Special Specification 6080
Fiber Hub (IP)

1. DESCRIPTION

Furnish, install, test, and make completely operational Fiber Hub (IP) with all internal components as shown on the plans, as detailed in this Special Specification and as directed by the Engineer.

2. MATERIALS

2.1 **General Requirements**. Provide each Fiber Hub complete with internal cabinet, all internal components, terminal strips, harnesses, connectors, shelves, fiber termination panels, fiber jumpers, fiber connectors, as well as all mounting hardware necessary to provide for installation of equipment as described herein, subsidiary to this item.

2.1.1 Provide Fiber Hubs identical in size, shape and quality throughout the entire project. Equip Fiber Hubs internally as specified herein. Submit design details to the Engineer for review and approval prior to fabrication.

2.1.2 Construct Fiber Hubs of welded sheet aluminum with a minimum thickness of 0.188 in., or of solid cast aluminum with a minimum thickness of 0.250 in., with minimum dimensions as shown on the plans. Continuously weld all exterior seams, make seams smooth, and file all edges to a radius of 0.03125 in. minimum. Do not use wood, wood fiber product, or flammable products in construction of Fiber Hub or internal components or shelves. Seal the Fiber Hub to prevent the entry of rain, dust and dirt, effectively making the Hub waterproof.

2.1.3 3Provide additional reinforcement needed for the assembly to sustain, without bending or deforming, the load of all accessories, installation and maintenance procedures, and expected outdoor environment. Provide permanently installed aluminum lifting ears permitting lifting with a sling. Round the corners of each lifting ear.

2.1.4 Provide a non-vented inner cabinet, consisting of key-lockable front and back doors designed to seal out all dust and moisture. Do not exceed 20 cu. ft. in volume, complying with NEMA Type 3S Standard (IEC 55). Construct the inner cabinet of the same material as the outer cabinet, and the doors using the same construction methods described elsewhere in this specification. Do not exceed 60 in. in overall height above the concrete foundation. Size inner cabinet to allow room for installation of UPS equipment outside of inner cabinet but inside of outer cabinet. Provide shelves and power outlets in inner cabinet sufficient for communication equipment specified elsewhere in this specification.

Equip the inner cabinet with a fluorescent lighting fixture, mounted at the top, using a 15 watt lamp F15T8, operated from a normal power factor, UL listed ballast. Install a shade to diffuse the light. Install a momentary, pin-type door switch on each inner cabinet door to turn the inner cabinet light on when either inner cabinet door is opened. Submit details of the internal cabinet to Engineer for approval. Equip both internal and external cabinets with Corbin 2 lockable access doors. Key all locks alike. Provide all Fiber Hubs by the same manufacturer. Mount the Fiber Hub on a concrete foundation as detailed in the plans.

2.1.5 Provide mounting holes for Fiber Hub a minimum of 1 in. diameter and with a 4 hole pattern of 40.5 in. x 25.0 in. centered in the bottom or as shown on plans.

2.1.6 Do not paint exterior finish of Fiber Hub. Finish the interior surfaces aluminum, silver gray, or white. Make all finishes smooth and free of flaws, with no sharp edges, inside or out.

2.1.7 Provide outer cabinet door frames double flanged on all 4 sides and provided with strikers to hold tension on and form a firm seal between door gasket and door frame. Provide flange with width of minimum of 1 in., measured from front end of flange to Fiber Hub outside surface.

2.1.8 Provide outer cabinet door openings a minimum of 42 in. wide by 63 in. high. Provide dust-tight gaskets on all door openings(inner and outer cabinet), consisting of 0.25 in. minimum thickness closed cell neoprene permanently bonded to the metal and covered with a silicone lubricant to prevent sticking to the mating surface.

2.1.9 Provide front and back outer cabinet doors for Fiber Hub, constructed of 0.188 in. (minimum) thickness aluminum. Equip doors with fixed pin, stainless steel, continuous piano type hinge. Provide 0.375 in. diameter minimum, plated steel rod catches to hold the doors open at both 90º and 180º, ± 10º, in a 60 miles per hour wind at an angle perpendicular to the plane of the door.. Do not allow door latch, in the latched position, to make contact with the Fiber Hub surface or flange lip.

2.1.10 Provide an operating handle made of stainless steel with a 7.5 in. handle and a minimum 0.50 in. diameter stainless steel shank for both inner and outer cabinet doors. Provide means to padlock each handle in the closed position. Provide a three-pointed draw roller type latching mechanism. Plate the center catch push-rods. Turn the push-rods edgewise at the outward supports, with a cross section of 0.25 in. by 0.75 in., minimum. Provide rollers with a minimum diameter of 0.875 in. and equipped with ball bearings and nylon wheels. Fabricate the center catch of plated steel, 0.1875 in. minimum.

2.1.11 Provide solid brass Corbin No. 2 type locks with replaceable cores for both inner and outer cabinet doors. Provide eight locks and 4 keys with each Fiber Hub. Provide locks with rectangular, spring-loaded bolts, and keys only removable in the locked position. Mount locks rigidly with 2 stainless steel machine screws. Provide locks where throw extends a minimum of 1/4 in. (± 1/32 in.) in the locked position, and the front of the lock is neither recessed nor extends more than 0.1875 in. from the face of the door. Mount locks so that tumblers are in the upper quadrant.

2.1.12 Provide louvered vents in the outer cabinet doors with a removable and reusable metal air filter 16 in. wide by 12 in. high by 1 in. thick that covers the vents and is held firmly in place with bottom and side brackets and a spring-loaded upper clamp so that any air entering cabinet goes through filter. Form the bottom filter bracket into a waterproof sump with drain holes to the outside. Design the louvered vents so that a stream of water from a pressure head, as found in lawn sprinkler systems, will not enter the cabinet. Cover the vent with screen having openings no larger than 0.125 sq. in. to prevent the entry of insects. Design the exhaust vent large enough to prevent excessive back pressure on the fan.

2.1.13 Provide vertical shelf support channels with a single continuous slot to allow shelves to be placed at any height within the Fiber Hub after installation in the field.

2.1.14 Provide each Fiber Hub with an extra set of Unistrut channels on either side of the front section of the cabinet to permit the mounting of additional equipment as necessary. Provide shelves at least 12 in. deep and located to provide a 1/2 in. clearance between the back of the shelf and the back of the Fiber Hub.

2.1.15 Vent and cool the Fiber Hub with 2 thermostatically controlled ball or roller bearing electric fans (Panmotor Model 4600x or equivalent), commercially available and with a total capacity of at least 100 cu. ft. of free air delivery per minute. Provide each fan with a manually adjustable thermostat that can be set to turn the fan on anywhere between 91°F and 149°F with a differential of not more than 10.8°F between automatic turn on and turn off. Protect the fan circuit at 125% of the amp rating of the fan motor. Provide a press-to-test switch to test the operation of the fan.

2.1.16 Mount both fans and thermostats to a plenum chamber at the top-front of Fiber Hub, allowing the ventilation system to draw air through the bottom of the rear door, up through the rack assembly, and exhaust through vents over the top of the front door.

2.1.17 Intake (including filter) and exhaust areas must pass a minimum of 120 cu. ft. of air per minute.

2.1.18 Equip each Fiber Hub outer cabinet with a fluorescent lighting fixture, mounted inside the top front, using a 15 watt lamp F15T8, operated from a normal power factor, UL listed ballast. Install a shade to diffuse the light. Install a momentary, pin-type type door switch on each outer cabinet door to turn the light on when the door is opened.

2.1.19 Terminate all conductors used in Fiber Hub wiring with properly sized spade type terminals. Size the wiring conductors to accommodate the current allowed by National Electrical Code for the respective circuits.

2.1.20 Provide telephone voice communication type line circuit with telephone jack and wall telephone (2554) with one jack/telephone and headset. Provide 50 ft cord with each telephone/headset. Provide surge suppression for telephone circuit.

2.1.21 Provide a 5 digit serial number unique to the manufacturer of the Fiber Hub, preceded by an assigned 2 letter manufacturer's code. Stamp the entire identification code and number on a metal plate and rivet to the Fiber Hub, or stamp the code directly on the Fiber Hub.

2.1.22 Provide 2 ea hand held fire extinguishers and 1ea 10 lb. bag of fire ant killer with Fiber Hub.

2.1.23 Provide details of the design of the Fiber Hub to the Engineer for approval prior to fabrication.

2.2 **Electrical Requirements**

2.2.1 **Electrical Service Terminal Block**. Provide an electrical service terminal block located at the bottom-right side as viewed from the front. Use the terminal block to terminate the incoming AC service and for the first stage of the Fiber Hub lightning protection.

Include these features in terminal block:

- Suitability for use as a power feed and junction point for 2 and 3 wire circuits.
- Ability for the line side of each circuit to handle 2 No. 6 AWG conductors.
- Plastic cover to prevent inadvertent contact.
- Rating of 50 amperes at 600 volts minimum.
- Two 20-position copper ground busses for AC neutral and chassis grounds. Screw size minimum No. 10-32 binder head. Ground busses electrically isolated from the AC grounded conductor and each other by 500 megohms when tested at 250 Volts DC, with the power line surge protector disconnected

2.2.2 **Power Line Surge Protection**. Install EDCO Model SHP-300-10 or proven equivalent power line surge protectors between both line conductors and equipment ground.

Isolate the AC neutral and equipment ground wiring from the AC line wiring with an insulation resistance of at least 10 megohms when measured at the AC neutral. Use white for the AC neutral conductor and green for the equipment grounding wiring.

2.2.3 **Power Distribution Assembly**. Provide a power distribution assembly utilizing no more than 7 in. of rack height, with a depth not exceeding 10 in. including terminal blocks, and with all equipment readily accessible for ease of replacement. Provide terminals used for AC service entry to the Power Distribution Assembly connections made of nickel or cadmium plated brass binder head screws sufficient to accommodate lugged conductors of No. 6 AWG.

Provide the following with the Power Distribution Assembly:

- One main circuit breaker, feeding equipment breakers located on the panel, rated for 50 amperes at 120 Volts AC.
- Four equipment circuit breakers wired to terminal blocks.
- One equipment circuit breakers wired to respective GFCI equipment receptacles.

- Radio interference suppressors, installed on the load side of the equipment circuit breakers. Install in series with the incoming AC power line before it is distributed to any equipment in the cabinet. The suppressors must provide a minimum attenuation of 50 decibels over a frequency range of 200 kilocycles to 75 megacycles, be hermetically sealed in a substantial metal case, be filled with a suitable insulation compound, be rated at 50 amperes minimum at 120 volts, 60 Hertz, and be approved by UL and EIA.

Use 20 amp (at 120 Volts AC) circuit breakers for the equipment and GFCI circuits. Identify rating of breaker and function with label below breakers on the front panel.

Use NEMA 5-15R duplex type equipment receptacles, with an integral ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption must occur on 6 milliamperes of ground-fault current and must not occur on less than 4 milliamperes of ground-fault current.

Locate terminal strips on the sides to the extent that it shall not be necessary to remove the electronic equipment from the Fiber Hub to make an inspection or connection. Protect terminal strips with a dielectric cover.

Provide and mount AC terminal blocks of barrier protected, single screw head per circuit design on the back panel of the power distribution assembly. Arrange terminal blocks so that they shall not upset the entrance, training and connection of incoming field conductors. Do not bring more than 3 conductors to any one terminal screw. Electrically energized conductors or connectors must not extend beyond the protection afforded by the barriers. Terminals used for cabinet circuit connections must secure conductors by means of a No.10-32 nickel or cadmium plated brass binder head screws, and all connections from the power distribution assembly to equipment must be made to these screw heads.

Permanently label all blocks with function and circuit breaker assignment.

2.2.4 **Wiring.** Cut all wires to proper length before assembly. Do not “double-back” any wires to take up slack. Cover harnesses to connectors with PVC sheathing or woven braiding. Secure cables with nylon cable clamps. Provide cable slack to facilitate removal and replacement of assemblies, panels and modules. Color-code all harnesses and wiring.

- Identify all wiring where connected to terminal strips, switches, radio interference suppressors, etc., with insulated pre-printed sleeving slipped over the wire before attachment of the lug or making the connection. Identify in plain words with sufficient details so that a translating sheet will not be required.
- Route all wiring containing line voltage AC separately and/or shielded from all low voltage wiring, i.e., control circuits. Route all equipment grounds directly and independently to the ground bus.
- Provide surge protectors for all ungrounded conductor wires entering or leaving the Fiber Hub. Keep the conductor leads and the surge protector leads as short as possible with all conductor bends formed to the maximum possible radius. Locate the protector units as near as 6 in. to the entry or exit point, and as far as possible from any electrical equipment. Connect the protector ground leads directly to the ground bus.
- Cover all conductors and live terminals or parts which could be hazardous to maintenance personnel with suitable insulation material.

2.2.5 **Uninterruptible Power Supply**. Install an Uninterruptible Power Supply (UPS) having a front panel with indicator and control switches. Install the UPS on a line device that provides uninterrupted AC power to a load regardless of AC source variations, fluctuations, and loss. Conform to all requirements and standards of the Environmental Protection Agency (EPA), The National Electrical Code (NEC), The Occupational Safety and Hazards Administration (OSHA), The Telecommunications Industry Forum (TCIF), the National Electrical Manufacturer’s Association (NEMA), the Acoustical Society of America (ASA), and the Institute of Electrical and Electronic Engineers (IEEE).

The UPS includes but is not limited to the following components:

- UPS Module
- Rectifier/Charger
- Static bypass switch
- Maintenance bypass switch
- Synchronizing Equipment
- Protective Devices
- Accessories (as specified herein)
- Control and monitoring panels
- Input/Output terminals for Hardwire Connection
- Batteries
- System control section with controls, metering and alarms.

Provide UPS unit consisting of a single UPS rated to supply the full load as specified herein.

Provide equipment identified in this specification as components of the UPS. Provide UPS with an input of 120 VAC single phase, and an output of 600 VA of 120 VAC, 60 Hz, single phase output power for 26.9 minutes at 1/2 load and 11.3 minutes at full load when a commercial AC power failure occurs.

Provide UPS that consists of standard equipment and meets specified capacity requirements.

2.2.6 **UPS Glossary and Definitions**. The following are definitions of terminology used in this specification:

- UPS is defined as an on line device that provides uninterrupted AC power to a load regardless of AC source variations, fluctuations, and loss.
- UPS Module is defined as a Rectifier/Charger and Inverter Unit with associated controls, synchronizing equipment, protective devices and auxiliary equipment required to provide precise AC power. UPS inverter shall provide 100% of the UPS rated power to the load continuously.
- Rectifier/Charger Unit is defined as that portion of a UPS module containing the equipment and controls necessary to convert input AC power to regulated DC power required for the input power to the inverter unit and for battery charging.
- Inverter Unit is defined as that portion of a UPS module containing the equipment and controls necessary to convert DC power, from the rectifier/charger or battery, to precise AC power for supplying power to a load, continuously 100% of UPS rating.
- UPS System Control Section is defined as that portion of the UPS module containing the metering, alarms, indicators and control functions.
- Static Bypass Switch is defined as a solid-state device used to automatically transfer the critical load to the bypass line in the event the UPS cannot supply continuous power and transfer the critical load back to the UPS when the trouble with the UPS has been corrected with no interruption to the critical load.
- Double Conversion UPS is defined as an on line UPS.
- Maintenance Bypass Switch is defined as the electromechanical device that connects the load directly to the bypass line and isolates the UPS module from the load without any interruption of AC power. Provide a UL508 in a NEMA1, enclosure fused for 30 amps at 120 VAC. (Make before break operation)

2.2.7 **UPS Materials**. Provide new, currently manufactured, defect and imperfection free parts comprising the UPS that have not been in prior service except as required during factory testing.

- Provide adequate ventilation to ensure that all components are operated within their environmental ratings. Provide sensors for all fans, connected to an alarm on the module control panel to indicate a fan failure.
- Provide electronic components in conformance with Special Specification “Electronic Components”.

2.2.8 **UPS Instrumentation**. Equip UPS with instrumentation to provide the following indications:

- Input AC Voltage

- Input Battery Voltage
- Percent of Battery Charge
- Output Voltage
- Output Frequency
- Battery Charge Current
- Output current
- Input current

2.2.9 **UPS Alarms**. Provide UPS with following alarm indications as well as dry contacts for each alarm, along with a single summary alarm:

- Input Power Failed
- UPS on Battery
- UPS in By-pass
- Low Battery Voltage
- Output failed
- Over Voltage (output)
- Cooling Fan Failed
- Input Breaker Open
- Battery Breaker Open
- Output Breaker Open

2.2.10 **UPS Operational Requirements**.

- **Normal Operation**. Electrical energy from the utility company power source is used to supply power to the UPS and the UPS powers the load during normal operations.
- **Rectifier/Charger**. Provide a solid state device which converts AC power into DC power. Connect the output to the batteries and to the inverter.
- **Inverter**. Provide solid state inverter which converts DC power to AC power.
- **Uninterruptible Power**. Automatically effect continuity of electric power within the specified tolerances to the critical load without power interruption, even with a failure or deterioration of the utility power supply.
- **AC Power Failure**. Automatically supply power from the battery to the inverter in the event of a failure of the AC power supply, with no interruption to or disturbance of the inverter output in excess of the limits of these specifications. Automatically power the UPS, recharge the battery, and supply power to the UPS output when the utility AC power is restored, without interruption or disturbances in excess of the limits of these specifications.

Shutdown the UPS automatically and energize an alarm if the battery is exhausted before AC power is reapplied to the UPS.

- **Static Bypass Switch**. If the logic senses a power failure it will signal the Static switch to switch to a good source. The switch will be transparent to the output power.
- **Maintenance Bypass Switch**. Provide UL 508 maintenance bypass switch with power available indicator that allows the complete UPS module to be de-energized without disruption of the load.

Provide maintenance bypass switch that is external to UPS, so that the UPS can be removed without any disruption. The UPS maintenance bypass switch serves as an external maintenance bypass switch for either ON-LINE UPS or LINE-INTERACTIVE UPS. Install maintenance bypass between the commercial power and the load equipment to allow UPS Module to be removed without power disruption to the load.

During normal operation, the maintenance bypass switch is set at UPS ON-LINE or UPS NORMAL, position. In this mode of operation, the Load input power is protected by UPS AC output against commercial power fluctuations and interruptions. In maintenance bypass mode of operation, the maintenance bypass switch

must be switched to Utility Position before removing UPS Module. In this mode of operation, the Load input power is transferred to commercial power by a make before break switch. The UPS Module may momentarily operate in overload protection due to the out flow of power to the utility line when the load is transferring from UPS output to Utility position. This does not harm the UPS System or load. The maintenance bypass switch requires input power of 120 VAC at 30 ampere. Provide three NEMA 5-20R duplex (2 wire) receptacles for Load input connection, and protect each receptacle with a 20 amperes fuse. Provide a green light connected to each receptacle outlet to indicate that the Load input power is available. (Make before break operation)

2.2.11 **UPS Electrical Requirements**. Provide solid state electronic devices. Hermetically seal all semiconductor devices. Make all relays dust tight; do not use open relays.

Size the UPS to provide a minimum of the required KVA and voltage output. Provide load voltage and bypass line voltage of 120 VAC, 2 wire with a separately derived and isolated (utility) load side ground wire.

- **Efficiency.** Provide UPS, including the static transfer switch, with an efficiency of no less than 85% at the least efficient load.
- **Component Ratings**. The maximum working voltage, current, and di/dt of all solid state power components and electronic devices shall not exceed 75% of their rating. Provide electrolytic capacitors that are computer grade and operated at no more than 90% of their voltage rating.
- **Battery**. Provide UPS battery that is contained inside the UPS cabinet and have a capacity to support the rated load as specified at temperature of 50°C. Provide 5 year batteries at manufacturer's rated standards.
- **Rectifier**. Provide UPS that will recharge the battery in 8 hours or less with the UPS operating in normal condition, loaded to 100% capacity and the batteries completely discharged.
- **Electrical Characteristics**. Provide UPS with the following electrical characteristics:

Input.

Voltage Range:	±10%, -20% of nominal input
Frequency Range:	±10% of nominal input (60 Hz)
Current In-Rush:	Five times (5X) full load
Limiting:	Current for less than 8.0 mS, thereafter 110% full load current
Magnetizing Sub-cycle In-Rush:	Five times (5X) normal full rated input current maximum
Power Factor:	0.9 lagging or better at steady state
Current Limit:	Maximum of 110% normal full load input current
Battery:	Nominal Factory Setting

Output.

Voltage Adjustment Manually Range:	±5% manually
Frequency Regulation:	0.1%
Voltage Transients:	
20% Load Step:	±4%
30% Load Step:	±5%
50% Load Step:	±8%
Loss of AC Input:	±1%
Manual Transfer @ 100% load:	±4%
Voltage Transient:	To within 1% of output voltage
Recovery time:	Rating within 20 milliseconds
Harmonic Content:	Max 5%, total Max 3%, any single harmonic
Overload:	125% of full load rating for 10 min. 150% of full rated load for 30 sec
Current Limit:	150% of full pad current
Fault Clearing:	Sub-cycle current of at least 300% of normal full load current

- **Grounding.** Electrically isolate the UPS module AC output neutral from the UPS chases and bond at the derived isolated output ground terminal. Provide the UPS module chassis with an equipment ground system terminal.
- **Breakers**. Provide the UPS module with both an AC and DC output circuit breaker sized to allow the performance as specified herein and to provide proper fault protection. Provide the rectifier/charger with an input circuit breaker of the frame size and trip rating to supply full rated load to the critical load and recharge the battery at the same time. Provide the circuit breaker with an undervoltage trip so that the circuit breaker will open automatically when the control voltage is lost.
- **Surge Suppression**. Equip the UPS with transient voltage surge suppression as defined by the IEEE 587/ANSI C62.41, category A and B. Transient Protection, Grounding, Bonding, and Shielding Requirements for Equipment.

2.2.12 **UPS Environmental Requirements**. Provide UPS that does not generate noise in excess of 68db measured 4 ft. from the nearest surface of the cabinet. Provide UPS capable of withstanding any combination of the following external environmental conditions without mechanical or electrical damage or degradation of operating characteristics:

Operating Ambient Temperature:	32°F to 104°F
Relative Humidity:	0 to 95%, non-conden
Altitude:	0 to 10,000 ft.(AMSL)

2.2.13 **UPS Submittals**. Provide a complete engineering submittal in a paragraph-by-paragraph response format to include documentation supporting all claims made by the manufacturer.

2.2.14 **Compliance**. Include following details when indicating compliance with specification:

- Indicate compliance on a paragraph-by-paragraph basis.
- Make reference to appropriate documentation, as an attachment to the bid package.
- Include referenced documentation supporting this claim as an attachment to the bid package.

2.215 **Exception**. Where Exception is stated, propose an alternate product or specification. Include the following details for each exception statement:

- State the specification claimed by the manufacturer for the product being proposed.
- Make reference to appropriate documentation.
- Include the referenced documentation supporting this claim as an attachment to the bid package.

2.216 **Supporting Documentation**. Include documentation supporting the manufacturer's claims with the bid package, consisting of:

- Appropriate and specific test data.
- Certified performance data (including information on component ratings, heat rise and dissipation)
- Specification data.
- Detail drawings, including cabinet and/or rack face drawings, circuit drawings, and cable diagrams.
- Product literature.
- Installation instructions.
- System configuration with single line drawings with all circuit breakers identified by number.
- Functional relationship of various equipment’s comprising the UPS unit including weights and dimensions.

2.2.17 **UPS Spare Parts**. Provide a list of recommended spare parts with prices.

2.2.18 **UPS Documentation**. Provide printed literature and brochures describing the equipment. Include two copies of all the following literature with each UPS system furnished:

- Complete operator's manual.
- Complete maintenance and repair manual.
- Complete installation manual with drawings.
- Detailed start-up instructions.
- Complete parts manual.
- Schematics of the complete UPS System including all printed circuit boards or modules.
- Circuit diagrams.
- Wiring diagrams.
- Copy of Factory Test and QC Documents.
- Trouble Point of Contact and Phone Numbers.
- Registration Documents.
- Recommended Spare Parts List (assembled as a kit).

2.2.19 **General Responsibilities for UPS**. Do not deviate from this specification except when in possession of a written exception from TxDOT. Should there be a conflict between published standards and the narrative specifications, the more stringent provision shall apply.

Any deviation or failure to comply with any part of this specification and the referenced documents will be considered to be in non-compliance with this specification. Provide engineering and field technical support as may be required by TxDOT contractor or representative to ensure reliable equipment installation and operation.

2.3 **Communication Equipment Requirements**. Provide, install, and make fully operational in the Fiber Hub and with the TransGuide system the communication equipment as shown on the plans and in this specification. Provide equipment that is fully compatible with the TransGuide system. Provide all internal components, cable trays, fiber jumpers, ST connectors, fiber termination panels, equipment racks, panels, terminal strips, terminal blocks, harnesses, connectors, mounting hardware and incidentals necessary to install equipment. All parts necessary to install and make equipment operate are subsidiary to the Item Fiber Hub (IP).

2.4 Communication equipment provided (or provided by TxDOT as shown on plans) and installed in the Fiber Hub (meeting the Special Specifications and quantities as shown in the plans) includes but is not limited to:

- "Field Ethernet Switch"
- "Field Terminal Server"

2.5 **Environmental Design Requirements**. Provide Fiber Hub that operates within specifications under the following conditions:

- Ambient temperature range of 0°F to 158°F.
- Temperature shock not to exceed 30°F per hour, during which the relative humidity shall not exceed 95%.
- Relative humidity range not to exceed 95% over the temperature range of 40°F to 100°F.
- Moisture condensation on all surfaces caused by temperature changes

2.6 **Fiber Hub Foundation**. Provide concrete Fiber Hub Foundation as shown in plans. Construct the foundation in accordance with Item 656, "Foundations for Traffic Control Devices". Provide details of the design of the foundation to the Engineer for approval prior to fabrication. Ground the Fiber Hub using a 5/8" minimum copper clad ground rod 8 ft. long driven into the ground and installed the foundation ground box.

3. CONSTRUCTION METHODS

3.1 **General Requirements**. Utilize latest available techniques in design and construction to minimize the number of different parts, subassemblies, circuits, cards, and modules. Design equipment for ease of maintenance. Provide component parts readily accessible for inspection and maintenance and that can be tested and maintained with simple hand held tools, basic meters and oscilloscopes. Do not use wood, wood fiber, or flammable products for any components, racks or shelves within the Aggregation Point.

3.2 **Electronic Components**. Comply with Special Specification "Electronic Components" included elsewhere in the project documents.

3.3 **Mechanical Components**. Provide stainless steel external screws, nuts, and locking washers. Do not use self tapping screws unless specifically approved by the Engineer.

Use parts made of corrosion resistant material, such as plastic, stainless steel, aluminum or brass.

Protect all materials used in construction from fungus growth and moisture deterioration.

Separate dissimilar metals with an inert dielectric material

4. DOCUMENTATION REQUIREMENTS

Provide the following documentation:

4.1 Three paper and 1 mylar reproducible copies of the complete and accurate final Fiber Hub wiring diagram.

4.2 Three paper and 1 mylar reproducible copies of the complete parts list including names of vendors for parts not identified by universal part numbers such as JEDEC, RETMA or EIA.

4.3 Two sets of non-fading Fiber Hub wiring diagrams identifying all circuits in such a manner as to be readily interpreted. Insert one set in a heavy duty plastic envelope approved by the Engineer and place in Fiber Hub. Deliver the other set to the Engineer.

5. TESTING REQUIREMENTS

5.1 **General.** It is the policy of Texas Department of Transportation to require performance testing of all materials and equipment not previously tested and approved. If technical data is not considered adequate for approval, samples may be requested for test by the Engineer. The contract period will not be extended for time lost or delays caused by testing prior to final Texas Department of Transportation approval of any items.

Subject equipment covered by this specification to Design Approval Tests and Factory Demonstration Tests at the equipment manufacturer's facility to determine conformance with all the specification requirements. The Engineer may accept certification by an independent testing lab in lieu of the Design Approval Tests, to verify that the Design Approval Tests have previously been satisfactorily completed. Arrange for and conduct the tests in accordance with the testing requirements stated herein. Unless otherwise specified, the Contractor is responsible for satisfying all inspection requirements prior to submission for the Texas Department of Transportation's inspection and acceptance. Texas Department of Transportation reserves the right to have a representative witness all design approval tests and factory demonstration tests.

Compare the results of each test with the requirements specified herein. Failure to conform to the requirements of any test shall be counted as a defect, and the equipment shall be subject to rejection by Texas Department of Transportation. Rejected equipment may be offered again for retest provided all non-compliances have been corrected and retested by the Contractor and evidence thereof submitted to the Engineer.

5.2 **Design Approval Tests**. Conduct Design Approval Tests on one or more samples of each type of equipment, as approved by the Engineer, to determine if the design of the equipment meets the requirements of this Specification. Conduct the tests in accordance with the approved test procedure as described in Article 6. Notify the Engineer a minimum of 25 days in advance of the time when tests are to be conducted.

- Vibration. The equipment must show no degradation of mechanical structure, soldered components, plug-in components, or satisfactory operation in accordance with the manufacturer's equipment specifications after being subjected to the vibration tests as described in Section 2.2.5, “Vibration Test”, of NEMA Standard TS1-1989 or latest revision.

- Consequences of Design Approval Test Failure. Conduct Design Approval Tests on units randomly selected from the prototype design manufacturing run. If only one design prototype is manufactured, conduct test on that unit. If the unit fails the Design Approval Test, correct the design fault and repeat the entire Design Approval Test. Deliver modified units which include design changes required to pass the Design Approval Tests, at no additional cost to TxDOT.

5.3 **Primary Power Variation for UPS**. Provide equipment that meets the specified performance requirements when the input voltage is ± 20 volts from the nominal value of 115 volts. Operate the equipment at the extreme limits for at least 15 minutes without failure of equipment.

5.4 **High Frequency Test for UPS**. Provide equipment that meets the requirements of the Operational Test of the Factory Demonstration Test when subjected to the high-frequency and voltage transient interference specified in Section 2.1.6 “Transient, Power Service” of NEMA standard TS 1, latest revision in effect on the date of the proposal.

5.5 **Production Line Inspection and Test for UPS**. Furnish to TxDOT for review, the manufacturer's standard production line inspection and test reports for each lot of UPS Systems and related equipment.

5.6 **Quality Assurance/Quality Control Procedure for UPS**. Submit the QA/QC manual describing these procedures with the bid proposal for TxDOT review.

6. WARRANTY

Guaranty that equipment furnished and installed for this project shall perform according to the manufacturer's published specifications. Warrant equipment against defects and/or failure in design, materials and workmanship in accordance with the manufacturer's standard warranty. Assign to the Department all manufacturers’ normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Repair or replace defective equipment at the manufacturer's option during the warranty period at no cost to the Department. Provide equipment that has no less than 95% of the manufacturer's standard warranty remaining on the date that equipment invoices are submitted by the Contractor for payment. Any equipment with less than 95% of its warranty remaining will not be accepted by the Department.\

7. MEASUREMENT

7.1 The Fiber Hub (IP) will be measured as each unit furnished, installed and tested in accordance with this Special Specification.

7.2 The Fiber Hub Foundation will be measured as foundation furnished and installed.

Hub. Deliver the other set to the Engineer.

8. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Fiber Hub (IP)” and “Fiber Hub Foundation”. This price is full compensation for furnishing, placing, and testing all materials and equipment, for all conduit, cables, fiber jumpers, power supplies, surge protectors, connectors, concrete, reinforcing steel, anchor bolts, materials, labor, documentation, shop drawings, training, equipment and incidentals.