintenance (O&M) data as called for in Acceptance Procedures for Toll Facilities. O&M data to include:

1. All approved shop drawings, product data, and/or cutsheets.

2. Installation, connection, and maintenance information on each type of surge suppression.

3. Procedure and/or timetable for recommended periodic inspection of devices to determine continued usefulness, as applicable.

T742-7.3 Warranty

Provide warranties in accordance with the following:

1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of SPDs that fail in materials or workmanship within five years from date of Substantial Completion.

2. For Data line SPDs, Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge SPDs that fail in materials or workmanship within two years from date of Substantial Completion.

3. Any SPD, that shows evidence of failure or incorrect operation during the warranty period (to include failure of visual failure indicators) shall be replaced or repaired by the manufacturer during the warranty period. The manufacturer shall provide replacement units to the Department for installation.

T742-7.4 Construction Requirements.

Install SPDs that bear the UL seal and are marked in accordance with the referenced standard for the intended use. Install SPDs located in accordance with requirements of all applicable National Fire Protection Association (NFPA) codes (including NFPA 780 and NFPA 70) and in compliance with the standards listed in T742-9.1.

T742-7.4.1 Verification of Project Conditions. Prior to installation coordinate and verify existing project conditions and progress as follows:

1. Verify proper grounding is in place.

2. Verify proper clearances, space, etc. is available for SPD.

3. Coordinate so that proper overcurrent device, as recommended by manufacturer, is installed to feed each surge suppression device.

4. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

a. Notify Department not less than two days in advance of proposed utility interruptions.

b. Do not proceed with utility interruptions without Department's written permission.

T742-7.4.2 General.

1. Provide, install, and connect an SPD's at the first electrical service disconnecting means. Branch breakers in the MDP shall serve as the disconnecting means for the SPD.

2. Provide, install and connect an SPD at each branch panelboard that serves outdoor equipment. Branch breakers in the panelboard shall serve as the disconnecting means for the SPD.

3. TEB Sites: Provide, install and connect an SPD at each Critical Power Panelboard. i.e. Panel C. Branch breakers in the panelboard shall serve as the disconnecting means for the SPD.

4. Provide, install and connect an SPD to protect the backup generator feeder at each Automatic Transfer Switch (ATS) in project. The SPD will include an integral disconnecting means installed by the SPD manufacturer.

5. Provide, install, and connect SPD at location where CCTV, access control and communication equipment is connected to line voltage (120V). Provide cords and receptacles as required to connect SPD equipment to equipment being protected and maintain U.L. listing.

6. Surge protection equipment must be selected by contractor to match the equipment being protected including wire sizes, operating volts, amps, and circuit impedance.

7. Installation of SPD equipment and its grounding must be in accordance with the manufacturer's recommendations to assure short and proper ground paths.

8. Install external SPDs with a maximum of 24" length leads. Position the SPD as close to the circuit breaker used as possible. Utilize the breakers closest to the SPD mounting.

9. Install the leads slightly twisted together, but as short and straight as possible with no kinks or coils and an eight-inch minimum bending radius.

T742-7.4.3 Installation of SPDs.

1. Except for CCTV, access control and communication equipment, install SPDs as close as practical to the electric panel or electronic equipment to be protected, consistent with available space.

2. SPDs must be close-nippled to the device being protected in a position nearest the neutral bus (if present) to minimize wire lead length between SPD and the buses or control breaker to which the SPD connects. SPD leads must not extend beyond the SPD manufacturer's recommended maximum lead length without specific approval of the engineer.

3. Install SPDs in a neat, workmanlike manner. Lead dress must be as short and as straight as possible and be consistent with recommended industry practices for the system on which these devices are installed.

4. Install SPDs in a manner that allows simple replacement within short periods of downtime.

5. Except for point of use type SPDs, install a means of disconnecting the SPD at the panel. At the MDP locations, provide a dedicated 60 amp, breaker for the SPD device. At the distribution secondary and/or subpanels location, provide dedicated 30 Amp, breaker for the SPD device. Change rating of CB's noted above as required to properly provide system as recommended by manufacturer.

T742-7.4.4 Telephone Circuits.

1. Systems utilizing telephone company pairs as a transmission medium shall be provided with SPD conforming to respective device in Part 2 of this specification.

2. SPDs shall be installed at each point where interface is made to telephone company pairs.

3. In cases where a modem or other device is used to interface with the telephone circuit the following procedure shall apply:

a. Where the modem or coupling device is furnished by the telephone company the SPDs shall be installed on the system side of the modem or coupling device.

b. Where the modem or coupling device is furnished by the system contractor, the SPD shall be installed on the telephone line side of the modem or coupling device.

T742-7.4.5 Signaling, Communications and Data Conductors. Any signaling conductor, CCTV conductor, Ethernet conductor, Power over Ethernet (PoE) conductor, or SCADA system conductor that is routed in an exterior environment shall be protected by a surge protection device (SPD). The SPD's will be mounted indoors where possible.

T742-7.4.6 Placing System into Service. Before energizing any SPD, the installer shall measure the electrical system voltage and frequency and verify that each SPD is properly rated for use with measured voltage and frequency.

T742-7.4.7 Field Quality Control.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

2. Testing: Perform the following field tests and inspections.

a. After installing surge protective devices, but before the electrical circuitry has been energized, measure the continuity of each lead. Measure between the equipment being protected and the point of connection to the SPD.

b. Complete startup checks according to manufacturer's written instructions.

T742-7.4.8 Demonstration. Train Department's maintenance personnel to adjust, operate, and maintain SPDs.

T742-7.5 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T742-8 Lighting Fixtures and Lamps

Furnish and install lighting fixtures and lamps as shown in the Plans.

T742-8.1 Materials.

T742-8.1.1 Standards: Lighting fixtures and lamps must meet the following applicable industry standards:

1. NEMA WD 6 - Wiring Devices-Dimensional Requirements
2. NFPA 70 - National Electrical Code
3. NFPA 101 - Life Safety Code

T742-8.1.2 Qualifications: Manufacturer must be a company specializing in manufacturing the products specified in this sub-section with minimum three years' documented experience.

T742-8.1.3 Luminaires: Provide luminaires in accordance with the lighting fixture schedule in the Plans.

T742-8.1.4 Emergency Lighting Units: Provide self-contained emergency lighting units in accordance with the Plans and the following:

1. Light source: LED (light emitting diodes).
2. Battery: 12 volt, with 1.5 hour capacity.
3. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.
4. Indicators: Lamps to indicate AC ON and RECHARGING.
5. TEST switch: Transfers unit from external power supply to integral battery supply.
6. Electrical Connection: Connection shall be hardwired via conduit (cord and plug connection shall not be allowed).

T742-8.1.5 Exit Signs: Provide exit sign fixtures suitable for use as an emergency lighting unit in accordance with the Plans and the following:

1. Light source: LED (light emitting diodes).
2. Battery: 12 volt, nickel-calcium, lead calcium type, with 1.5 hour capacity.
3. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twenty-four (24) hours.
4. Indicators: Indicator lamps to indicate AC ON and RECHARGING.
5. TEST switch: Transfers unit from external power supply to integral battery supply.
6. Electrical Connection: Connection shall be hardwired via conduit (cord and plug connection shall not be allowed).

T742-8.1.6 Exterior LED Light Fixtures: Provide Flat face, low profile, wall mount, exterior light fixtures in accordance with the Plans and the following:

1. The baseplate must be manufactured from marine grade die-cast aluminum. The baseplate flange shall interlock and wrap around the lens base to prevent water intrusion.
2. Lens: The lens must be made from ultraviolet stabilized, high impact resistant, virgin injection molded polycarbonate. Ensure the lens is held in place by a push/turn/lock in place device that does not require tools. The lens and lens base will be secured with a single, concealed, captive fastener with a center pin.
3. Gasketing: A self-adhesive neoprene gasket must seal between the baseplate to the mounting surface.

4. The LED light source color temperature must be 3500 degrees Kelvin with a minimum CRI of 82.

T742-8.2 Submittals and Shop Drawings

Submit documents in accordance with Section 5 and General Requirements for Toll Site Electrical Infrastructure . Submit manufacturer's operation and maintenance instructions for each product.

T742-8.3 Construction Requirements

T742-8.3.1 Installation: Furnish and install luminaires in accordance with the following:

1. Install suspended luminaires using pendants. Provide pendant length required to suspend luminaire at the indicated height in the fixture schedule.
2. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
3. Install wall mounted luminaires, emergency lighting units and exit signs at height as indicated on Drawings, as scheduled.
4. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within the luminaire.
5. Bond products and metal accessories to the branch circuit equipment grounding conductor.
6. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.
7. Connect battery operated emergency light fixtures to local lighting circuit ahead of all switches. Provide and install all wiring as required for proper operation.
8. Where ceiling mounted fixtures are called for in the Light Fixtures Schedule and on the drawings, this Contractor shall provide fixture trims and supports as required to match the type of ceiling system being furnished.
9. In addition to attaching ceiling mounted lighting fixtures to ceiling system, Surface mounted fixtures and/or ceiling boxes shall be supported to superstructure with all-thread rod.
10. Light fixtures shall not have any labels exposed to normal viewing angles. This includes manufacturer labels and U.L. labels.
11. Provide low voltage transformers and power supplies for all low voltage light fixtures.
12. Install tents of fire rated materials as required for fixtures in fire rated ceilings as per applicable codes.
13. Thermal protection for all fixtures with tents or fixtures surrounded by insulation.
14. Pendant suspended light fixtures shall be installed using the original equipment manufacturers pendant kit and materials. Threaded rods shall not be substituted for the manufacturer’s pendant kit.
15. Coordinate fixtures installed in mechanical rooms with piping and ductwork prior to installation and relocate fixtures as required to provide proper illumination and future access to the fixture for maintenance.
16. Locate all remote ballasts in well ventilated and accessible spaces.

T742-8.3.2 Field Quality Control.

1. Operate each luminaire after installation and connection. Inspect for proper connections and operation.

2. Aim and adjust luminaires as indicated.

3. Position exit sign directional arrows as indicated.

T742-8.3.3 Cleaning. Clean installed work in accordance with Acceptance Procedures for Toll Facilites and the following:

1. Clean electrical parts to remove conductive and deleterious materials.

2. Remove dirt and debris from inside the enclosures.

3. Clean photometric control surfaces as recommended by manufacturer.

4. Clean finishes and touch up damaged paint.

T742-8.4 Acceptance Procedures

1. Demonstrate luminaire operation for minimum of two hours during Primary Walk Through. See Acceptance Procedures at Toll Facilites.

2. 1. Relamp any luminaires that have failed lamps at Substantial Completion

T742-8.5 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

T742-9 Static Uninterruptible Power Supply System for Outdoor Communication Cabinets

T742-9.1 Description.

Provide all labor, materials, services, testing, and equipment necessary to provide Static Uninterruptible Power Supply (UPS) systems with internal bypass at each toll site.

T742-9.1.1 Modes of Operation

The UPS must operate as a true on-line double-conversion system in the following modes:

1. Normal - In normal operation incoming AC power must be fed to the input power factor corrected (PFC) rectifier that converts the AC power to DC power for the inverter. In this mode, derive power from utility power for the battery charger. Derive DC power for the inverter from the PFC rectifier to regenerate filtered and regulated AC sinewave power for the connected load. Begin charging the battery once the UPS is connected to utility power, regardless of whether the UPS is ON or OFF. In the event of a utility outage or severe abnormality (sag or swell), support the connected load from battery power from the inverter until the battery is discharged or the utility power returns, whichever occurs first.

2. Battery – Supply power from the inverter upon failure of utility / mains AC power, which obtains power from the battery. There must be no interruption in power to the critical load upon failure or restoration of the utility / mains AC source.

3. Recharge - After a utility / mains AC power outage, automatically restart and resume supplying power to the inverter and the battery charger to recharge the battery upon restoration of utility / mains AC power.

4. Automatic Restart - After a utility / mains AC power outage and complete battery discharge, automatically restart the UPS and resume supplying power to the critical load and to the battery charger which will automatically recharge the battery upon restoration of utility / mains AC power. This feature must be capable of being disabled by the user.

5. Bypass - The integral bypass must perform an automatic transfer of the critical AC load from the inverter to the bypass source, in the event of an overload, PFC failure, internal over temperature, DC bus overvoltage or inverter failure conditions.

6. ECO –Allow users to enable and place the UPS in ECO mode of operation to reduce electrical consumption. The ECO mode operation must be an Active type, whereas the UPS powers the connected equipment through the bypass path and the UPS inverter must be on and operating at no load in order to stay synchronized to the bypass to ensure rapid transfers to inverter power when input power falls outside of the user customizable parameters. Provide a user customizable requalification time that input power must remain within the ECO mode parameters before transferring back to ECO operation. This is to minimize the number of transfers between bypass and inverter.

T742-9.1.2 Design Requirements

1. Voltage: Operate at either 120/208V or 120/240V by sensing the utility phase angle and configuring the dual inverters to the same angle: 120 or 240 degrees (or) 180 degrees. Nominal input/output voltage specifications of the UPS at rated load must be:

a. Input: The UPS must be able to operate from 120/208V, 50/60Hz (or) 120/ 240V, 50/60Hz without the use of selector switches or voltage taps. Input wiring must be 3-wire plus ground (L1, L2, N, G, with N solid bonded to G at the distribution panel).

b. Output: Output voltage must be present at terminals L1, L2 and N. The output voltage must be 120/240V, 60Hz. Voltage measured between L1-N and L2-N: 120VAC ±3%, 60Hz; L1-L2: 240VAC ±5%, 60Hz. If the UPS is started on battery with no input power present, the default output voltage must be 120/208V, 60Hz from the factory. After the UPS has been started from utility, the output voltage/frequency must match the last known input voltage/frequency that was applied.

2. Output Load Capacity: Provide output power as shown on the Plans with a 1.0 pf at 60 Hz.

3. Internal Battery: Utilize valve-regulated, non-spillable, lead acid cells.

4. Reserve Time: Provide a minimum of 4 minutes of reserve time. These times must be at full load with ambient temperature of 77°F (25°C) with resistive loading.

5. Battery Recharge: Provide a three-stage battery charger designed to prolong battery life. Recharge time for UPS internal batteries must be 5 hours maximum to 90% capacity after a complete discharge into full load.

T742-9.2 Performance Requirements

T742-9.2.1 AC Input to UPS

Voltage: The point at which the UPS transfers to battery operation must be dependent on the amount of load that the UPS is supporting. The UPS must operate from the following voltage ranges without drawing power from the batteries:

1. Low Line Voltage Range

a. From 0 to 50%load the low line voltage is constant.

b. From 51-100% load the low line voltage increases at a linear rate.

c. For loads over 100%, the low line voltage remains constant.

Load		Low Line Voltage
100% to 51%	L-N Transfer	60 - 90 ± 3.1VAC
	L-N Comeback	68 - 98 ± 3.1VAC
50% to 0%	L-N Transfer	60 ± 3.1VAC
	L-N Comeback	68 ± 3.1VAC

2. High Line Voltage Range

High Line Range	120/208V Models

High Line Transfer	149.5 ± 3.1VAC
High Line Comeback	142.5 ± 3.1VAC

3. Frequency: Auto-sense input frequency when first powered up and operate within the following frequency specifications. UPS must be capable of cold start with default frequency of 60Hz. Once started, the frequency operating window must be 40-70Hz. Provide three frequency settings in the Configuration program: Auto frequency sensing (factory default setting), 50Hz frequency conversion and 60Hz frequency conversion.

4. Input Power Factor: >0.99 lagging at rated load.

5. Input Current Harmonic Distortion: THD must be less than or equal to 3% at linear, full load operation. THD must be less than or equal to 5% at nonlinear, full load operation.

6. Inrush Current (initial startup, no load): Provide with a maximum inrush current of 6 times the full load peak input current.

7. Surge Immunity & Protection: UPS must conform to ANSI C62.41, Category B.

T742-9.2.2 AC Output, UPS Inverter

1. Voltage Configuration: 120/240VAC, 60Hz, single-phase, 3-wire-plus-ground (L-L-N-G). Optional output voltage settings must be user-adjustable.

2. Voltage Regulation: Voltage regulation must be ± 1% steady state.

3. Frequency Regulation: ±3.5Hz synchronized to bypass. ±0.1Hz free running or on-battery operation.

4. Frequency Slew Rate: 1.0Hz per second maximum. The slew rate must be user-selectable for non-parallel units, options to be 0.2, 0.5, or 1.0Hz/S. For parallel units, the slew rate must be fixed at 0.2Hz per second.

5. Voltage Distortion: <2% total harmonic distortion (THD) typical into a 100% linear load, <5% THD typical into a 100% non-linear load. For parallel units, <3% total harmonic distortion (THD) typical into a 100% linear load, <6% THD typical into a 100% non-linear load.

6. Load Power Factor Range: The load power factor range must be 0.65 lagging to 1.0 (unity) leading without power derating.

7. Output Power Rating: Provide as shown on the Plans.

8. Inverter Overload Capability

Overload Percent	Duration Inverter must support rated load
105% to 125% 125% to 150% >150%	5 minutes 60 seconds Minimum of 200ms

9. Voltage Transient Response: The transient response of the output voltage with resistor step loading will be +/-5% for input supply from off to on and for a load from 0% to 100% and 100% to 0%. Transient response in the output voltage with resistor step loading will be +/-4% for input supply from off to on and for a load from 20% to 100% and 100% to 20%.

10. Transient Recovery Time: To nominal voltage within 60ms.

11. AC-AC Efficiency: The UPS must be EPA Energy Star Qualified with a 93% AC –AC at full rated linear load.

T742-9.2.3 Environmental Conditions and Ambient Temperature

1. Operating: The ambient temperature range, when UPS is operational, must be from 32°F to 104°F (0°C to 40°C). There must not be any degradation in the

performance when operating in this range. Automatic derating must occur for operation in higher ambient temperatures. Storage: 5°F to 104°F (-15°C to 40°C)

2. Relative Humidity: Operating: 0 to 95% non-condensing. / Storage: 0 to 95% non-condensing.

3. Altitude: 10,000 ft. (3,000m) max., without power derating when operated within the temperature specified in Section 1.4, Item A. Ambient temperature must be derated 9°F (5°C) for each additional 1600 ft. (500m) above 10,000 ft. (3,000m).

4. Audible Noise: The audible noise of the UPS must be less than 55dBA max when measured at 1 meter from front, sides, or rear.

T742-9.2.4 User Documentation

Supply the specified UPS system with Safety Instruction & Warning Sheet, WEEE recycling sheet (ISO 14001 compliance), printed copy of quick start guide, printed copy of factory test report. The user manual must be downloaded from the web and includes installation instructions, a functional description of the equipment with block diagrams, safety precautions, illustrations, step-by-step operating procedures and general maintenance guidelines.

T742-9.2.5 Warranty

The UPS manufacturer must warrant the UPS against defects in materials and workmanship for three (3) years. The no-hassle replacement warranty must include shipping costs to the customer site for the new replacement unit and shipping costs from the customer site for the return of the failed unit. Optional two (2) year full coverage extension warranties must be available from the manufacturer. The manufacturer's standard and extended warranties must cover all parts, including the battery.

T742-9.2.6 Quality Assurance

The manufacturer must be certified to ISO 9001:2008. Before shipment, the manufacturer must fully and completely test the system to ensure compliance with the specification.

T742-9.3 Materials.

All materials and components making up the UPS must be new, of current manufacture and must not have been in prior service except as required during factory testing. All relays must be provided with dust covers.

1. Wiring practices, materials and coding must be in accordance with the requirements the standards listed in Section 1.2 and other applicable codes and standards. All wiring must be copper.

2. The UPS unit must be composed of: input PFC converter, IGBT inverter, battery charger, input filter and internal bypass circuit; and batteries consisting of the appropriate number of sealed battery cells; and must be housed in a rack-tower NEMA type 1 enclosure and must meet the requirements of IP20

3. Provide forced-air cooled UPS by an internally mounted, continuously operating fan. Fan speed must be controlled by the UPS from 50% to 100%. Air intake must be through the front of the unit and exhausted out the rear of the unit.

T742-9.3.1 Input Converter

Incoming AC power must be converted to a regulated DC output by the input converter supplying DC power to the inverter. The input converter must provide input power factor correction (PFC) and input current distortion reduction.

1. AC Input Current Limit: Provide the input converter with AC input current limiting whereby the maximum input current is limited to 125% of the full load input current rating.

2. Input Protection: Provide the UPS with built-in protection against under voltage, over current and overvoltage conditions including low-energy lightning surges, introduced on the primary AC source. The UPS must sustain input surges without damage per criteria listed in ANSI C62.41, Category A, Level 3.

3. Battery Recharge: Provide a three-stage battery charger designed to prolong battery life. Provide a 3 hours maximum recharge time for the internal UPS batteries to 90% capacity (full-load discharge rate). Provide DC overvoltage protection so that if the DC voltage exceeds the pre-set limit, the UPS will shut down automatically and the critical load will be transferred to bypass.

T742-9.3.2 Inverter

The UPS inverter must be a pulse-width-modulated (PWM) design capable of providing the specified AC output. The inverter must convert DC power from the input converter output or the battery into precise sinewave AC power for supporting the critical AC load.

1. Overload: Provide an inverter that can supply current and voltage for overloads exceeding 100% and up to 200% of full load current with a visual indicator and audible alarm to indicate overload operation. For greater currents or longer time duration, the inverter must have electronic current-limiting protection to prevent damage to components. Provide a self-protecting inverter against any magnitude of connected output overload. Inverter control logic must sense and disconnect the inverter from the critical AC load without the requirement to clear protective devices.

2. Protect the inverter by the following DC shutdown levels:

a. DC Overvoltage Shutdown

b. DC Under voltage Shutdown (End of Discharge)

c. DC Under voltage Warning (Low Battery Reserve); factory default set at 2 minutes (user configurable 2 to 30 minutes).

3. Output Frequency: Control the output frequency of the UPS with an oscillator. Maintain the output frequency to ±0.1Hz of nominal frequency during Battery mode, Frequency Converter mode or when otherwise not synchronized to the utility/mains source.

4. Output Protection: The UPS inverter must employ electronic current limiting circuitry.

5. Battery Over Discharge Protection: To prevent battery damage from over discharging, the UPS control logic must automatically raise the shutdown voltage set point; depending on output load and connected battery system at the onset of battery operation.

T742-9.3.3 Display and Controls

The UPS must be provided with a microprocessor-based unit status display and controls section designed for convenient and reliable user operation. The monitoring functions such as voltages, currents, UPS status and alarm indicators must be displayed on a full color graphical LCD display.

1. The display must be menu driven navigation and use control buttons for ease of navigation and selection of the configurable parameters.

2. Automatic Battery Test: Provide automatic battery test functionality with the factory default test interval set at every 8 weeks. The battery test must ensure the capability of the battery to supply power to the inverter while loaded. If the battery fails the test, the UPS must display a warning message to indicate the internal batteries need replaced. The Automatic Battery test feature must be capable of being disabled or configured to operate

through the UPS Configuration Program or from the LCD display. The frequency of the Automatic Battery test must be user adjustable.

T742-9.3.4 Bypass

Provide a double-pole bypass circuit as an integral part of the UPS. Provide a make-before-break transfer, and provide a maximum detect and transfer time of 4-6. Design the bypass circuit to ensure the simultaneous transfer of the L1 and L2 poles. Configure the bypass to wrap around the PFC converter, battery charger, DC-DC converter, inverter and battery. Use the rear-panel mounted UPS input circuit breaker for the bypass circuit and route bypass power through the UPS input filters and surge suppression circuit. The bypass circuit default position must be in the Bypass mode (utility).

1. Automatic Transfers: Activate the bypass automatically with the transfer control logic, transferring the critical AC load to the bypass source, after the transfer logic senses one of the following conditions:

a. UPS overload
b. UPS over temperature
c. PFC failure
d. Inverter failure
e. DC bus overvoltage

2. Once the overload condition is reduced, the load must be automatically transferred back to inverter power. An over temperature requires manual transfer back to inverter power after cooling.

T742-9.3.5 Internal Battery

Use valve-regulated, non-spillable, lead acid cells (VRLA) as a stored-energy source for the specified UPS system. The internal battery must be user replaceable and includes a blind-mate style connector located on the rear of the battery kit. House the battery internal to the UPS cabinet and size to support the inverter at rated load and power factor, with ambient temperature of 25°C (77°F) for a minimum of 4 minutes reserve time. The expected life of the battery must be 3-5 years or a minimum 260 complete discharge cycles. The UPS units have the capability to allow the operator to replace the internal battery.

T742-9.3.6 Output Distribution

Hardwire the output distribution input/output as standard.

T742-9.3.7 Communication Options

1. Include two communication ports to allow the operator to field-install an optional communication card. A communications card may be installed during any state of UPS operation (On, Standby or Off states). Provide one of each of the communication cards described below:

b. The Relay Interface Card provides contact closure for remote monitoring of alarm conditions in the UPS, delivering signals for On Battery, On Bypass, Low Battery, Summary Alarm, UPS Fault and On UPS. Provide contacts rated at 24VAC or 24VDC at 1A. Provide connections to a terminal block connector with cable provided by the end user.

T742-9.3.8 Additional UPS Features

1. On the rear panel, provide a terminal block to provide low voltage signals for On Battery, Low Battery, Any Mode Shutdown and Battery Mode Shutdown.

2. Any-mode Shutdown: Provide functionality to shut down the UPS output by turning Off the rectifier, inverter and bypass so that there is no power to the loads. Any-Mode Shutdown must be able to be performed locally and remotely.

3. Battery Mode Shutdown: Provide functionality to shut down the UPS by turning Off the rectifier, inverter and bypass so that there is no power to the load when the UPS is on Battery. Battery Mode Shutdown must be able to be performed locally or remotely.

a. Local Any-Mode Shutdown can be entered from the battery mode shutdown device on the back of the unit.

b. Remote Any-Mode Shutdown can be initiated by a battery mode shutdown button mounted at a remote location.

c. The actuation of the battery mode shutdown must be logged as an event in the event history log.

d. Remote power off must be performed by a NC/NO contact.

e. The remote connection must be provided via terminal block connector.

f. A 12Vdc, 50mA current limited source must be available from the UPS for relay drive.

g. The battery shutdown signal will not cause an immediate shutdown, it will instead start a 2 minute shutdown timer. This timer cannot be stopped once it is triggered. If the utility voltage returns during this count down timer then the UPS will still shutdown and must remain shut down for 10 seconds. The auto-restart setting must then dictate whether the UPS turns back ON when the power is restored.

h. Battery mode Shutdown wiring must conform to all national, regional and local wiring regulations.

4. USB Port: The USB communications port (Version 2.0) must meet the HID Power Device standard, version 1.0 or later [redacted]

T742-9.4 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

TECHNICAL SPECIAL PROVISION

FOR

_____

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T745
SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM

T745-1 Description.

Furnish all labor and materials necessary to provide, install and test a Supervisory Control and Data Acquisition System at each toll site.

T745-2 Materials.

T745-2.1 SCADA System must meet the following applicable industry standards:

1. FCC rules, part 15 – Limits for a Class A digital device.
2. IEEE C62.41 - Guide on Surge Voltages in AC Power Circuits Rated up to 600V.
3. MODBUS over serial line specifications and implementation guide V1.0
4. UL requirements throughout document include UL or other National Recognized Testing Laboratory (NRTL) approved by the United States Department of Labor, Occupational Safety and Health Administration (OSHA) under the requirements of 29CFR1910.7.

Provide a SCADA system at each toll site consisting of a SCADA Control Panel (SCP) to monitor various parameters and conditions associated with the toll site:

1. Electrical distribution system
2. Backup generator
3. ATS
4. Fuel tank
5. TEB or Cabinet AC systems
6. RTC enclosure(s)
7. OCC enclosure
8. Power panel.

Provide analog sensors, monitors, and position indicating contacts installed in the equipment or in the enclosures to provide inputs to the SCADA control panel. The remote sensors, monitors and components will be connected to the SCADA control panel with communication cables in raceways to form a complete system.

A technician from Florida's Turnpike Enterprise will load the final programming at the SCADA control panel for final acceptance and commissioning tests.

Provide conduit and cabling in accordance with the SCADA Diagram included in the Plans.

The SCADA Control Panel must be manufactured by a UL508 Panel fabrication shop.

[redacted]

T745-2.2 Power Distribution Frame Monitoring Equipment: Furnish and install the equipment monitored by the SCADA system and the associated monitoring equipment located on the power distribution frames. Power distribution frame monitoring cables must communicate back to the SCADA Control Panel in the OCC via the PLC located in the Power Meters Enclosure (PMs) for toll facilities with on-site power. Power distribution frames at toll facilities with off-site power will interface directly with the SCADA Control Panel since a Power Meters Enclosure will not be present.

T745-2.2.1 Main Circuit Breaker: The position of the main circuit breaker will be monitored at the first service disconnect by using auxiliary dry contacts on the circuit breaker. The auxiliary contacts will be open when the circuit breaker is open and closed when the circuit breaker is closed. A 24 VDC signal from the SCADA control panel will be routed through the auxiliary contacts.

T745-2.2.2 SCADA Power Meters Enclosure: The incoming utility power and the incoming emergency generator power will be monitored by power meters located in the SCADA Power Meters Enclosure mounted to the power distribution frame at RTC sites with On-Site Power.

Incoming utility power will be monitored at the first service disconnecting means by a power meter (PM-N) located in the SCADA Power Meters Enclosure mounted to the power distribution frame. The power meter will communicate with the SCADA system by MODBUS protocol. The meter will sample the waveforms at 128 samples per second and include waveform capture of 3 cycles when triggered by an alarm. Control power will be provided by the clean power circuit routed from a UPS in the OCC.

The power meter (PM-N) will be Delta Power Meter DPM-C530 with 120VAC control power, panel mount with integrated display and will measure the following parameters:

1. Utility voltage and frequency will be monitored at the line side of the first service disconnect. The power meter (PM-N) sensing leads will be protected by a factory installed voltage disconnect (#VTFB-6) with a 1 Amp fuse.

2. Total utility current will be monitored at the first service disconnect. Class B current transformers with secondary current output of 0 to 5 Amps must be factory installed and the current transformer load side leads will be routed through a factory installed shorting type terminal block equal to cat # CTSB-10. Connect the CT's load side leads to the power meter (PM-N).

3. Watts, Watt-Hours, Volt-Amps, reactive power, power factor, and harmonics will be monitored at the first service disconnect by the power meter (PM-N).

Incoming emergency generator power to the ATS will be monitored by a power meter (PM-G) located on the SCADA Power Meters Enclosure. The power meter will communicate with the SCADA system by MODBUS protocol. The meter will sample the waveforms at 128 samples per second and include waveform capture of 3 cycles when triggered by an alarm.

The power meter (PM-G) will be equal to Delta Power Meter DPM-C530 with 120 VAC control power.

Each Power Meters Enclosure (PMs) is a Cat# FDOTRSPRPM3RX as manufactured by Sta-Con Inc. The Cat# FDOTRSPRPM3RX will include the following components housed inside a 24" x 20" x 12" NEMA 3[redacted] enclosure with a 17" x 21" carbon steel metal backplane.

1. Ground Buss (#8-1) SQD PK7GTA
2. Control Breaker – SQD QOU115
3. (2) 5 Amp Fuse – BUSSMANN ABC-5-R
4. (2) 2 Amp Fuse – BUSSMANN ABC-2-R
5. (2) Fuse Holders – SQD NSYTRV42SF6
6. Surge Protective Device (120V/1Phase) – Bussmann BSPM1120S2G
7. (1) Intrusion Switch – Cherry E13-00K

8. Monitoring Units – Delta DPM-C530
9. Programmable Logic Controller – Delta AS228R-A
10. AI Module, 4AI – Delta AS04AD-A
11. Power Supply, 24VDC 120W – Delta DRP024V120W1AA
12. Power Supply, 5VDC 50W – Delta PMC-05V050W1AA50W
13. (8) Terminal Strips – (32A) [Grey] – SQD NSYTRV42
14. Terminal Strip End Cover – SQD NSYTRAC22
15. (2) Terminal Strip Jumpers – SQD NSTRAL410
16. Control Relay – Schneider RXM2AB1BD
17. Relay Socket – Schneider RXZE2S108M
18. Diode – 1N4007
19. (2) 4 Pole CT Shorting Term. Block – Schneider 3090TB4
20. (10) Terminal Strips – Schneider 9080-GK6
21. Terminal Block End Barrier – Schneider 9080-GK6B
22. Distribution Block (+24V Bus, -24V Bus) – ABB 17953422
23. Time Delay – Macromatic TE-8816U

T745-2.2.3 Engine Generator: The backup generator electrical and mechanical parameters will be monitored by the SCADA Power Meters Enclosure. [redacted]

1. The backup generator circuit breaker position will be monitored by using auxiliary contacts on the generator circuit breaker. The auxiliary contacts will be open when the circuit breaker is open and closed when the circuit breaker is closed. A 24 VDC signal from the SCADA control panel will be routed through the auxiliary contacts.

2. A control relay in the SCADA control panel will be capable of remotely starting and stopping the backup generator.

T745-2.2.4 Automatic Transfer Switch: The position of the Automatic Transfer Switch (ATS) will be monitored by AB, NO/NC auxiliary dry contacts within the ATS. The A contact will be closed when the ATS is in the Normal position and the B contact will be open the ATS is in the Normal position. The AB contacts will change state when the ATS moves to the Emergency position. A 24 VDC signal from the SCADA Power Meters Enclosure will be routed through the auxiliary contacts.

1. Field install Class B current transformers (CT's) in the ATS to measure the current in the emergency generator feeder. Ensure the CT's secondary current output is 0 to 5 Amps, and install a CT shorting block model #CTSB-10. Connect the CT's current sensing leads to the power meter (PM-G) located on the SCADA Power Meters Enclosure.

2. Field install voltage sensing leads in the ATS to measure the voltage in the emergency generator feeder. Install a fused voltage sensing terminal block Schneider model # VTFB-6 with 1 Amp fuses. Connect the voltage sensing leads to the power meter (PM-G) located on the SCADA Power Meters Enclosure.

T745-2.2.5 SPDs: The alarm contacts on the surge suppression devices at the Automatic Transfer Switch (ATS), emergency distribution panel (EDP), and Emergency Panelboard (EP1) will be monitored by the SCADA system.

T745-2.2.6 AC Units: The branch circuit current for each AC unit in the RTCs and the OCC will be monitored. The 4 – 20 milliamp current sensors will be located in the panelboard that serves the AC units. Ensure the current sensors are [redacted]

T745-2.3 RTC Cabinet Monitoring: Furnish the RTC SCADA components and associated monitoring equipment and turn over to the Engineer. Furnish the following:

T745-2.3.1 RTC SCADA Module: Each RTC will contain a [redacted] as manufactured by [redacted] The Cat# [redacted] will include the following components housed inside a 24" x 20" x 12" fiberglass enclosure cat# A24P20 with a 17" x 21" carbon steel metal backplane.

1. Ground Buss (#8-1) SQD PK7GTA
2. (2) Filter Louvers BLINE KBFA15U
3. Control Breaker – SQD QOU115
4. (2) 5 Amp Fuse – BUSSMANN ABC-5-R
5. (2) 2 Amp Fuse – BUSSMANN ABC-2-R
6. (2) Fuse Holders – SQD NSYTRV42SF6
7. (3) Intrusion Switches – Cherry E13-00K

[redacted]

9. AI Module, 4AI – Delta AS04AD-A
10. Power Supply, 24VDC 120W – Delta DRP024V120W1AA
11. (8) Terminal Strips – (32A) [Grey] – SQD NSYTRV42
12. (2) Terminal Strip End Covers – SQD NSYTRAC22
13. (2) Terminal Strip Jumpers – Schneider NSTRAL410
14. (4) Control Relays – Schneider RXM2AB1BD
15. (4) Relay Socket – Schneider RXZE2S108M
16. (4) Diode – 1N4007
17. (1) Temperature / Humidity Sensor – Veris HW2TA2A
18. Distribution Block (+24V Bus, -24V Bus) – ABB 17953422
19. Time Delay – Macromatic TE-8816U

T745-2.3.2 Doors: The door positions for each RTC will be monitored by DPDT door position dry contact tamper switches. The door tamper switches contacts will be open when the door(s) are open and closed when the door(s) are closed.

T745-2.3.3 AC Units: The RTC air conditioning units will be continuously monitored by the SCADA System. The operating information and alarms will be transmitted to the SCADA System on a two conductor, 18 AWG, stranded, tinned copper, overall foil shielding cable that has a PVC outer jacket.

T745-2.3.4 Leak Detector: A leak detector will monitor the bottom of the enclosure of each RTC cabinet for water intrusion. Solid state normally open contacts will open if water is detected. A 24 VDC signal from the SCADA control panel will be routed through the contacts. Model GEM ELS-1100 series with mounting type #143580.

T745-2.4 OCC Monitoring: Furnish and install the equipment monitored by the SCADA System and the associated monitoring equipment located the OCC Cabinets. All cabling for power and data that serve each RTC that emanate from the OCC must be terminated in the OCC and be coiled at a length equal to the length of the conduit between the OCC and each RTC plus twenty feet of slack. Furnish and install the following:

T745-2.4.1 SCADA Control Panel: Each OCC will contain a SCADA Control [redacted] The SCADA Panel must include the following components housed on a custom 17.5" x 14" aluminum mounting bracket designed for recessed cabinet mounting:

1. Ground Buss (#8-1) SQD PK7GTA

2. Control Breaker – SQD QOU115
3. (2) 5 Amp Fuse – BUSSMANN ABC-5-R
4. (2) 2 Amp Fuse – BUSSMANN ABC-2-R
5. (2) Fuse Holders – SQD NSYTRV42SF6
6. Surge Protective Device – Bussmann BSPM1120S2G
7. AH500 Backplane (6-slot) – Delta AHBP06M1-5A
8. AH500 Power Supply Module – Delta AHPS05-5A
9. AH500 CPU Module – Delta AHCPU530-EN
10. AH500 Digital Input Module (16PT) – Delta AH16AM10N-5A
11. AH500 Relay Output Module (16PT) – Delta AH16AN01R-5A
12. AH500 Analog Input Module (4-Channel) – Delta AH10EN-5A
13. (2) AH500 Space Module Dust Cover – Delta AHASP01-5A
[redacted]
15. Power Supply, 24VDC 120W – Delta DRP024V120W1AA
16. Terminal Strip – (32A) [Grey] – SQD NSYTRV42
17. Terminal Strip End Cover – SQD NSYTRAC22
18. (4) Control Relays – Schneider RXM2AB1BD
19. (4) Relay Sockets – Schneider RXZE2S108M
20. Distribution Block (+24V Bus, -24V Bus) – ABB 17953422
21. Time Delay – Macromatic TE-8816U

T745-2.4.2 AC Units: The OCC air conditioning units will be continuously monitored by the SCADA System. The operating information and alarms will be transmitted to the SCADA System on a two conductor, 18 AWG, stranded, tinned copper, overall foil shielding cable that has a PVC outer jacket.

T745-2.4.3 Doors: The door positions for each OCC will be monitored by DBDT door position dry contact tamper switches. The door tamper switches contacts will be open when the door(s) are open and closed when the door(s) are closed.

T745-2.4.4 UPS: The uninterruptible power supply (UPS) unit(s) will be monitored using Network Interface Cards (NIC). The NIC card(s) will be factory provided and will communicate with department's network switch using the [redacted]

T745-2.4.5 SCADA Control Panel AC Input: A control power circuit will be installed for the SCADA control panel. The branch circuit will be a 120 VAC, 20 Amp circuit that originates from the UPS inside the OCC.

T745-2.4.6 Leak Detector: A leak detector will monitor the bottom of the enclosure for each OCC for water intrusion. Solid state normally open contacts will open if water is detected. A 24 VDC signal from the SCADA control panel will be routed through the contacts. Model GEM ELS-1100 series with mounting type #143580.

T745-3 Submittals and Shop Drawings.

Submit shop drawings in accordance with Section 5, General Requirements for Toll Site Electrical Infrastructure, and the following:

1. A separate set of shop drawings must be submitted for each SCADA system at each site. Each set of shop drawings associated with each site will show the unique name of the RTC site in the title blocks. Typical information associated with multiple sites will be rejected for insufficient information.

2. Include the following information in each set of SCADA shop drawings.

a. Hardware Product Information Submittal:

b. Hardware product information must include, but not be limited to: catalog cut sheets, data sheets, performance surveys, test reports, equipment lists, material list, diagrams, pictures, and descriptive material. The product information must cover all items including mechanical devices, mounting components, wiring, terminal strips, connectors, accessories, and spare parts. The submittal information must show the standard and optional product features, as well as all performance data and specifications.

3. Prior to commencement of manufacture (or shipment for stock items), the SCADA System Provider must submit for review product information for all equipment and material specified in this Section. Include specification sheets on each remote sensor, power meter, or interface card that will communicate or provide status to the SCADA system.

4. Connection Diagrams

a. Show the placement, labeling and wiring of components within panels, cabinets, and consoles. Wire lists and wireless diagrams will not be accepted. Components must be shown arranged in the physical layout (not necessarily to scale), as it would appear to a person servicing the equipment. Wiring designations, and routing designations, will follow the projects drawings standards. The connection diagrams will be submitted on 11 x 17 inch paper.

b. The SCADA System Provider will submit connection diagrams for all new panels, cabinets, and consoles Loop diagrams may not be substituted for connection diagrams.

5. Interconnection Diagrams

a. Interconnection diagrams will be site specific and will show the external wiring between terminals of associated equipment, control panels, motor control centers, terminal boxes, field switches, field sensors, meters, critical power panels, and any other device, panel, or enclosure. Interconnection diagrams must clearly depict all cable types, conductors, and cable tags. Cable tagging must conform to project standards.

b. The SCADA System Provider must prepare and submit interconnection diagrams for all major system components.

6. Panel Fabrication and Layout Drawings (PLFD)

a. As a minimum, PLFD will include front, back, and section views; the locations of all mounted components; drawing scale; nameplate engraving schedule; and structural materials and supports. A bill of material will also be provided on the drawing, or as a separate document. All drawings will be scaled. Overall dimensions and minimum clearances must be shown. Sufficient detail must be included to demonstrate material choices, outward appearance, construction methods, and seismic force resistance.

b. Complete shop drawings will be submitted for all panels, cabinets, and consoles which are fabricated, or modified, for this project. Reviewers will have the right to make modifications to the interior and exterior layouts of panels as part of the shop drawing review. No additional compensation will be provided to the SCADA System Provider for changes. The SCADA System Provider will budget for one redesign of the panel layout to incorporate the reviewers' changes..

T745-4 Warranty.

The manufacturer will warrant all components against defects in materials and workmanship for two years. The warranty will cover all parts for two years and onsite labor for two years.

T745-4.1 Quality Assurance

1. Control Panel Integrator Qualifications

2. Minimum of ten years' experience in the design, manufacture, and testing of solid-state PLC systems is required.

3. FACTORY TESTING

4. Before shipment, the manufacturer fully and completely tests the system to assure compliance with the specification.

T745-4.2 Products submitted other than listed part numbers are the responsibility of the contractor for system integration and revised PLC programming to make any substitute product integrate into the SCADA system.

T745-5 Construction Requirements.

T745-5.1 Fabrication: All materials and components making up the SCADA system will be new, of current design, and not in prior service except as required during factory testing. The SCADA system will be constructed of replaceable subassemblies.

T745-5.2 Wiring: Wiring practices, materials, and coding will be in accordance with the requirements of the National Electrical Code (NFPA 70) and the National Electrical Manufacturer Association.

Cables with shields and/or drain wires will have the shield and/or drain wire grounded at the SCADA control panel end only.

Each cable or conductor installed for the SCADA system will be field labeled at both ends of the cable or conductor. Labels will be installed within 6 inches of the ends of each cable or conductor. Ensure the labels are self-laminating and the label material is vinyl with white matte finish and black 12-point text that is heat and solvent resistant. Contact the Tolls Engineering Department for wire naming conventions and label syntax.

Wiring inside the SCADA control cabinet will be routed through PVC wide finger wiring ducts. The white wiring ducts will have removable covers. The wiring duct will be equal to Panduit, Type G wide finger wiring duct.

T745-5.3 Field Quality Control

Upon completion of the work, test the installation to ensure that the installation is entirely free of ground faults, short circuits, and open circuits and that it is in satisfactory working condition. Furnish all labor, materials, and apparatus necessary for making the required tests.

Remove and replace any defective material or workmanship discovered as a result of these tests at no expense to the Department and make subsequent re-tests to the satisfaction of the Engineer.

The following inspections and test procedures will be performed by trained field service personnel during the SCADA system start-up and commissioning:

1. Visual Inspections
    a. Inspect equipment for signs of shipping or installation damage.
    b. Verify installation per drawings.
    c. Inspect cabinets for foreign objects.
2. Mechanical Inspections
    a. Check all I/O modules are correctly fitted.
    b. Check all power supply modules are correctly fitted.
    c. Check all terminal screws, nuts, and/or spade lugs for tightness.
3. Electrical Inspections
    a. Confirm input voltage is correct.

b. Confirm each remote sensor, meter, and interface card is functioning correctly.

4. Install and/or test the following items before notifying the Department that the SCADA system is ready to be programmed:

a. SCADA system control panel installed and energized.

b. The tolling communications cabinet is installed.

c. The power serving the OCC is energized.

d. Testing of the OCC fiber optic cables in accordance with specifications 633 – Intelligent Transportations Systems - Fiber Optic Cable Interconnect, has been completed satisfactorily.

e. Network switch is installed and energized.

T745-5.4 Replacement Parts Stocking

Replacement parts must be available through a local distributor within 100 miles of the job site. The parts and materials within the SCADA control cabinet must be available 24 hours a day, 7 days a week, 365 days a year from a local distributor. Include the local distributors name on the shop drawings.

T745-6 Basis of Payment.

The work specified in this Section will not be paid for directly but will be considered as incidental work.

TECHNICAL SPECIAL PROVISION

FOR

_____

FINANCIAL PROJECT NO.: _____-_-__-__

This item has been digitally signed and sealed by _____ on the date adjacent to the seal. Printed copies of this document are not considered signed and sealed and the signature must be verified on any electronic copies.

Date: _____
Fla. License No.: _____
Firm Name: _____
Firm Address: _____
City, State, Zip Code: _____

SECTION T746
OUTDOOR COMMUNICATION CABINETS

T746-1 Description.

Furnish and install toll communication cabinets along with the required accessories as shown in the Plans.

T746-2 Materials.

Provide UL or other NRTL Listed NEMA 3R 316 stainless steel enclosure and the following:

1. Cabinet with an open bottom. Louvers and vents are not permitted.
2. Single front and rear access doors - Gasketed doors with continuous hinge held closed by 3-point latching mechanism with door stop kits
3. Enclosure lighting activated by door open/close
4. Cabinet must be structurally designed to comply with FBC requirements for Risk Category II buildings and structures. Wind loads for the cabinet used in structural calculations must be the 3-second wind velocity (gusts) per FBC Section 1620 "High Velocity Zones - Wind Loads" for Miami-Dade County.
5. Cabinet must have a means of bonding, such as a lug, to the site grounding system
6. Cabinet must be installed on a minimum 3" high open base /riser/pedestal
7. Sunshields constructed of the same material and gauge metal as the cabinet, covering all exposed sides of the enclosure with 1" standoff separators
8. Full length EIA-310 compliant 19-inch rack rails for mounting equipment in the front and back. Cabinet must have a minimum 36 usable rack units (RU) available vertically. All mounting rails to be configured as square hole cage nut type 12-24 Black
9. Slide out shelf occupying 1RU
10. Two (2) sets of Equipment Support Brackets or a 4-post rack unit frame.
11. Three (3) sets of 3-inch Horizontal Wire Management.
12. One (1) SCADA system furnished and installed.
13. One (1) UPS for the OCC components furnished and installed.
14. One (1) UPS for each RTC furnished and installed.
15. Fiber Distribution Panel (Fiber Patch Panel)
16. Include the following wiring devices in each OCC:
    a. Two (2) 15A simplex receptacles for dedicated use of the AC units each with a NEMA type matching the plug from the AC units.
    b. One (1) 20A NEMA 5-20R receptacle for convenience power.
    c. One (1) 20A NEMA L5-20R receptacle for the OCC UPS.
17. One (1) vertical Power Distribution Unit (PDU) furnished and installed.
    a. PDU shall be single phase monitored, surge protected.
    b. PDU shall be NEMA 5-20R compliant and have a minimum of (12) NEMA 5-20R, standard simplex outlets.
    c. The PDU input power cord must come factory installed from the manufacturer with L5-20P plug (field retrofitted cords will not be accepted).
    d. PDU shall be vertically mounted directly to the OCC using mounting hardware or tool-less feature.

T746-2.2 Air Conditioner Units: Provide two (2) factory-installed side-mounted AC units each at 230V, 1-phase. Unit, size, make and model must be as indicated on the Plans. Shop-

mount each unit on different sides of the enclosure (never on the same side or on the front or back).

T746-2.3 Fiber Distribution Panel (FDP): Provide Fiber Distribution Panel (FDP) in accordance with the following:

1. Manufacturers Provide a product from one of the following, or approved equal, meeting the requirements in the contract documents:

a. LEVITON OPT-X 2000i SDX 2RU Rack Mount Enclosures with four (4) SDX adapter plates (5F100-2LC), OS2 fiber type, SC duplex adapter type with pre-terminated pigtails, four (4) splice trays (heat shrink, plastic holders 12 fibers), and cable clamp kit. Accessories include cable strain relief kit and fiber management ring kit.

b. CORNING CCH-02U closet connector housing, two rack units, supplied with four pre-terminated CCH pigtail splice cassettes (CCH-CS12-59-P00RE)

2. 19"-EIA width rack mountable, FDP(s) suitable for loose tube, single or ribbon fiber optic cables housed inside of the communication cabinet.

3. Provide one (1) FDP be provided per lateral fiber drop, or interconnect, with the following features:

a. One (1) fiber distribution and splice enclosure must occupy 2RU, and must accommodate at least four (4) Pre-terminated splice cassette /pigtail splice modules / splice trays, as supplied by the FDP manufacturer for the make and model of the FDP.

b. Slide out tray

c. See through, removable top cover

d. Removable tinted polycarbonate front door

e. Strain relief brackets, routing clips and guides

f. Mounting brackets for proper installation

4. Each pre-terminated cassette, pigtail splice module / splice tray must be in accordance with the following:

a. Six (6) SC/UPC duplex, single-mode, ceramic insert composite ports

b. Twelve (12) single mode factory polished pre-terminated pigtails

c. Twelve (12) single fiber heat-shrink splice protectors

d. Protective braided tubing for incoming cable

e. Grommets and cable ties for additional strain relief

f. Mounting hardware for use with the fiber optic distribution panel (FDP)

5. Provide (12) single mode SC to SC jumpers for each set of two FOC buffers entering an OCC with the length necessary to patch through all lateral fibers color-to-color.

6. The FDP must be mounted at the position next below the top cable management position within the OCC.

7. The number of fiber ports must comply with the number of strands per cable sheath being dropped to the toll equipment building.

8. Provide adjustable front and rear equipment mounting rails to properly mount the FDP. The mounting rails must be square hole cage nut with #12-24 hardware.

T746-3 Submittals and Shop Drawings.

T746-3.1 Calculations and Shop Drawings: Submit shop drawings in accordance with Section 5 and General Requirements for Toll Site Electrical Infrastructure for cabinet installation on pad. Submittal of shop drawings must include manufacturer's installation manual. Substitutions that are different than the basis of design for the cabinet and / or AC units provide supporting materials to show equivalency as identified in General Requirements for Toll Site

Electrical Infrastructure. Confirm that each AC unit can independently maintain the temperature within the cabinet.

T746-3.2 Data Sheets: Provide data sheets for the cabinet and all accessories, din rail, cable management, Fiber Distribution Panel, UPS, SCADA and all associated components.

T746-4 Warranty

The OCC, AC units and lighting under this specification section will be warranted by the manufacturer against defects in material and workmanship for a period of 1 year from the date of acceptance. The warranty will include parts, shipping costs, rigging costs, labor, and travel expenses, to replace the equipment or repair the equipment in place, in accordance with the manufacturers published service manuals.

Warranty for the individual components in the OCC will be in accordance with the specification section for each component.

T746-5 Construction Requirements.

The communication cabinets must be properly bonded and grounded to the existing or new grounding system.

T746-5.1 OCC: The OCC must be mounted securely to the toll equipment pad in accordance with the plans and approved shop drawings.

1. Install in accordance with NECA "Standard of Installation".
2. Install enclosures and boxes plumb.
3. Install cabinet fronts plumb.
4. Use the factory mounting holes to secure and support cabinets and enclosures. Do not field drill mounting holes.

T746-5.2 Cleaning and Testing: The completed OCC assembly (enclosure, penetrations, AC and all associated elements) must be subjected to a hose-down water test in the field to confirm that the entire assembly conforms to NEMA 3RX standards and is at a minimum waterproof. The hose-down water test must be executed after the enclosure and all its associated elements have been constructed on site and with the Department and the CEI present to witness the test. This test must occur during the primary walk-through. Water must be directly hosed on all areas susceptible to water intrusion, such as the exterior interface between the AC units and the enclosure, interior interface between the AC units and the enclosure (hose water through/inside the cooling unit), around all doors, penetrations (conduit/wireway/etc.), and any other areas that were factory or field cut, welded, or sealed. If there is water intrusion in any water amount or any indication thereof, the OCC enclosure assembly will not be accepted.

Cleaning of the cabinet and all installed accessories must be in accordance with Acceptance Procedures for Toll Facilities and the following:

1. Clean electrical parts to remove conductive and harmful materials.
2. Remove dirt and debris from enclosure.
3. Clean finishes and touch up damage.

T746-6 Method of Measurement.

The Contract unit price for each OCC, furnished and installed, will include furnishing, placement, and testing of the cabinet, all its components, systems, materials, equipment, accessories, and for all tools, labor, equipment, hardware, supplies, shop drawings, utility connections, documentation, associated surge protection devices, SCADA system components, uninterruptable power supply(ies) and incidentals necessary to complete the work. The cost of the

Acceptance Procedures for Toll Facilities at each RTC toll site location must also be included in the cost of the OCC.

T746-7 Basis of Payment.

Price and payment will be full compensation for all work specified in this Section. Payment will be made under:

Item No. 746-1 Outdoor Communication Cabinet - Each.