Special Specification
Traffic Data Collection System

1. Description: Remove, install, clean, repair, replace, adjust, and inspect components of a traffic data collection system, in accordance with the details on the plans and this Item.

2. Materials: Unless otherwise noted on the plans, furnish all materials, required to repair breaks or other shorts in electrical conductors and cable. This will include, but not be limited to, all concrete, ground boxes, wire mesh, and pipe casing. The Department will furnish all other materials. Pick up materials at the locations and times shown on the plans.

   Assume responsibility for all materials furnished by the Department. Use material furnished by the Department for this Contract only. Return unused or removed material deemed salvageable by the Engineer to the Department upon completion of the work and prior to final payment at location shown on the plans or as directed. Dispose of any material deemed not salvageable by the Engineer in accordance with federal, state, and local regulations.

   The contractor will furnish materials in accordance with the following:

   a. Encapsulation material

      i. Epoxy – IRD AS475 or TxDOT approved

      ii. Loop Sealant – ChemQue or TxDOT approved

      iii. Splice Protection - Uraseal Type ES200SV or TxDOT approved

   b. Class I Piezoelectric Sensors (Piezo I) - Must be compatible with the following Electronic Classification Units: (see plans for additional information)

      i. ECM MicroHestia

      ii. PAT DAW 100 Piezoelectric

      iii. PAT DAW 190 Piezoelectric

   c. Class II Piezoelectric Sensors (Piezo II) - Must be compatible with the following Electronic Classification Units: (see plans for additional information)

      i. PEEK ADR-2000+

      ii. PEEK 241

      iii. IRD-PAT ITC

   d. Sensor brackets, as needed (furnished with Class II Piezoelectric Sensors)

e. Piezoelectric Lead-In Wire - 50 ohm coaxial cable RG-58A/U type, high density polyethylene jacket (Tyco Electronics Part #01CHD00002 or TxDOT approved)

f. For Splice Repairs

    i. BNC Connectors - AMP P/N 1-221128-0 or TxDOT approved

    ii. Feed through Adapter - AMP P/N 221551-3 or TxDOT approved

g. Item 476, “Jacking , Boring or Tunneling Pipe or Box”

h. Item 618, “Conduit”

i. Item 620, “Electrical Conductors”

j. Item 624, “Ground Boxes”

k. Item 628, “Electrical Services”

l. Item 656, “Foundations for Traffic Control Devices”

m. Item 685, “Roadside Flashing Beacon Assemblies”

n. Item 688, “Pedestrian Detectors and Vehicle Loop Detectors”

    i. Loop Wire - IMSA Spec 51-5 (PVC Tube) 1 conductor 12 AWG 19 strand copper wire (Belden Part #580706 or TxDOT approved)

    ii. Loop Lead-In Wire - Two conductor twisted and shielded 14 AWG stranded copper wire IMSA Spec 50-2 (Belden Part #581061 or TxDOT DHT #4482)

o. Required/Recommended Tools and Materials:

    i. Concrete saw (minimum 35 hp and 3/8 inch and 3/4 inch wide diamond blades recommended)

    ii. Water – For saw and cleaning cuts

    iii. Pneumatic hammer (electric or air driven)

    iv. Hammer and chisel

    v. High pressured water spray rig

    vi. Air compressor with hose and nozzle (minimum output of 150 cubic feet per minute recommended)

    vii. Pneumatic or electric drill (with low revolutions per minute) with mixing paddle

viii. Broom

ix. Wire brush

x. Gas torch with pear burner

xi. Putty Knife – 3, 4, or 5 inch

xii. Disposable gloves

xiii. Duct Tape – 2 to 4 inch

xiv. Masking tape

xv. Rags

xvi. Silicone, plumber's putty, and expanding foam

xvii. Cleaning solvent such as acetone (Gasoline and rubbing alcohol are NOT acceptable)

xviii. Straight edge (12 foot minimum recommended)

xix. Tape measure (25 foot minimum recommended)

xx. Measuring Wheel

xxi. Fish Tape (100 foot minimum recommended)

xxii. Pavement paint

xxiii. Chalk line

xxiv. Plastic Ties

xxv. Non-corrosive tags

xxvi. Rope – ¼" General purpose

p. TxDOT will furnish the following materials:

i. Traffic Data Collection Cabinet

ii. Electronic Control Unit (as per the plans) – Complete unit including wire harnesses, batteries, and power supply, as appropriate for specific unit

iii. Modem – Complete unit including RS-232 cable

3. Equipment: The contractor will furnish all equipment, tools, and machinery necessary for the proper prosecution of the work. This will include, but is not limited to, concrete saw, ditching machine, boring machine, fault detectors, and splicing tools.

4. The equipment, tools, and machinery will be on the work site in good repair and operating condition prior to beginning work. If at any time, the Engineer determines any equipment is defective to the point that it may affect the quality of the work, that equipment will be immediately repaired or replaced.

    a. Prior to Installation.

    b. Location of Site: TxDOT field personnel will locate and mark each location prior to arrival of the contractor.

    c. Weather: The roadway must be dry. Installation cannot be completed when roadway surface becomes wet. Temperature at the time of installation in cold weather is a factor that will affect the curing time of the encapsulating materials.

    d. Personnel Required for Installation: A minimum of two contractor personnel are required for site installation.

5. Construction.

    a. Condition of the Roadway Surface: The roadway surface should be smooth, level, straight, and free of ruts, patches, and cracks. Pavements that have been heater-scarified are unacceptable.

    b. Reinstallation.

        i. Outside lane installation shall be moved upstream of the traffic three to five feet to avoid any road surface deterioration from previous installation or as otherwise drawn on the plans.

        ii. Inside lane installation shall be moved downstream of the traffic three to five feet to avoid any road surface deterioration from previous installation or as otherwise drawn on the plans.

    c. Loop and Sensor Layout: Carefully mark all loop and sensor cuts to be perpendicular or parallel, as appropriate, to the flow of traffic. Lead-in wire cuts shall be straight from the loop or sensor to a common point off the edge of the pavement where conduit is located.

        i. Loops: Each lead-in wire shall have its own cut for up to a four lane facility. For more than four lanes, see the plans for additional information.

        ii. For Piezo I Installation:

            1. The loop shape is a rectangular cut, 6’6” wide by 8’2” long, centered in the travel lane between the two travel lane boundary stripes. NOTE: The corners shall be at 90º angles. (See TDC(X)-05 standard plan sheet)

2. The leading edge of the leading sensor, first sensor to detect an axle, shall be installed one foot behind the leading edge of the loop. The lagging edge of the exit sensor, second sensor to detect an axle, shall be installed one foot in front of the lagging edge of the loop. The distance from leading edge to leading edge of the leading sensor and exit sensors shall be six feet.

3. The coaxial cable end of the sensor shall be aligned with the center of the white or yellow travel lane boundary stripe.

iii. For Piezo II Installation:

1. The loop shape is a square cut, 6' by 6', centered in the travel lane between the two travel lane boundary stripes.

2. The leading edge of the leading sensor to detect an axle shall be installed one foot in front of the leading edge of the loop. The leading edge of the exit sensor to detect an axle shall be installed one foot behind the lagging edge of the loop. The distance from leading edge to leading edge of the leading and exit sensors shall be eight feet.

3. The coaxial cable end of the sensor shall be aligned with the center of the white or yellow travel lane boundary stripe.

d. Cutting the Roadway for Loop and Sensor Installation.

i. Wet or dry cut is at the discretion of the installer if in asphalt. Concrete requires a wet saw cut to prevent a high heat build-up at the cutting surface and water will be needed to prevent damage to the blades.

ii. The size of the cut is crucial to the success of the installation. If the cut is too small, then the sensor will not operate properly. If the cut is too large, then additional epoxy may be necessary to complete the installation. Make periodic checks of saw cut depth and cut width to ensure the cuts are within allowable tolerances.

iii. The grooves for all loop cuts shall be 3/8" wide and 2" or more deep. NOTE: Cuts shall be 3" as the loop passes under Piezo I sensors.

iv. The grooves for all lead-in cuts shall be 3/8" wide and 2" deep.

v. The grooves for all sensor cuts shall be as follows:

1. For Piezo I:

a. Sensor: 2" wide by 2 1/4" deep

b. Loop: 6'6" wide by 8'2" long by 2" deep (3" under sensors)

2. For Piezo II:

    a. Sensor: 3/4” wide by 1” deep

    b. Loop: 6’ wide by 6’ long by 2’ deep

3. The length of the cuts for the sensors shall be approximately 6 inches longer than the sensor with 3 inches on each side of where the sensor will be installed.

4. The sensor lead-in cuts shall be straight in the direction of the appropriate conduit.

5. For Piezo I sensor cuts, chisel out any material in the center between saw cuts. For Piezo II sensor cuts, use a 3/4” wide diamond blade or gang blades together to get a single 3/4’ wide cut.

vi. Use high pressure water or compressed air to clean all foreign matter out of the cuts and five inches on all sides of the cuts.

vii. Carefully dry the cuts using torches, torpedo heaters, electric heaters, or natural evaporation, depending on weather conditions. Use caution not to burn the asphalt if a torch is used. Use of air pressure to dry the cuts will not be allowed as a small quantity of oil will be contained in the air and can contaminate the cut.

viii. Place a 4” wide strip of duct tape along both edges of the sensor cuts from end-to-end leaving 1/8” distance between the edge of the cut and the edge of the tape.

e. Loop and Sensor Installation.

i. For each loop, use 12 gauge, stranded wire and make four clockwise turns that begin and end at the lead-in cut. Splice each loop with loop lead-in wire ensuring that there is a good mechanical and electrical connection.

ii. The loop and sensor lead-ins should be straight and centered in the cuts. For Class I installations, the loop wire shall run in the cut beneath where the sensors will be installed.

iii. The sensor lead-in shall be identified in the cabinet and pull box with non-corrosive tags to designate lane and sensor assignments. Lane designation shall be made using the following criteria:

1. For north/south highway, northbound shall be considered the primary direction.

2. For east/west highways, eastbound shall be considered the primary direction.

3. Lane 1 shall be assigned to the outside (right) lane, regardless of cabinet location. Subsequent lane designations shall be made sequentially to and from the equipment cabinet.

iv. Prior to installation of the sensors, check the electrical measurements (see Section 5H). Complete the appropriate fields on the Sensor Reading Data Sheet. (See TDC(X)-05 standard plan sheet)

v. For Piezo I installation:

1. Clean all surfaces of each sensor with cleaning solvent.

2. Attach the sensor hangers with plastic ties. (See TDC(X)-05 standard plan sheet) Test fit each sensor to ensure the top of the sensor will be flush with the roadway surface.

3. Remove the sensor from the cut and set aside.

vi. For Piezo II installation:

1. Lay the sensor on the tape next to the cut. Ensure that the sensor is straight and flat.

2. Place the sensor brackets on the sensor, about every 6 inches from edge-to-edge.

3. Bend the end of the sensor downward at a 30 degree angle. Bend the lead-in cable attachment end down at a 15 degree angle and then 15 degree back up until level (forming a lazy Z).

4. Carefully place the sensor in the cut. The end of the sensor should be at least 2” from the end of the cut, and the tip should not touch the bottom of the cut. The lead-in cable attachment should also not touch the bottom or the sides of the cut. The sensor should be located 3/8” below the surface of the roadway, and the top of each bracket should be about 1/8” below the surface of the road. Visually inspect the length of the sensor to ensure it is at uniform depth along its length and it is level (not twisted, canted, or bent).

5. Allow 3” between the lead-in cable attachment point with the sensor and the beginning of the conduit. (Reference the manufacturer’s supplied instructions and see TDC(X)-05 standard plan sheets.)

vii. Use tape, silicone or plumbers putty to seal the sensor lead cut from the sensor cut to prevent epoxy from entering sensor lead cut during installation.

viii. NOTE: Due to a longer cure time, the epoxy should be mixed and poured FIRST before the loop sealant.

ix. NOTE: Pouring of multiple layers of epoxy and loop sealant MUST be done quickly to ensure a proper installation as the encapsulation materials begin to harden very soon after they are prepared.

x. Prepare the epoxy by following the manufacturer's supplied instructions.

xi. For Piezo I installation:

1. As soon as the first batch of epoxy is prepared, pour epoxy into the cut in multiple layers to fill half the cut. Evenly distribute the epoxy along the length of the cut.

2. Immediately place the sensor into the middle of the cut.

3. Ensure that the epoxy is in direct contact with the bottom of the sensor along the entire length of the sensor. If this does not occur, then remove the sensor and either redistribute the epoxy or add additional epoxy to the cut before replacing the sensor.

4. Center the sensor down the middle of the cut and weight down the sensor to hold the assembly in place.

5. After the initial set (approximately 10 min depending on temperature and humidity conditions - the epoxy will not be fluid but should be slightly spongy), remove the sensor supports. Be sure to clean the supports as soon as possible as they can be reused many times. NOTE: Take care in removing the supports. Use wire cutters to cut the plastic ties as close to the surface of the epoxy as possible. Do not twist or turn the cutters while cutting and do not try to remove the plastic ties from under the sensor.

6. Continue pouring epoxy into the cut with the sensor installed.

7. Using a paint mixing stick or trowel, distribute the epoxy along the sensor and smooth out. Care must be taken not to make a trough on top of the sensor. The cuts should be filled with enough epoxy to be flush with the road surface after the epoxy has settled, as it will shrink while curing.

8. While the epoxy is setting, scrape any epoxy away that has slopped onto the tape around the perimeter of the cut.

9. Ensure that all excess epoxy has been removed from the tape around the perimeter of the cut.

10. Use a scraper or trowel to strike off the surface being sure to only use enough downward pressure to barely hold the trowel against the tape. Maintaining a constant speed, start at one end of the sensor and once started, do not stop.

xii. For Piezo II installation:

1. As soon as the first batch of epoxy is prepared, pour epoxy into the cut in multiple passes so that it flows under the sensor and does not trap air bubbles.

2. Using a paint mixing stick or trowel, lightly spread (feather) the grout smooth along the length of the slot. The cut should be overfilled slightly to result in a 1/16” bulge above the road surface after the epoxy has settled. (See TDC(X)-05 standard plan sheet)

xiii. As soon as the epoxy starts to cure, remove the tape from around the sensors next to the now filled cuts. Route the lead-in cables through their respective lead-in cuts.

xiv. Fill loop cuts with any remaining epoxy or loop sealant to be flush with road surface after encapsulation material has settled. Smooth any excess material over the road surface.

xv. Clean the site.

xvi. When the epoxy and loop sealant are fully cured, the lane may be opened to traffic. Failure to wait for the encapsulation materials to fully cure may ruin the installation and cause it to fail prematurely.

f. Termination of Cables.

i. All wires will converge to a common point at the edge of the roadway shoulder. This common point shall be as close as possible to the center of the roadway installations to maintain the shortest run of wire possible to the traffic cabinet.

ii. All wires shall have sufficient length to extend to the traffic data collection cabinet.

iii. No sensor coaxial cable shall be spliced within the original supplied length that is attached to the sensor thru a factory process. If PVC is required from the shoulder of roadway to pull box, then 2 inch PVC shall be used. All exposed saw cuts, containing piezo sensor cables and loop wire shall be sealed with loop sealant.

iv. All wire in the pull box shall be rolled up and secured together in one bundle. All wire in the pull box shall be of sufficient length to facilitate ease of splice repair, if necessary. Each detector and sensor lead-in shall be labeled as shown on the plans. Labels shall be black characters on a white, heat-shrinkable, polyolefin material. Labels shall be printed by mechanical device specifically designed for labeling wire. The printer and label shall be capable of producing 15 characters. Label shall be printed with black ink. Hand lettering is not acceptable.

v. Make final measurements on all loops and sensors and complete the information on the Sensor Reading Data Sheet.

g. Electrical Measurements for Road Sensors.

i. Piezo Sensors before Installation (BK Precision 875B LCR Meter or TxDOT approved)

1. Sensor capacitance (Class I): 30-45 nF
2. Sensor capacitance (Class II): 16-26 nF
3. Sensor capacitance (Brass Linguini): 8-14 nF
4. Sensor dissipation: 0.0-0.03
5. Shield to center conductor resistance: >50 MΩ (infinite)

ii. Piezo Sensors after Installation (BK Precision 875B LCR Meter or TxDOT approved)

1. Sensor capacitance (Class I): 30-45 nF
2. Sensor capacitance (Class II): 16-26 nF
3. Sensor capacitance (Brass Linguini): 8-14 nF
4. Sensor dissipation: 0.0-0.03
5. Waveform: (Tektronix THS720A or TxDOT approved) (minimum 100 MHz bandwidth with 500 Ms/s sample rate)
    a. Clean, sharp spikes with little or no negative signal
    b. Light car: 50 mV to 500 mV
    c. 18-Wheel tractor trailer: 200 mV to 5 V

iii. Loop Measurements after Installation

1. Loop inductance: 100-250 µH (BK Precision 875B LCR Meter)
2. Insulation test: > 100 MΩ (AEMC Model 1045 Insulation Resistance Tester) (NOTE: Care must be taken to not damage the Electronic Classification Unit)
3. Continuity resistance: < 5Ω (BK Precision 388A Digital Multimeter)

4. Loop Quality (“Q”): > 10 (US Traffic Corp Model ILA-550 or TxDOT approved)

5. Maximum Δ (delta) L: > 1.200 (US Traffic Corp Model ILA-550 or TxDOT approved)

iv. Conduit - 2 inch conduit be used unless other noted on plans or directed by Engineer

v. Cabinet Foundation -

1. Install traffic data collection cabinet (similar to traffic signal controller cabinet) as specified by the plans in accordance with Item 656, “Foundation for Traffic Control Devices” and Standard Plan TS-CF-04, “Traffic Signal Controller Cabinet Base and Pad.”

2. Install bead of silicone along the entire external perimeter of cabinet base where it meets the foundation to seal all gaps.

vi. Ground Rods –

1. Install ground rod including running copper ground wire to the required ground connection inside cabinet.

2. The resistance to earth ground should be less than 25 ohms, unless otherwise permitted by TxDOT.

vii. Solar Panel - Install solar panel, battery cabinet, and batteries on separate aluminum pole assembly as indicated on Solar Powered Roadside Flashing Beacon Assembly Details (Aluminum) SPRFBA(3)-04.

viii. Wiring Diagram - Wire all sensors, loops, power (AC or DC), and phone in the cabinet as shown on the plans. (See TDC(X)-05 standard plan sheet)

ix. Site Diagram with Measurements and Sensor Reading Data Sheet -

1. For all new installations, the contractor will prepare a site diagram noting all major infrastructure items including, but not limited to, power pole, phone box, cabinet, conduit, pull boxes, roadway features, sensors, and loops. Measurements shall be noted for all distances.

2. Information as noted per the Sensor Reading Diagram (See TDC(X)-05 standard plan sheet) shall be completed, as applicable, for all installation, repair, and preventative maintenance work.

h. Preventative Maintenance and Repairs

i. For all site maintenance inspections, check every piece of system for damage. Obvious problems include bullet holes in cabinets, missing telephone Customer Service Box, broken conduit, sunken pull boxes, leaning poles, etc.

    1. Inspect all detector loops and sensors in the roadway surface for exposure or deterioration. Repair the damage as noted below.

    2. When needed, seal conduit ends with an approved material.

    3. Inspect and clean debris from all existing ground boxes. Tighten lid bolts or, if missing, replace as needed. Seal conduit ends as necessary with approved sealant.

    4. Remove any and all graffiti on traffic data collection system installation.

    5. Verify that the internal fl

ii. Piezoelectric sensors must be maintained to prolong the service life and ultimately reduce the long-term costs of sensor replacement. The frequency and extent of maintenance depends on the installation and site conditions. As a result, the amount of maintenance required at different sites will vary substantially. Some installation may go maintenance-free for several years at a time, while others may need more frequent repairs (for example, every 4 to 6 months) to insure the continued integrity of the installation. The maintenance of sensors generally involves controlling the propagation of cracks in and around the sensor. Cracks will generally form in one of four ways:

    1. In the asphalt at the shoulder.

    2. In the sensor at the shoulder.

    3. In the sensor in the wheel tracks.

    4. At the sensor/asphalt interfaces.

iii. Crack Repairs at the Shoulder

    1. The cracks should be widened slightly to a depth of about 1/4 inch, making use of a hammer and chisel, a pavement saw or grinder, if one is available.

    2. Make sure the pavement is clean and dry before using a joint sealing compound, flexible loop detector sealant, or other product to seal the crack(s).

iv. Crack Repairs in the Sensor at the Shoulder

    1. The cracks generally run parallel to the direction of traffic and occur within 1 to 3 inches from the end of the sensor. The crack, which usually

does not intersect with the sensor itself, is caused by repeated tire loads crossing at or near the shoulder line. The sensor installation at this location is naturally weaker as a result of edge effects.

2. The crack should be repaired by removing the block of epoxy that is separated (cracked) from the sound portion of the sensor.

3. During removal of the epoxy block, EXTREME CARE must be taken to not damage or break the lead-in RG-58 coaxial cable that is contained in the block of epoxy. One must never be in a hurry when attempting this operation.

4. Once the block of epoxy is removed, the cavity should be thoroughly cleaned before it is back-filled. If the cable is accidentally cut or damaged, it must be repaired and resealed against the possible intrusion of water before the cavity is backfilled.

5. Then back-fill the cavity with the same type of epoxy used for the original installation.

v. Crack Repairs in the Wheel Tracks

1. The cracks are generally an indication of excessive rutting that occurs over short or long periods of time. Cracks in the wheel tracks can also be caused by excessive road deflection under load. The excessive deflection may be a result of asphalt fatigue (in which case you will likely see alligator cracks in the asphalt as well as the sensor), spring thaw, or simply a weak pavement structure. The distress begins as intersecting hairline cracks in or near the wheel path. Unless repaired, the epoxy will begin to sprawl away from the installation and expose the sensor. Sooner or later, the sensor will fail.

2. Though this type of pavement or sensor distress will ultimately lead to the early demise of the sensor, the sensor's life can be prolonged by repairing the cracked and broken sections of epoxy periodically.

3. All cracked or loose pieces of epoxy must be removed or chiseled form the affected area.

4. Once all loose and unsound pieces of epoxy are removed, the exposed surface should be washed and then cleaned with a wire brush in combination with a solvent, such as acetone.

5. As with a new installation, tape should be used on either side of the repair area to contain the new epoxy as it is poured and finished.

vi. Crack Repairs at the Sensor/Pavement Interface

1. The cracks that run along the length of the sensor can be caused by several factors. If the distress is a hairline crack between the installation epoxy and the asphalt, this is a sign that normal thermal expansion and contraction in the pavement is breaking the bond between the asphalt and epoxy. Another form of the distress results when the asphalt begins to sprawl at the epoxy-asphalt interface. Asphalt sprawling will occur in combination with the cracking, particularly when the bond between the epoxy and asphalt remains solid, but the adjacent asphalt cracks. When this occurs, the section of asphalt between the epoxy and the crack will begin to sprawl. Most often, this sprawling is not very severe as the crack in the asphalt generally occurs within one aggregate width from the sensor.

2. The propagation of the crack between the epoxy and asphalt can be compounded by sloppy installation practices. For example, if the cut is not cleaned completely during the original installation, the residue on the face of the cut will weaken the bond of the epoxy to the asphalt face. In other cases, the cut may have been blown dry with compressed air that contained too much suspended oil. In blowing the cut dry, the oil would have contaminated the face of the cut, thereby weakening the bond between the epoxy and the asphalt.

3. This distress is prepared by opening the crack with a pavement saw or grinder. The cut should be made down the asphalt/epoxy interface.

4. The exposed asphalt must be carefully inspected, and loose or weakened pieces of asphalt should be removed.

5. The entire cut must be completely clean and dry.

6. The sensor should be washed and then cleaned with a wire brush in combination with a solvent, such as acetone.

7. As with a new installation, tape should be used on either side of the repair area to contain the new epoxy as it is poured and finished.

vii. Damaged Sensor

1. With the Electronic Control Unit disconnected, take readings from sensor connections in the cabinet to determine which sensor is damaged.

2. Visually inspect sensor in an attempt to determine where the problem originates. Look for exposed wires, deterioration of pavement, etc.

3. If there is no obvious visual damage, cut splice in pull box and take readings to determine if damage is in the roadway. Take shield to center conductor resistance from pull box to cabinet to determine if problem exists with the lead-in. If no fault is found in the sensor or lead-in, then re-splice sensor and retest at cabinet.

4. If the problem is in the lead-in wire, then splice a new lead-in wire with a BNC Connector, to the sensor and pull it to the cabinet.

5. If it is deemed to be a damaged sensor, then use a 3/4” saw blade to cut out the damage sensor to a depth of 1”.

6. Reinstall new sensor using the standard installation procedures above. Cut a separate lead-in cut for repaired sensors.

viii. Damaged Loop

1. With the Electronic Control Unit disconnected, take readings from loops in cabinet to determine where the problem exists.

2. Visually check site in an attempt to determine where the problem originates. Look for exposed wires, deterioration of pavement, etc.

3. If there is no obvious visual damage, cut splice in pull box and take readings to determine if damage is in the roadway. Jumper the lead-in connections in the cabinet and take continuity readings from the pull box to the cabinet to determine if problem exists with the lead-in. If no fault is found with the lead-in, re-splice loop and lead-in, remove jumper in cabinet and retest.

4. If damage is in the roadway, use a 3/8” saw blade to cut over the existing loop at a depth of 2” and reinstall using the standard installation procedures above. Cut a separate lead-in.

ix. Phone Line Problems

1. Check for dial tone at the customer service box.

2. If there is no dial tone at Customer Service Box, then notify the Engineer.

3. If there is a dial tone at the Customer Service Box, but none at the cabinet, then visually inspect the connections and wire from the phone jack to the customer service box. Repair as needed.

x. AC Power Problems

1. Check breaker inside cabinet to ensure it hasn’t been tripped, and if it has, then reset breaker.

2. Check the power at the AC disconnect, and if there is no power, then notify the Engineer.

3. If there is power at the AC disconnect, then visually inspect the connections and wire from the wire between the cabinet and AC disconnect. Repair as needed.

xi. Solar Panel Power Problems

1. To test the battery, remove the solar panel input or disconnect it from the regulator. Check the battery with a digital multimeter. For 12 VDC systems, the meter should show a reading of greater than 12.3 volts and less than 15 volts under a load of approximately 3 amps or greater. An automobile's headlight makes a good load. If the battery voltage drops dramatically (less than 11 V) when the test load is applied, then the battery must be replaced.

2. To test the solar panel, disconnect it from the regulator. For 12 VDC systems, in full sun with no load, the reading on a digital multimeter should be greater than 18 VDC. Readings will vary with different weather conditions with more sun shining on the panel yielding a higher voltage reading.

3. To test the voltage regulator output and ability to charge, ensure that the solar panel is connected to the regulator. Remove or disconnect the battery and with the solar panel in full sun, check the output on the voltage regulator terminals labeled battery "+" and "-". If there is no output, then the regulator must be replaced.

i. Traffic Control.

i. Traffic control shall consist of: providing, installing, moving, replacing, maintaining, cleaning, and removing upon completion of work, all barricades, signs, barriers, cones, lights, signals, arrow boards, truck-mounted attenuators and other traffic control devices necessary to provide a safe work zone for installation or repair activities.

ii. All traffic control devices shall conform to the requirements shown in the "2003 Texas Manual on Uniform Traffic Control Devices for Streets and Highways" (TxMUTCD); the "Compliant Work Zone Traffic Control Device List" (CWZTCD), the Traffic Control Plan (TCP) standard sheets, and the Barricade & Construction (BC-03) standard sheets. The 2003 TxMUTCD is currently available at http://www.dot.state.tx.us/trf/mutcd.htm. The contractor shall select the traffic control plan based upon the number of lanes, where the work area is and whether there is an adequate field of view. The traffic control plan shall be set up as shown on the Typical Applications shown in Part VI of the TXMUTCD, TCP (1-1)-98, TCP (1-2)-98, TCP (1-3)-98 or TCP (1-4)-98, or as directed by a TxDOT representative. The use of truck-mounted attenuators shall be required when shown on the Typical Application or the TCP Standard Sheets. The above Traffic Control Plans and Barricade and Construction standards are available at the following web site: http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/toc.htm. The latest version of the CWZTCD is available at the following web site: http://www.dot.state.tx.us/trf/ctrldvcs/trfteps1.htm.

iii. The contractor will be responsible and available on the work site to ensure compliance with the TCP. TxDOT personnel may observe the implementation and will have the authority to assure compliance with the TCP and will stop work if implementation is unsafe.

iv. The existing roadway shall remain open during construction or repairs. At no shall more than one lane in one direction of a four-lane roadway and one lane of a two-lane roadway be closed to traffic.

v. The various types of lane closures are as follows:

1. Type I - with Certified Police Officer and Vehicle

2. Type II - without Certified Police Office and Vehicle

3. TMA - Furnish Truck Mounted Attenuator

4. NIGHT - Work between the hours of 6:00 PM and 7:00 AM.

vi. The contractor will not be allowed to block any traffic lanes between the hours of 7:00 AM to 9:00 AM and 4:00 PM to 6:00 PM unless otherwise directed by the engineer.

vii. The contractor shall obey all state and local traffic laws, ordinances, and regulations during the prosecution of the proposed work.

viii. The contractor shall have all necessary equipment needed to perform the work. The use of yellow rotating beacons or omnidirectional flashing amber warning lamps is encouraged. The warning lamp shall be mounted on the vehicles in such a manner as to allow clear visibility from all directions.

ix. All equipment and vehicles shall be approved by the engineer prior to being used and shall be able to efficiently produce the desired results.

x. All contractor personnel shall wear safety vests and white hard hats while in the right-of-way.

j. Final Acceptance and Testing:

i. Contractor needs to coordinate with Engineer for final acceptance and testing by TxDOT personnel.

ii. Contractor will supply TxDOT personnel with the completed Site Diagram with Measurements and Sensor Reading Data Sheet prior to final testing and acceptance.

iii. Operate completed traffic data collection system continuously for at least 30 days in a satisfactory manner. If any contractor furnished equipment fails during the 30

day test period, repair or replace that equipment. This repair or replacement will start a new 30 day test period.

iv. Replace materials that are damaged or have failed prior to acceptance. Replace failed or damaged existing collection system components when caused by the contractor.

k. Measurement. This Item will be measured as each axle sensor installed, successfully tested, and functional in accordance with this Specification.

i. Sensor Class I. “Piezoelectric Sensor – Class I” will be measured by each sensor complete in place. The minimum quantity for payment of each damage repair is as specified in the plans or specifications.

ii. Sensor Class II. “Piezoelectric Sensor – Class II” will be measured by each sensor complete in place. The minimum quantity for payment of each damage repair is as specified in the plans or specifications.

iii. Loop-Class I. “Loop for Class I Piezoelectric Sensor” will be measured by each loop complete in place. The minimum quantity for payment of each damage repair is as specified in the plans or specifications.

iv. Loop-Class II. “Loop for Class II Piezoelectric Sensor” will be measured by each loop complete in place. The minimum quantity for payment of each damage repair is as specified in the plans or specifications.

v. Ground Box. By each ground box complete in place.

vi. Conduit. By each foot complete in place.

vii. Splice. By each complete splice in place.

viii. Foundations. By each foundation complete in place.

ix. Ground Rod. By each ground rod completed in place.

x. Solar Panel Assembly. By each complete assembly in place.

xi. Solar Panel. By each complete solar panel in place.

xii. Solar Panel Regulator. By each complete solar panel regulator in place.

xiii. Solar Panel Assembly Battery. By each complete set of batteries.

xiv. Preventative Maintenance. By each location.

xv. Lane Closures (Type I). By each lane.

xvi. Lane Closures (Type I) (TMA). By each lane

xvii. Lane Closures (Type I) (NIGHT). By each lane.

xviii. Lane Closures (Type II). By each lane.

xix. Lane Closures (Type II) (TMA). By each lane.

xx. Lane Closures (Type II) (NIGHT). By each lane.

l. 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 “Piezoelectric Sensor” of the class specified and “Loop” of the class specified.

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 each item. This price shall be full compensation for furnishing all materials and manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

Completion of the Sensor Reading Data Sheet will be required for all installation, repair, and preventative maintenance work and will be considered subsidiary to all applicable payment items.