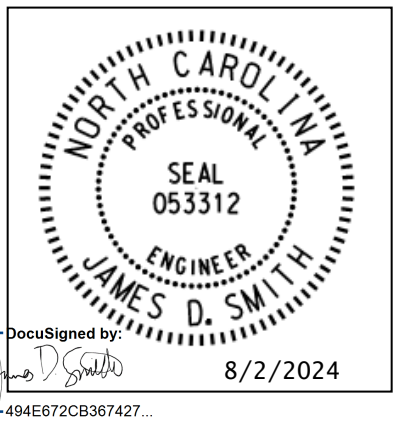

CONTRACT NO. DD00464
Signals and Intelligent Transportation Systems
Weigh-In Motion Upgrade
Project Special Provisions
(Version 24.1)

Prepared By:

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This seal is for sections 1-20 only.

Document not considered final unless all signatures completed.

Contents

1. 2024 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES

The 2024 <u>Standard Specifications</u> are revised as follows:

1.1. Junction Boxes (1098-6)

Page 10-220, add after line 16:

(D) Special Oversized Junction Boxes

Provide special oversized junction boxes and covers with minimum inside dimensions of 36" (l) x 24" (w) x 24" (d).

2. GENERAL REQUIREMENTS

2.1. DESCRIPTION

A. General

Conform to these Project Special Provisions; the Plans; the *2024 Standard Specifications for Roads and Structures* (hereinafter referred to as the "*Standard Specifications*"); and *the 2024 NCDOT Roadway Standard Drawings* (hereinafter referred to as the "Standard Drawings").

In the event of a conflict between these Project Special Provisions and the *Standard Specifications*, these Project Special Provisions shall govern.

Conform to the NC Statewide Information Technology Standards and Policies as described at http://it.nc.gov

B. System Description

This project consists as a minimum of furnishing and installing the following technologies in Halifax County at the northbound and southbound I-95 Weigh Stations near Mile Marker 151 to form an Automated Commercial Vehicle Processing System and Credential Screening System to be operated by the North Carolina State Highway Patrol (NCSHP). The overall function and operation of the Automated Commercial Vehicle Processing System and credential screening system is to provide information to the scale house and commercial vehicle driver as to actions required. This project consists of installing equipment at the locations throughout the project limits as listed below:

1) ADVANCE LOCATIONS
   a) Weigh-in-Motion (WIM)
   b) Traffic Survey Group (TSG) Data Collection
   c) Overview Camera
   d) Automatic License Plate Reader (ALPR)
   e) Automated Tire Monitoring System (ATMS)
   f) Inductive Loops

2) NOTIFICATION LOCATIONS
   a) Changeable Message Signs (CMS)
   b) Inductive Loops

3) COMPLIANCE LOCATIONS
   a) Inductive Loops (main line)
   b) Inductive Loops (ramp)

6) SCALE HOUSE LOCATIONS
   a) Centralized Equipment

The individual systems as listed above and their supportive components, monitors, electronics, wiring including support structures will form an Automated Commercial Vehicle Processing System and Credential Screening System to be operated by the NCSHP.

C. Required System Operations

Provide a fully operational Automated Commercial Vehicle Processing System and Credential Screening System. Credential screening will be based on hierarchy requirements as shown below:

a) 1st Tier Priority: Weigh in Motion, Tire Anomaly System
b) 2nd Tier Priority: Existing 3rd Party Programs (Pre-Pass, Drivewyze); Data provided by these programs will be their approved NCSHP screening data and vehicle file ID information.
c) 3rd Tier Priority: Automated License Plate Reader

Integration with the existing 3rd party programs is required. The Contractor must request in writing from the existing 3rd party programs their desire to integrate in the new WIM system operations within 30 days after Letting. The Contractor must include in this request receipt of an acknowledgment signature from the 3rd party program that any cost associated with integrating their program shall be the responsibility of those respective 3rd party programs.

The required operations of this system are based on processing criteria established for the WIM, ATMS, ALPR & Overview Camera information, while the vehicles are traveling on the mainline of the Interstate. The CMS will direct the commercial vehicles in compliance based on the Tier Priorities listed above to bypass the weigh station, thus ensuring greater efficiencies for both the commercial vehicles and the weigh station.

Vehicles not meeting the established Tier Priority criteria, or selected for a random pull-in, will be notified by the CMS to enter the weigh station for further processing. The Automated Commercial Vehicle Processing System and Credential Screening System will be responsible for making the sort decision.

Data obtained from the ALPR identification system will be used as a 3rd tier data source.

The TSG Data Collection sites are required to meet FHWA 13 for vehicle data collection. The data collection system shall be fully compatible with NCDOT's existing Traffic Data Management System (TDMS) developed by MS2. The bin definitions for both vehicle class and speed must be identical for all lanes at the Advance Locations.

D. Processing of Commercial Vehicles

The following scenario describes how commercial vehicles will be processed:

1) All trucks approaching the weigh station will be directed into the right lane of I-95 by means of static signing located prior to the Advance Locations.

As a truck passes the Advance Location, the equipment in the right-most lane will collect vehicle WIM data consisting of axle weight and spacing, gross vehicle weight, vehicle speed, classification, vehicle length, and ATMS data. The TSG Data Collection Sites will not screen commercial vehicles for reporting to the weigh station.

Additionally, an ALPR camera/system will take a photo of the vehicle's license plate for character recognition for comparison to the database records along with an overview CCTV camera that captures images of each truck as they travel past the location. Images of the vehicles are transmitted to the Scale House Server and become part of the Vehicle ID Record that will be comprised of the WIM data, ATMS data, and ALPR. All Vehicle ID data/records will be sent to the Scale House Server for processing.

2) At the Notification Location, all commercial vehicles are directed by the CMS to either Enter or Bypass the Weigh Station based on the Tier Priority data established above. Commercial vehicles will be directed by the CMS to either Enter or Bypass the Weigh Station for further processing based on evaluated results obtained from the WIM, ATMS and data received (credential & Safety) from the ALPR. All vehicles are subject to a random pull in requirement.

3) The scale house operator uses the information obtained from the Advance Locations to identify why a truck was required to report to the station (i.e., credentials check, weight check, tire anomaly, or random pull-in) and processes the truck accordingly.

2.2. MATERIAL

A. Qualified Products

Furnish new equipment, materials, and hardware unless otherwise required. Inscribe manufacturer's name, model number, serial number, and any additional information needed for proper identification on each piece of equipment housed in a case or housing.

Furnish factory assembled cables without adapters, unless otherwise approved by the Engineer, for all cables required to interconnect any field or central equipment.

Ensure all Contractors-furnished equipment, including pieces and components of equipment, hardware, firmware, software, middleware, internal components, and subroutines which perform any date or time recognition function, calculation, or sequencing will support a four-digit year format for a period of at least 50 years and will support user-definable parameters for setting the start and end dates for daylight savings time.

Certain equipment listed in these Project Special Provisions must be pre-approved on the Department's ITS & Signals Qualified Products List (QPL) by the date of installation. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project.

The QPL is available on the Department's website at the following address:
https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals-Qualified-Products.aspx

B. Warranties

Unless otherwise required herein, provide manufacturer's warranties on Contractors-furnished equipment for material and workmanship that are customarily issued by the equipment manufacturer and that are at least 2 years in length from the successful completion of the 30-day observation period. Include unconditional coverage for all parts and labor necessary or incidental to repair defective equipment or workmanship and malfunctions that arise during warranty period.

For light emitting diode (LED) signal modules, provide a written warranty against defects in materials and workmanship for a period of 60 months after installation of the modules. During the warranty period, the manufacturer must provide replacement modules within 45 days of receipt of modules that have failed at no cost to the Department.

C. Firmware and Licensing Upgrades

Provide the Department with backups of the System roadside operations software and operating system, application programs, data files and any other element necessary to restore any of the roadside operations controller servers and workstations to normal operation after repair or replacement. Provide this material on compact disk or other approved media. Include instructions for restoring the software and data.

Provide three (3) copies of all software packages.

Ensure software performance upgrades that occur during the contract period up through final acceptance of the project are available to the Department at no additional cost.

Software upgrades that are developed to correct operating characteristics shall be available to the Department at no additional cost until the warranty period expires.

Provide licensed copies of all software/firmware to the Department for any programmable devices furnished by the Contractor and installed in this project for which licensed software has not already been provided by the Department. The Department shall have the right to install any software/firmware for maintenance and support on all hardware provided under this contract.

Provide software/firmware for maintenance and support of the system including support software, utility software, roadside equipment software, and all other programmable devices provided by the Contractor.

C. Plan of Record Documentation

Comply with all requirements of Article 1098-1(F) of the *Standard Specifications* for providing plan of record documentation for all work performed under this Project.

2.3.CONSTRUCTION METHODS

A. General

Unless otherwise stated in these Project Special Provisions, perform work that meets the requirements of the *Standard Specifications* and these Project Special Provisions. In the event of a conflict between these Project Special Provisions and the *Standard Specifications*, these Project Special Provisions shall govern.

Locate all underground utilities before beginning drilling, digging, and trenching operations.

Immediately cease work and notify the Engineer and affected owners if damage to existing utilities, cables, or equipment occurs. Make all required repairs and replacements at no additional cost to the Department.

B. Regulations and Codes

Furnish material and workmanship conforming to the *National Electric Code* (NEC), *National Electric Safety Code* (NESC), Underwriters Laboratories (UL), or other listing agencies approved by the North Carolina Department of Insurance, and all local safety codes in effect on the date of advertisement. Comply with Article 4, Chapter 87 of the *North Carolina General Statutes* (Licensing of Electrical Contractors). Comply with the Plans, all previously referenced specifications, and all applicable local ordinances and regulations before and during all stages of the electrical work.

When required by the local ordinances and governmental agencies, upon completion of the work, have all systems inspected and approved in writing by the authorized governmental electrical inspector for the area. Furnish written certification of the authorized inspector’s approval to the Engineer. Inspection by the authorized governmental electrical inspector does not eliminate nor take the place of the inspections by the Engineer. Upon the Engineer’s receipt of written certification and the Contractor’s written request for a final inspection of the installations, the Engineer will perform a final inspection.

Where required, conform to ITE, AASHTO, and ASTM standards in effect on the date of advertisement.

C. Maintenance and Repair of Material

Furnish the Engineer with the name and telephone number of the supervisory employee who will be responsible for maintenance and repair of equipment during all hours.

Maintain and repair all Contractor-furnished and installed communications related equipment within the project construction limits until completion of the Observation Period and receipt of written notification of final acceptance of the project. This requirement for maintaining and repairing said equipment shall remain in effect in the event of severe weather (see NOAA National Severe Storms Laboratory website http://www.nssl.noaa.gov/primer/) or a natural disaster, including but not limited to floods, winter weather, lightning, damaging winds, hail, tornado, tropical storm, or hurricane.

Remove and replace all equipment that fails. The Department will furnish the Contractor replacement equipment for Department-furnished equipment that fails.

D. Wire and Cable

For installation in a conduit system, lubricate cable and wires before installing in conduit. Use lubricant that will not physically or chemically harm cable jacket, wire insulation, and conduit.

Only splice lead-in cables in junction boxes using UL®-approved, underground splice connectors using gel-filled splice connectors in accordance with Standard Drawing 1725.01. Splice all other electrical wire and cable inside equipment cabinets, and cabinet base extenders/adapters at nickel-plated brass, recessed-screw, barrier-type terminal blocks or using gel-filled splice connectors. Unless specifically allowed, connect no more than two conductors to the same terminal screw. Do not splice any electrical wire or cable other than lead-in cables in junction boxes.

Maintain color-coding of wires through splices.

Protect ends of wire and cable from water and moisture.

Place permanent labels on all wires and cables to clearly identify each one. Use an indelible black ink marker or approved labeling devices to write on the permanent labels when required.

Install all wire and cable with necessary hardware including, but not limited to shoulder eyebolts, washers, nuts, thimbleyelets, three-bolt clamps, J-hooks, split bolt connectors, grounding clamps, and lashing material.

E. Inductive Loop Tests and Grounding

Submit a completed Inductive Loop & Grounding Test Form available on the Department's website. The form is located on the Department's website at:

https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx

Provide a length of marker tape 6 to 12 inches below finished grade directly over grounding electrodes and conductors.

F. Electrical Bonding

Using an approved termination means, connect a number 10 AWG minimum 19-strand copper conductor (Type THWN) with green insulation to serve as an equipment grounding conductor to

metal poles and other metallic components which are not otherwise bonded, through means approved by the Engineer.

2.4. MEASUREMENT AND PAYMENT

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section. Include the incidental costs for furnishing and/or installing materials and equipment expressly required under the contract for successful completion of the contract, but whose measurement and payment is not specifically stated under any of the contract pay items, into the unit cost(s) for the various items in the contract.

3. SPECIAL OVERSIZED JUNCTION BOXES (BROADBAND)

3.1. DESCRIPTION

Furnish and install special oversized junction boxes with covers, graded stone, concrete collar, and all necessary hardware in accordance with the plans and specifications. Comply with the provisions shown in the special oversized junction box typical detail drawing.

3.2. MATERIAL

A. General

Refer to Divisions 8 and 10 of the 2024 *Standard Specifications for Roads and Structures*.

Item	Section
Incidental Concrete Construction	825
General Requirements for Aggregate	1005
Portland Cement Concrete Production and Delivery	1000
Reinforcing Steel	1070

Furnish material, equipment, and hardware under this section that is pre-approved on the ITS and Signals QPL.

B. Junction Box

Provide junction boxes with at least two size 3/8-inch diameter stainless steel hex head cover bolts to match inserts in the box. Ensure junction boxes are provided with open bottoms.

Provide vertical extensions of 6 inches to 12 inches as required by project provisions. Provide the required logo on the cover. Provide pull slot(s) with stainless steel pin(s).

Provide third party certification that the junction boxes and covers meet ANSI/SCTE 77 2013 and Tier 22 loading. Provide certification that testing methods are compliant with ANSI/SCTE 77 2013.

Provide special oversized junction boxes and covers with minimum outside dimensions of 48" (l) x 30" (w) x 36" (d) as shown in the plans.

Provide a cover embossed with the following wording “NCDOT Fiber Optic.” Additionally, furnish an access point/hatch on the lid to allow access to the tracer wire bonding/isolation test switch that is

located inside the junction box (See "Tracer Wire Bonding/Isolation Test Switch" requirements below).

Provide special oversized junction boxes with mouse holes or knock-outs fabricated in the sides to accommodate conduit entrances. Boxes fabricated without mouse holes or knock-outs shall be approved by the manufacturer for field drilling conduit entrance holes. Consult the manufacturer to identify the amount of surface area that can be removed for field drilling conduit entrance holes without violating the boxes structural integrity. Upon request, provide written approval from the manufacturer stating their recommendations.

C. Tracer Wire Bonding/Isolation Test Switch

For all special oversized junction boxes (Broadband), furnish as an integral part of the junction box assembly, a tracer wire access testing port via a retractable mechanism that allows easy access to the tracer wire system through a Bonding/Isolation switch. Ensure the Bonding/Isolation switch can be accessed through a small hatch located in the lid of the junction box. The hatch should be designed into the lid and secured via a security bolt. The Bonding/Isolation switch must be retractable so it can be accessed without removing the lid of the junction box. The Bonding/Isolation switch shall include a minimum of (5) termination lugs for trace wires and (1) lug for grounding. Once the Bonding/Isolation switch is moved via the retractable mechanism, ensure the switch can be disengage effectively breaking the bond and allowing individual isolation of tracer wire circuits for locating. Ensure the Bonding/Isolation switch on the retractable mechanism is mounted in a location on the interior wall of the junction box which will not interfere with the installation or removal of the lid. When the Bonding/Isolation switch is pushed back down via the retractable mechanism, the Bonding/Isolation switch shall automatically return to a closed or bonded position.

Furnish a 5/8" * 10', copper clad, ground rod to be driven inside the junction box.

3.3. CONSTRUCTION METHODS

A. Special Oversized Junction Boxes (Broadband)

Install special oversized junction boxes (Broadband) at the locations shown in the plans. Install the special oversized junction boxes over the existing conduit. Field cut knock-outs on each end of the junction box so that the existing conduit passes through the newly installed junction box. Splicing of existing conduit and fiber is not allowed.

Backfill beneath and around the boxes using #57 or #67 washed stone in conformance with Section 1005 of the 2024 Standard Specifications for Roads and Structures. Backfill beneath the box a minimum of 12 inches and around the exterior of the box a minimum of 3 inches.

Avoid placing junction boxes on slopes of 3:1 or greater.

B. Concrete Collar

Install a reinforced concrete collar that complies with Section 825 "Incidental Concrete Construction" and extends 12 inches for the edge of the junction box and 8 inches deep. Ensure the reinforcing of the concrete collar consists of two rectangular hoops of #4 rebar tied in the corners. Provide minimum Class B concrete. Fill construction joints between the junction box and the concrete with an expansion joint filler. Ensure concrete collar is installed flush with grade.

C. Electronic Marker Ball

Remove the existing electronic marker ball from the existing junction box and install it in the new special oversized junction box upon completion of the junction box installation. Ensure marker balls stay tuned to a frequency of 101.4 KHz. Test to ensure that the marker ball is functioning properly with an approved electronic locater device. Record precise latitudinal and longitudinal coordinates for the location of each marker ball/junction box.

D. Tracer Wire Bonding/Isolation Switch

For all special oversized junction boxes, install a ground rod (5/8" * 10', copper clad) in the junction box and secure a minimum of five feet of #10 AWG THWN, green insulated, 19-strand copper tracer wire to the ground rod using an approved bonding clamp.

Secure the opposing end of the tracer wire to the main bonding lug located on the Bonding/Isolation switch. Test ground rod resistance to obtain 20 ohms or less reading.

Secure all tracer wires that originate from the same side of the junction box together using a gel-filled wire nut along with a minimum of five feet slack Green, #10 AWG, THWN tracer wire to form a connection to one of the termination ports on the Bonding/Isolation switch.

Provide a permanent nylon tag to the tracer wire jumper close to the tracer wire terminal port that identifies the direction of the tracer wire system as it leaves the junction box. Use a black indelible ink pen or other approved method to label the nylon tag.

No splices of tracer wires are allowed outside of the interior portion of the junction box, unless approved by the Engineer. If external splices are necessary, use lockable connectors specifically manufactured for use in underground tracer wire systems. Connectors shall use a dielectric silicon filled compartment to seal out moisture and corrosion and shall be installed in a manner to prevent any uninsulated wire exposure. Gel-filled wire nuts are not acceptable for making splices outside of the junction box.

Upon completion and in the presence of the Engineer or the Engineer's representative, test all legs of the tracer wire system using a tuned frequency transmitter and locater to ensure the tracer wire system forms a complete and operational system.

3.4. MEASUREMENT AND PAYMENT

Junction Boxes (Special Oversized)(Broadband) will be measured and paid as the actual number of special oversized junction boxes furnished, installed and accepted. No measurement will be made of covers, graded stone, ground rods, installation of the existing marker ball, tracer wire bonding/isolation switch, tracer wire jumpers, or tracer wire testing as these will be incidental to furnishing and installing junction boxes.

Payment will be made under:

Pay Item	**Pay Unit**
Junction Boxes (Special Oversized) (Broadband)	Each

4. BASE MOUNTED EQUIPMENT CABINETS

4.1. DESCRIPTION

Furnish and install Type 332 base mounted equipment cabinets and all necessary hardware. Conform to CALTRANS Traffic Signal Control Equipment Specifications except as required herein.

Furnish all foundation mounting hardware, one Corbin Number 2 cabinet key, surge protection, lighting fixtures, grounding systems, thermostatically controlled exhaust fan, and all necessary hardware.

Type 332 Base Mounted Equipment Cabinets will serve as equipment cabinets to house various system components located throughout the project limits.

4.2. MATERIAL

Material, equipment, and hardware furnished under this section shall be pre-approved on the Department's QPL.

Provide moisture resistant coating on all circuit boards.

Provide a power line surge protector that is a two-stage device that will allow connection of the radio frequency interference filter between the stages of the device. Ensure that the maximum continuous current is at least l0A at 120V. Ensure that the device can withstand a minimum of 20 peak surge current occurrences at 20,000A for an 8x20 microsecond waveform. Provide a maximum clamp voltage of 280V at 20,000A with a nominal series inductance of 200µh. Ensure that the voltage does not exceed 280V.

A. Type 332 Cabinet Electrical Requirements

Furnish two sets of non-fading cabinet wiring diagrams and schematics in a paper envelope or container and placed in the cabinet drawer.

Provide surge suppression in the cabinet for each type of cabinet device. Provide surge protection for the full capacity of the cabinet.

All AC+ power is subject to radio frequency signal suppression.

Install a UL listed, industrial, heavy-duty type power outlet strip with a maximum rating of 15 A I 125 VAC, 60 Hz. Provide a strip that has a minimum of 3 grounded outlets. Ensure the power outlet strip is mounted securely; provide strain relief if necessary.

Provide a terminal mounted loop surge suppresser device for each set of loop terminals in the cabinet. For a 10x700 microsecond waveform, ensure that the device can withstand a minimum of 25 peak surge current occurrences at 100A, in both differential and common modes. Ensure that the maximum breakover voltage is 170V and the maximum on-state clamping voltage is 30V. Provide a maximum response time of less than 5 nanoseconds. Ensure that off-state leakage current is less than 10 µA. Provide a nominal capacitance less than 220pf for both differential and common modes.

Provide surge suppression on each communications line entering or leaving a cabinet. Ensure that the communications surge suppresser can withstand at least 80 occurrences of an 8x20 microsecond wave form at 2000A and a 10x700 microsecond waveform at 400A. Ensure that the maximum clamping voltage is suited to the protected equipment. Provide a maximum response time less than 1 nanosecond. Provide a nominal capacitance less than 1500pf and a series resistance less than 15 Ω.

Provide conductors for surge protection wiring that are of sufficient size (ampacity) to withstand maximum overcurrents which could occur before protective device thresholds are attained and current flow is interrupted.

Furnish an LED fixture in the rear across the top of the cabinet and another LED fixture in the front across the top of the cabinet at a minimum. Ensure that the fixtures provide sufficient light to illuminate all terminals, labels, switches, and devices in the cabinet. Conveniently locate the fixtures so as not to interfere with a technician's ability to perform work on any devices or terminals in the cabinet. Provide a protective diffuser/cover over the LEDs. Provide door switch actuation for the fixtures.

Furnish a quad power outlet (four 15-amp sockets) for use by network equipment. Furnish power allocations for network equipment. Total power made available to network and telephone company equipment not to exceed 20 amps at l 15VAC.

B. Type 332 Cabinet Physical Requirements

Provide a surge protection panel with loop protection devices that allows sufficient free space for wire connection/disconnection and surge protection device replacement.

Provide permanent labels that indicate the slot and the pins connected to each terminal. Label and orient terminals so that each pair of inputs is next to each other. Ensure that a Number 4 AWG green wire connects the surge protection panel assembly ground bus to the main cabinet equipment ground.

Provide a minimum 14 x 16 inch pull out, hinged top shelf located immediately below controller mounting section of the cabinet. The shelf must extend fully to allow the table surface to retract outside the cabinet approximately even with the bottom of the controller. Ensure the shelf has a storage bin interior which is a minimum of l inch deep and approximately the same dimensions as the shelf. Provide access to the storage area by lifting the hinged top of the shelf. Fabricate the shelf and slide from aluminum or stainless steel and ensure the assembly can support the controller plus 15 pounds of additional weight. Ensure the shelf has a locking mechanism to secure it in the fully extended position and does not inhibit the removal of the controller when fully extended. Provide a locking mechanism that is easily released when the shelf is to be returned to its non-use position directly under the controller.

Furnish two sets of non-fading cabinet wiring diagrams and schematics in a paper envelope or container and placed in the cabinet drawer.

4.3. CONSTRUCTION METHODS

Install base mounted equipment cabinets and all necessary hardware as required to provide a fully operational System. Ensure space in the equipment cabinet allows for all system components and network equipment.

Do not stencil company logos to the exterior of the equipment cabinet.

4.4. MEASUREMENT AND PAYMENT

Type 332 Base mounted equipment cabinet will be measured and paid as the actual number of Type 332 base mounted equipment cabinets furnished, installed and accepted.

No measurement will be made for cabling, connectors, cabinet attachment assemblies, conduit, condulets, grounding equipment, surge protectors, or any other equipment or labor required to install the equipment cabinet and integrate it with the localized system components as these will be considered incidental to furnishing and installing the base mounted equipment cabinet.

Payment will be made under:

Pay Item	**Pay Unit**
Type 332 Base Mounted Equipment Cabinet	Each

5. ELECTRICAL SERVICE

5.1. DESCRIPTION

Install new electrical service equipment as shown in the plans. Installation of all new electrical service pedestals, poles, and meter base/disconnect combination panels shall be the first item of work on this project to expedite the power service connections. Comply with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), the Standard Specifications, the Project Special Provisions, and all local ordinances. All work involving electrical service shall be coordinated with the appropriate utility company and the Engineer.

Obtain the maximum available ground fault current from the utility company. Print this information on a durable label and adhere to the dead front of the disconnect.

Ensure each service has only one disconnecting means in the enclosure. Place barriers in service equipment such that no uninsulated, ungrounded service busbar or service terminal is exposed.

5.2. MATERIAL

A. Meter Base/Disconnect Combination Panel

Furnish and install new meter base/disconnect combination panels as shown in the Plans. Provide meter base/disconnect combination panels that have a minimum 125A main service disconnect and a minimum of eight (8) additional spaces. Furnish a single pole 15A circuit breaker at locations shown in the Plans. Ensure meter base/ disconnect combination panel is listed as meeting UL Standard UL-67 and marked as being suitable for use as service equipment. Ensure circuit breakers are listed as meeting UL-489. Place barriers so that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. All exterior surfaces must be powder coated steel. Provide ground bus and neutral bus with a minimum of four terminals and a minimum wire capacity range of number 8 through number 3/0 AWG.

Furnish NEMA Type 3R combinational panels rated 100 Ampere minimum for overhead services and 200 Ampere minimum for underground services that meet the requirements of the local utility. Provide meter base with sockets' ampere rating based on sockets being wired with a minimum of 167 degrees F insulated wire. Furnish 4 terminal, 600-volt, single phase, 3-wire meter bases that comply with the following:

- Line, Load, and Neutral Terminals accept 4/0 AWG and smaller Copper/Aluminum wire

- With or without horn bypass
- Made of galvanized steel
- Listed as meeting UL Standard US-414
- Overhead or underground service entrance specified.

Furnish 1.5" watertight hub for threaded rigid conduit with meter base.

At the main service disconnect, furnish and install UL-approved lightning arrestors that meet the following requirements:

Type of design	Silicon Oxide Varistor
Voltage	120/240 Single Phase, 3 wire
Maximum current	100,000 amps
Maximum energy	3000 joules per pole
Maximum number of surges	Unlimited
Response time one milliamp test	5 nanoseconds
Response time to clamp 10,000 amps	10 nanoseconds
Response time to clamp 50,000 amps	25 nanoseconds
Leak current at double the rated voltage	None
Ground wire	Separate

B. Equipment Cabinet Disconnect

Provide new equipment cabinet disconnects at the locations shown in the Plans. Furnish a single pole 15A circuit breaker at locations shown in the Plans. Furnish panels that have a minimum of eight (8) spaces in the disconnect. Furnish circuit breakers with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure meter base/ disconnect combination panel is listed as meeting UL Standard UL-67 and marked as being suitable for use as service equipment. Ensure circuit breakers are listed as meeting UL-489. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. All exterior surfaces must be powder coated steel. Provide ground bus and neutral bus with a minimum of four terminals and a minimum wire capacity range of number 8 through number 3/0 AWG.

C. Modify Equipment Cabinet Disconnect

Replace the existing equipment cabinet disconnect with a new equipment cabinet disconnect at the location shown in the Plans. Furnish a single pole 15A circuit breaker at locations shown in the Plans. Furnish panels that have a minimum of eight (8) spaces in the disconnect. Furnish circuit breakers with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure meter base/ disconnect combination panel is listed as meeting UL Standard UL-67 and marked as being suitable for use as service equipment. Ensure circuit breakers are listed as meeting UL-489. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. All exterior surfaces must be powder

coated steel. Provide ground bus and neutral bus with a minimum of four terminals and a minimum wire capacity range of number 8 through number 3/0 AWG.

D. 10KVA Single-Phase Step Up/Step Down Transformer

Furnish and install a double-wound, resin encapsulated transformer to isolate the line side voltages from the load side voltages and step up and step down voltage as shown in the Plans. Provide the transformer with the following specifications:

- Primary Volts: 480 volts with 21 AMPS Max. 60Hz.
- Secondary Volts: 120/240 with 83/41 Amps Max. 60Hz.
- 10 kVA power rating.
- Electrostatic shielding between primary and secondary windings.
- Epoxy-silica encapsulated core and coil.
- Copper windings and copper lead wire terminations.
- Multiple front and bottom knockout for conduit entry/exit.
- Ground studs for conduit bonding.

Provide the transformer in a NEMA 3R enclosure suitable for mounting to a metal or wood pole.

E. 3-Wire Copper Service Entrance Conductors

Furnish 3-wire stranded copper service entrance conductors with THWN rating. Provide conductors with black, red, and white insulation that are intended for power circuits at 600 Volts or less and comply with the following:

- Listed as meeting UL Standard UL-83
- Meets ASTM B-3 and B-8 or B-787 standards.

See the Plans for wire sizes and quantities.

F. 3-Wire Copper Feeder Conductors

Furnish 3-wire stranded copper feeder conductors with THWN rating for supplying power to field equipment cabinets. Provide conductors with black or red, white, and green insulation that are intended for power circuits at 600 Volts or less and comply with the following:

- Listed as meeting UL Standard UL-83
- Meets ASTM B-3 and B-8 or B-787 standards.

See the Plans for wire sizes and quantities.

G. 4-Wire Copper Feeder Conductors

Furnish 4-wire stranded copper feeder conductors with THWN rating as shown in the plans. Provide conductors with black, red, white, and green insulation that are intended for power circuits at 600 Volts or less and comply with the following:

- Listed as meeting UL Standard UL-83

- Meets ASTM B-3 and B-8 or B-787 standards.

See the Plans for wire sizes and quantities.

H. 6" X 6" X 8" Treated Wood Pedestals

Furnish 6" x 6" x 8' treated wood pedestals for mounting electrical service equipment as shown in the Plans. Furnish treated wood poles that comply with the requirements in the Standard Specs and meets ASTM B-3 and B-8 or B-787 standards.

I. Grounding System

Furnish 5/8"x10' copper clad steel grounding electrodes (ground rods), #4 AWG solid bare copper conductors. Comply with the NEC, Standard Specifications, these Project Special Provisions, and the Plans.

5.3. CONSTRUCTION METHODS

A. General

Coordinate with the Engineer and the utility company to de-energize the existing service temporarily prior to starting any modifications.

Permanently label cables at all access points using nylon tags labeled with permanent ink. Ensure each cable has a unique identifier. Label cables immediately upon installation. Use component name and labeling scheme approved by the Engineer.

B. Meter Base/Disconnect Combination Panel

Install meter base/disconnect combination panels with lightning arrestors as called for in the Plans. Route the feeder conductors from the meter base/disconnect equipment cabinets in conduit. Provide rigid galvanized conduit for above ground and PVC for below ground installations.

C. Electrical Service Disconnect

Install equipment cabinet disconnects and circuit breakers as called for in the Plans. Install THWN stranded copper feeder conductors as shown in Plans between the electrical service disconnect and the equipment cabinet disconnect. Route the conductors from the equipment cabinet disconnect to the equipment cabinet in rigid galvanized steel conduit. Bond the equipment cabinet disconnect in accordance with the NEC. Ensure that the grounding system complies with the grounding requirements of these Project Special Provisions, the Standard Specifications and the Plans.

D. Modify Equipment Cabinet Disconnect

Modify the existing equipment cabinet disconnect as called for in the Plans. Install THWN stranded copper feeder conductors as shown in Plans between the electrical service disconnect and the equipment cabinet disconnect. Route the conductors from the equipment cabinet disconnect to the equipment cabinet in rigid galvanized steel conduit. Bond the equipment cabinet disconnect in accordance with the NEC. Ensure that the grounding system complies with the grounding requirements of these Project Special Provisions, the Standard Specifications and the Plans.

E. 10KVA Single-Phase Step Up/Step Down Transformer

Furnish and install a single-phase step up/step down transformer in a NEMA 3R enclosure. Step up voltage from 120/240 volts to 480 volts from the Duke Energy service pole serving the proposed

equipment. Step down voltage from 480 volts to 120/240 volts at the equipment cabinet. Route the conductors from the transformer secondary to the equipment cabinet or equipment cabinet disconnect in rigid galvanized conduit. Bond the equipment cabinet disconnect in accordance with the NEC.

Provide all mounting hardware and other parts and labor necessary to successfully install the transformer. Provide primary and secondary fused overcurrent protection at each transformer. Ground the transformer per NEC 450.

F. 3-Wire Copper Service Entrance Conductors

At locations shown in the Plans, furnish and install 3-wire THWN stranded copper service entrance conductors in 1.25 inch rigid galvanized risers as shown in the plans. Install a waterproof hub on top of the electrical service disconnect for riser entrance/exit. Size the conductors as specified in the Plans. Comply with the Standard Specifications and Standard Drawings and all applicable electrical codes.

G. 4-Wire Copper Feeder Conductors

At locations shown in the Plans, install 4-wire THWN stranded copper feeder conductors to supply 240/120 VAC to the DMS field equipment cabinets. Size the conductors as specified in the Plans. Comply with the Standard Specifications and Standard Drawings and all applicable electrical codes.

H. 3-Wire Copper Feeder Conductors

At locations shown in the Plans, install 3-wire THWN stranded copper feeder conductors to supply 120 VAC to the equipment cabinets. Size the conductors as specified in the Plans. Comply with the Standard Specifications and Standard Drawings and all applicable electrical codes.

I. 6” X 6” X 8’ Treated Wood Pedestals

Install 6” x 6” x 8’ treated wood pedestals a minimum of 3 feet below grade.

J. Grounding System

Install ground rods as indicated in the Plans. Connect the #4 AWG grounding conductor to ground rods using an irreversible mechanical crimping method. Test the system to ensure a ground resistance of 20-ohms or less is achieved. Drive additional ground rods as necessary or as directed by the Engineer to achieve the proper ground resistance.

Submit to the Engineer a completed Inductive Loop & Grounding Test Form available on the Department’s website at:

https://connect.ncdot.gov/resources/safety/Pages/ITS-and-Signals.aspx

5.4. MEASUREMENT AND PAYMENT

Meter base/disconnect combination panel will be measured and paid as the actual number of complete and functional meter base/disconnect combination panel service locations furnished, installed and accepted. Breakers, lightning arrestors, exposed vertical conduit runs to the cabinet, and any remaining hardware, fittings, and conduit bodies to connect the electrical service to the cabinet will be considered incidental to meter base/disconnect combination panels.

3-Wire copper service entrance conductors will be incidental to furnish and installing the meter base/disconnect combination panel. All other required feeder conductors will be paid for separately.

Equipment cabinet disconnect will be measured and paid as the actual number of complete and functional equipment cabinet disconnects furnished, installed and accepted. Breakers, exposed vertical conduit runs to the cabinet, ground rods, ground wire and any remaining hardware and conduit to connect the equipment cabinet disconnect to the cabinet will be considered incidental to the equipment cabinet subpanel.

Modify equipment cabinet disconnect will be measured and paid as the actual number of modified and functional equipment cabinet disconnects furnished, installed and accepted. Breakers, exposed vertical conduit runs to the cabinet, ground rods, ground wire and any remaining hardware and conduit to connect the equipment cabinet disconnect to the cabinet will be considered incidental to the equipment cabinet subpanel.

10KVA Step Up/Step Down Transformer will be measured and paid in actual number of complete and functional 10KVA step up/step down transformers furnished, installed and accepted. Enclosures, mounting hardware, pre-formed pad, and any remaining hardware, fittings, and conduit bodies to connect the isolation transformer will be considered incidental to the 10KVA step up/step down transformer and will be considered incidental to the 10KVA step up/step down transformer.

4-Wire copper feeder conductors will be measured and paid as the actual linear feet of 4-wire THWN stranded copper feeder conductors furnished, installed and accepted. Payment is for all four conductors. Measurement will be for the actual linear footage of combined conductors after all terminations are complete. No separate payment will be made for each individual conductor. No separate payment will be made for different wire sizes. No payment will be made for excess wire in the cabinets.

3-Wire copper feeder conductors will be measured and paid as the actual linear feet of 3-wire THWN stranded copper feeder conductors furnished, installed and accepted. Payment is for all three conductors. Measurement will be for the actual linear footage of combined conductors after all terminations are complete. No separate payment will be made for each individual conductor. No separate payment will be made for different wire sizes. No payment will be made for excess wire in the cabinets.

No measurement will be made of 6” x 6” x 8’ wood pedestals as these will be incidental to furnishing and installing the Meter base/Disconnect combination panel and 10KVA Step Up/Step Down Transformer/Transformer.

5/8” X 10’ grounding electrode (ground rod) will be measured and paid as the actual number of 5/8” copper clad steel ground rods furnished, installed and accepted. No separate payment will be made for irreversible mechanical crimping tool as this will be considered incidental to the installation of the ground rod.

#4 solid bare grounding conductor will be measured and paid as the actual linear feet of #4 AWG solid bare copper grounding conductor furnished, installed and accepted. Measurement will be along the approximate centerline from the base of the electrical service disconnect to the last grounding electrode.

Payment will be made under:

Pay Item **Pay Unit**

Meter Base/Disconnect Combination Panel .....Each

Equipment Cabinet Disconnect.....Each

Modify Equipment Cabinet Disconnect.....Each

10KVA Step Up/Step Down Transformer.....Each

4-Wire Copper Feeder Conductors .....Linear Foot

3-Wire Copper Feeder Conductors .....Linear Foot

5/8" X 10' Grounding Electrode.....Each

#4 Solid Bare Grounding Conductor .....Linear Foot

6. LANE CONTROL SIGNS

6.1. DESCRIPTION

Furnish and install LED lane use control signs, signal heads, wire entrance fittings, driver boards, relays, mounting assemblies, signal cable, grounding systems, visors, and all necessary hardware as shown on the plans. Furnish lane control signs with environmental enclosures rated for outdoor use.

6.2. MATERIAL

A. General

Furnish and install LED lane control signs with double stroke red "X" and green arrow symbols with 5 mm LEDs at locations shown on the plans. Furnish and install double stroke LEDs that display 2 independent "Green Arrow" displays as shown on the plans. Furnish LED lane control signs with 45° green arrows that display independently. Ensure that the overall image can be progressively dimmed relative to the ambient light level changes detected by the photo sensor installed in the sign. Furnish LED lane control signs that consists of one power control board with opti-coupler isolated input control. Ensure that the opti-coupler inputs can be used to activate externally controlled dimming and multiple message functions as required. This is a two-message signal where the image is displayed with LEDs mounted directly on a black powder coated aluminum doorplate.

Furnish sealed polycarbonate protective slide out lens' that shield the LEDs from the environment. Ensure that the assembly is housed in a hinged 8" deep cabinet with 7" visors. The display of the signal message must be configured so that no latent image is visible under any lighting conditions when the signal is off. Furnish and install aluminum louvers over the front of the signal face to provide additional sun shading if necessary.

B. Electronic Requirements

The LED circuitry will consist of two main sub-circuits: the signal power control system and the LED power bus system. The power control circuitry shall be supplied with 115VAC (optional 12 or 24VDC). Protection components to guard the system against power surges and short circuits are built into the input power circuitry. The power supply will maintain regulation over the input voltage range of 90-130VAC (115VAC version). Opto-coupler isolated inputs provide control for LED functions such as dimming and multiple messages as required. Progressive dimming is activated when an integrated photo-diode sensor is installed. The output of the signal is then adjusted proportional to the

changes in the ambient light conditions over time. The flash function is activated by connecting an external sync signal to the opti-coupler input of the sign control or by setting a jumper that causes the sign to self-flash whichever is required. Individual messages are selected by applying power to the opti-coupler isolated control inputs, which can control as many as five different sign states.

All the features such as maximum dimming level and current sense level are factory set and user programmable. Special features like adjustable dimming for each channel (used to control brightness of one color or one image) allows for customized configurations with a standard interchangeable power control board. Consult the factory for specific ranges and limitations.

All the sub-circuits are designed in a modular fashion, allowing the replacement of any defective circuit strip or supply/control by a qualified technician without the use of a soldering iron. The circuit strips and boards are conformal coated to protect the individual devices and connections against moisture and corrosion.

The LEDs that are used for displaying messages or creating traffic control signals are available in several viewing angle and color combinations. The appropriate devices are selected according to the installation and application requirements specified by the customer. Standard viewing angles available from most manufacturers for 5mm (T1-3/4) LEDs are 6°, 15°, 23°, and 30°. Luminous intensity in milli-candela (mcd) output varies based on color and viewing angle. The following device specifications reflect one manufacturer's data sheets for the components used in this application. Any alternate manufacturer's components used will meet or exceed these specifications.

C. LED Specifications

AlInGaP (yellow & red) and InGaN (green) devices have a luminous intensity degradation of approximately 20% over 100,000 hours (11 years) when operated at a non-pulsed 20ma level.

Color	Dominant Wavelength	Min. Lum. Int. @ 20ma	Max. Lum. Int. @ 20ma	Viewing Angle
Green	520 nm	4600 mcd	9200 mcd	30°
Red	626 nm	4180 mcd	8200 mcd	30°

D. Enclosures and Finishes

The final enclosure, slide-in panels, visors, and associated hardware will be fabricated from aluminum or stainless steel as specified. The exterior aluminum enclosure, panels, and visors will have a black powder coated finish as well as the interior faceplates. All openings shall be gasketed or sealed and drain holes will be located in the lower corners of the enclosure to control condensation. The signals will be mounted with a user defined, optional mounting fixture. A textured polycarbonate panel will be incorporated into the sign to provide better blanking.

E. Power Requirements

The power for the red LEDs is 4 watts per 100 LEDs and for green LEDs it is 8 watts per 100 LEDs. Input power and controls are designed to accept 120 VAC and total power will not exceed 15 watts when any single message is activated. A terminal strip shall be provided and be clearly marked by an in-cabinet circuit diagram for easy installation and service.

F. Operator Control

Provide two rotary manual switches in each scale house for the weigh station operators to select the indications described below. Provide manual switches in each scale house at both front and back workstations for the operator to select the desired indication. The switch position shall clearly align with labels so it is clear what functional display has been selected.

The switches for the lane control signs shall include the following functional displays:

- Front – station open and signal directs traffic to front static scale with a green arrow display; when the lane is closed, a red "X" is displayed; a corresponding red or green ball is displayed on the back of the LED lane control sign so that the weigh station operator can visually confirm the LED lane control function.
- Both - station open and signal directs traffic to both static scales with green arrow displays on each of the LED lane control signs; a corresponding red or green ball is displayed on the back of the LED lane control sign so that the weigh station operator can visually confirm the LED lane control function.
- Rear – station open and signal directs traffic to rear static scale with a green arrow display; a red "X" is displayed; a corresponding red or green ball is displayed on the back of the LED lane control sign so that the weigh station operator can visually confirm the LED lane control function.
- Off – sign displays no message

Furnish metal switch housings in the scale houses. The switches shall be permanently labeled. Provide strain relief and grommets on all cable entrances into the switch housings.

6.3. Construction Methods

Furnish and install lane use control signs that are manufactured in accordance with the requirements in the Manual on Uniform Traffic Control Devices, Chapter 4M. The overall requirements include legibility at a minimum distance of 300 feet, message blackout regardless of lighting conditions, limited viewing angles based on application requirements, and readability in all specified lighting conditions. The product shall be able to operate within specifications over an ambient temperature range of -35°F to +165°F.

Install two-section traffic signal heads with 12" LED round signal ball on the back of the lane control signs to indicate either red or green status of the corresponding lane control sign.

Mount the lane control signs and signal head on the metal poles with mast arms using stainless steel band clamps.

Install manual switches in the lane use vehicle signal cabinet allowing a weigh station operator to select the appropriate operational status. Install a scale house manual switch for the operator to select any of the functional displays described above.

6.4. Measurement And Payment

Lane control sign will be measured and paid as the actual number of lane control signs furnished, installed, and accepted.

No measurement will be made for visors, wire entrance fittings, interconnecting brackets, driver boards, relays, mounting assemblies, or operator control panels as these will be considered incidental to furnishing and installing the lane control signs.

Payment will be made under:

Pay Item	Pay Unit
Lane Control Sign	Each

7. WEIGH-IN-MOTION SYSTEM/TRAFFIC SURVEY GROUP DATA COLLECTION SYSTEM

7.1. DESCRIPTION

Furnish and install a Weigh in Motion System (WIM) on the mainline, consisting of in-road sensors and roadside electronics. Ensure the WIMs data is transmitted from the roadside controller to the scale house server to be utilized in the Credential Screening Process. The weight data will be made part of vehicle record that will include date, time and vehicle speed, and other information typically supplied with a WIM system.

7.2. MATERIALS

Furnish and install Weigh in Motion (WIM) and Traffic Survey Group (TSG) Data Collection Systems on the mainline, consisting of in-road sensors and roadside electronics. Ensure the WIMs data is transmitted from the roadside controller to the scale house server to be utilized in the Credential Screening Process. Ensure the TSG Data Collection System provides a data collection system that meets the requirements of FHWA 13 for vehicle data collection and is fully compatible with NCDOT's existing Traffic Data Management System (TDMS) developed by MS2 and allowing the data auto-polled into the TDMS. The weight data will be made part of vehicle records that will include date, time and vehicle speed, and other information typically supplied with a WIM system.

Furnish WIM strip sensors that have an uncompensated temperature coefficient of sensitivity of no more than +/-0.02%/ºC.

The WIM strip sensors shall automatically and accurately weigh, with the tolerances set forth herein, each axle of a multi-axle vehicle and calculate the gross weight of the vehicle by summing the individual axle weights. Each vehicle having a gross weight of 39,000 pounds or more shall be checked for compliance with the Bridge Formula Weights (23 U.S.C. 127, 23 CRF 658) as defined by the Federal Highway Administration. The WIM strip sensors shall perform these measurements and calculations while the vehicle passes over the WIM strip sensors but not to exceed 5 seconds.

The gross and individual axle weights of each vehicle shall be accurately established to within the error limits listed in Table 1. These error limits shall be maintained within a confidence level of two standard deviations (95%) for a minimum sample of 100 vehicles. The sample shall consist of a variety of multiple-axle trucks passing over the sensors at speeds ranging from a minimum of 10 mph to a maximum of 100 mph. Tank trucks, livestock, car haulers and those vehicles whose suspension

characteristics are determined to affect the scale performance shall not be included in the sample nor shall trucks whose speed varies by 10% or more.

Table 1 - WIM strip Sensors Accuracy

PARAMETER	TOLERANCE
Single Axle Weight	± 15% of actual weight
Axle Group (2 or more) Weight	± 10% of actual weight
Gross Weight	± 6% of actual weight
Axle Spacing	± 6 inches
Vehicle Speed	± 1 mph
Temperature Coefficient of Sensitivity	-.02% per degree C

The actual weight is defined as the vehicle weight established by static weighing on a multi- platform truck scale properly operating within the appropriate tolerance as established for a Class IIIL device as defined by the National Institute of Standards and Technology Handbook 44. The WIM strip sensors shall operate over an ambient temperature range of -40 to +175 degrees F.

Supply a list of at least five installations where the WIM strip sensors have been installed in similar environmental conditions with the same or higher traffic volume and speeds for a minimum of five years. Supply clients' contact information for the five installations.

The WIM strip sensors shall perform the following functions:

- Operate at vehicle speeds between 10 and 85 mph.
- Determine the compliance of each vehicle based on single-axle weight, axle group weight, and GVW.
- For each vehicle more than 39,000 pounds GVW, determine the compliance of the on- sensor vehicle with the Bridge Formula.
- Store data (including images) by truck classification broken down by day, month, and calendar year.
- The WIM strip sensor classifier/controller shall be capable of downloading all data stored on its internal or external storage device.
- The WIM strip sensor classifier/controller shall be capable of receiving executable control command.
- Suitably demonstrate that the WIM strip sensors will provide a service life of 5 years. This can be provided by documented customer feedback on operating sites in use and by life cycle cost evaluation.

Attach the WIM strip sensors to a lead-in cable, which extends from the piezoelectric sensor to the equipment cabinet. The lead-in cable shall be a two-conductor 18 AWG twisted shielded cable.

The necessary hardware and software will be standard with the WIM. The processing components of the system shall generate a data output that is sent to the Scale house along with the ATMS, ALPR, Overview Camera Image, etc.

A. Sensor Sealant

Provide a sand-epoxy resin sealant/grout to secure and seal the sensor and lead-in cable into the pavement. Provide shrink-free material that adheres to both concrete and asphalt.

Provide a sealant that meets the following requirements:

- Pot Life: 20-40 minutes at 32 degrees F
- Minimum Curing Temperature: 46 degrees F
- Density: 1 ounce/cubic inch.

Provide a sealant that meets the following mechanical requirements after seven days:

- Compressive strength: > 8,365 tons/ft.2
- Flexural strength: > 365 tons/ft.2
- Compressive strength: > 8,365 tons/ft.2
- Adhesive strength on steel: > 42 tons/ft.2
- Adhesive strength on concrete: > 10 tons/ft.2

7.3. CONSTRUCTION METHODS

A. Installation

Install and space apart from each other the individual WIM strip sensors as shown in the Plans and as recommended by the manufacturer.

The WIM strip sensor configurations shall be installed in accordance with the manufacturer's recommendations and shall be designed to monitor a single lane of traffic. Ensure the design and layout of the WIM strip sensor configurations shall ensure the system independently weighs both sides of the vehicle thus obtaining weight information sufficient to determine any side-to-side balance condition of the vehicle.

The saw slots, including tail and lead-in sections for the WIM strip sensor configurations, must be dry and free of debris prior to their installation. Use compressed air to remove debris and moisture from the saw slot as necessary.

The WIM strip sensor slot in the pavement shall be no larger than 3.5 inches wide and extend no deeper than 2.8 inches. Mount WIM strip sensors precisely flush with the surface of roadway.

Seal the WIM strip sensors and associated lead-in cable in an epoxy sealant to prevent moisture penetration. Install WIM strip sensors in such a manner that they will not be damaged by road maintenance such as snow removal. Warranty WIM strip sensors for a minimum of two (2) years against defects in materials or workmanship.

Furnish on-site engineering consulting by the manufacturer for the installation of the WIM strip sensors.

Connect the ends of the lead-in cable coaxial cable to the equipment controller's charge amplifier inputs as directed by the manufacturer. Program the equipment controller as instructed by the manufacturer's representative. Establish communications between the equipment controller and downstream equipment controller and the Scale House via the fiber optic cable system and perform calibrations test as required.

B. Calibration and Acceptance

Calibrate the piezoelectric sensors using a single five (5) axle, test tractor/trailer combination (3S2), complete with air ride suspension and a non-shifting static load. Load the truck to within 90 to 100% of allowable Gross Vehicle Weight for the road under test.

Conduct the calibration procedure as follows:

- Weigh the vehicle using the static weigh scales. Record the weight information on the front (single axle), drive (tandem axle group), and trailer (tandem axle group). Calculate the Gross Vehicle Weight (GVW) of the vehicle by adding the three weights together.
- Measure and record the distance between the five (5) individual axles on the truck.
- Use the test vehicle and make three (3) test passes over the system under test at a selected speed, which is indicative of the truck traffic at the site. Make adjustments on site during this time to fine tune the axle spacing, and weight output of the WIM system.
- Once all initial adjustments have been made, make two (2) additional test passes with the test vehicle to confirm the accuracy of the adjustments. If all the readings fall within the ASTM ranges for the WIM, continue the tests. If this is not the case, make additional adjustments and make two (2) more confirming passes with the test truck.

Demonstrate through the acceptance tests that the system passes all criteria according to ASTM E1318 Standard, achieving ASTM accuracy Type III. Perform the acceptance test using the test truck, make an additional ten (10) passes at a selected speed that is indicative of the truck traffic at the test site. Place all the data into a spreadsheet with the approval of the Department.

Calculate the mean error and standard deviation for all recorded measurements at the end of the ten (10) test passes. Perform the calculations as follows:

For weight measurements, calculate the percent error for each test pass using the following formula:

[(WIM Weight - Static Weight)/Static Weight] x 100 = % error

Calculate the mean error for each weight type (single, group, GVW) as follows (with each weight type calculated individually):

- % errors for single, group or GVW/# of samples = Mean error.

- Calculate the error for individual axle spacings using the following formula (each of the four axle spacings calculated individually).
- 10 of [(WIM Axle Spacings - Actual Axle Spacing)]/10 = Mean Axle Spacing Error.

Enter all the calculated errors into the spreadsheet.

Check the calculated result against the acceptable range for the ASTM values. There will be one of two results:

1. If 95% of all recorded test results, (single axles, axle groups, GVW, axle spacing) fall within the ASTM specified tolerance then the system will have passed the requirements.

2. If less than 95% of the calculated differences fall within the ASTM specified tolerance, then readjust the system and make an additional ten (10) test passes to retest the system.

7.4. MEASUREMENT AND PAYMENT

Weigh-In-Motion System will be measured and paid as the actual number of number of Weigh-In-Motion Systems furnished, installed, and accepted. Measurement will be made for the equipment controller and software, cables, amplifiers, epoxy, WIM strip sensors, electrical conductors, Ethernet (3 foot or 6 foot) cables, conduit, condulets and conduit fittings located between the sensors and the equipment cabinet, acceptance testing, testing vehicle and set-up, as this will be considered incidental to furnishing and installing the Weigh in Motion System.

TSG Data Collection System will be measured and paid as the actual number of number of TSG Data Collection Systems furnished, installed, and accepted. No measurement will be made for the cables, amplifiers, epoxy, WIM strip sensors, electrical conductors, Ethernet (3 foot or 6 foot) cables, acceptance testing, testing vehicle and set-up, as this will be considered incidental to furnishing and installing the TSG Data Collection System.

Payment will be made under:

Pay Item	**Pay Unit**
Weigh-In-Motion System	Each
TSG Data Collection System	Each

8. AUTOMATED TIRE MONITORING SYSTEM

8.1. DESCRIPTION

Furnish and install an Automated Tire Monitoring System (ATMS) on the mainline, consisting of road sensors and roadside electronics. Ensure the ATMS data is transmitted from the roadside controller to the scale house server to be utilized in the Credential Screening Processes.

8.2. Requirements

Furnish and install an ATMS consisting of in-road sensors and roadside electronics to identify those vehicles that are unsafe due to missing, mismatched, or flat tires on dual tire sets, and identification of single tires, dual tires and wide based tires (super singles).

The ATMS must be able to detect tire anomalies of commercial vehicles at highway speeds (20 to 75 mph) in steady state traffic flows. Ensure, in general, the sensors for the ATMS can operate successfully when installed in a mainline or ramp application at WIM locations where trucks are being weighed and screened for enforcement activities.

The ATMS shall be able to detect Wide Based Tires, Single Tires, Dual Tires, and flat tires on dual tire sets. The system shall have a referenceable accuracy exceeding 80%.

The ATMS detection sensors must be able to be installed in existing highway pavements without the need for special concrete slabs or site preparation. The sensors shall be of a size that will afford installation in the existing pavement without overly distressing or reducing the life of the existing pavement. Installation of sensors shall be accomplished by installing the sensors in a prepared cut in the existing pavement and secured and encapsulated with a vendor supplied epoxy sealant.

Provide an epoxy sealant to secure and seal the sensor in the pavement that has minimum flexural strength of 10,000 psi and is approved by the manufacturer of the ATMS sensor.

Sensors shall be replaceable upon failure.

8.3. CONSTRUCTION METHODS

A. Installation

Install the in-road sensor equipment as directed by the manufacturer and as shown in the Plans. The saw slots, including tail and lead-in sections for the sensor configurations, must be dry and free of debris prior to their installation. Use compressed air to remove debris and moisture from the saw slot as necessary.

Mount and install the sensors precisely flush with the surface of roadway and/or as directed by the manufacturer.

Seal the sensors and associated lead-in cable in an epoxy sealant to prevent moisture penetration.

Install sensors in such a manner that they will not be damaged by road maintenance such as snow removal. Warranty sensors for a minimum of two (2) years against defects in materials or workmanship.

Furnish on-site engineering consulting by the manufacturer for the installation of the sensors.

Connect the ends of the lead-in cable to the roadside electronics equipment as directed by the manufacturer. Program the roadside electronics as instructed by the manufacturer’s representative. Establish communications between the ATMS and the Scale House via the fiber optic cable system.

B. Acceptance Testing

Perform acceptance test using a five (5) axle, test vehicle/tractor/trailer combination (3S2), complete with air ride suspension and a non-shifting static load. Load the truck to within 50% of allowable Gross Vehicle Weight for the road under test. The State will furnish the test vehicle.

Conduct the acceptance test procedure as recommended by the manufacturer using the calibration vehicle as necessary.

Demonstrate through the acceptance tests that the system passes all criteria and accuracy reporting.

- Using the test truck, make a minimum of ten (10) passes at a selected speed that is indicative of the truck traffic at the test site.
- Record the number of times the system indicates a tire anomaly to ensure the system meets an 80% or better accuracy rate in reporting a Tire Anomaly.

8.4. MEASUREMENT AND PAYMENT

Automated Tire Monitoring System will be measured and paid as the actual number of Automated Tire Monitoring Systems furnished, installed, and accepted. Measurement will be made for the equipment controller and software, cables, epoxy, sensors, electrical conductors, Ethernet (3 foot or 6 foot) cables, conduit, condulets, and conduit fittings located between the sensors and the equipment cabinet, acceptance testing, testing vehicle and set-up, as this will be considered incidental to furnishing and installing the Automated Tire Monitoring System.

Payment will be made under:

Pay Item	**Pay Unit**
Automated Tire Monitoring System	Each

9. AUTOMATED LICENSE PLATE READER SYSTEM

9.1. DESCRIPTION

Furnish and install an Automated License Plate Reader System (ALPR) equipment with all necessary hardware and software in accordance with the Plans and these Project Special Provisions. Provide an overview image of the vehicle and automatically locate and identify with the corresponding alphanumeric information and jurisdiction/location of issue.

The ALPR system must be capable of producing an ALPR image and an overview image of the passing commercial vehicles.

Ensure the captured still frame image and data captured by the ALPR system is transmitted with the vehicle record from the roadside controller to the scale house server to form an Automated Commercial Vehicle Processing System and credential screening system.

Ensure the ALPR still frame image corresponds with the matching Overview Camera images as discussed elsewhere in these Project Special Provisions.

Furnish an ALPR system that produces multiple state and alphanumeric license plate interpretations per vehicle with varying flash, shutter and gain settings to ensure a high-quality image regardless of weather or lighting conditions. At a minimum, the ALPR system must read and interpret license plates from the following states:

1) North Carolina
2) South Carolina
3) Virginia
4) Florida
5) Georgia
6) Tennessee
7) Indiana
8) Pennsylvania
9) Illinois
10) Ohio
11) Texas
12) New Jersey

The system must provide effective license plate capture at night using IR illuminators and no other external lighting source.

Furnish an ALPR system with a plate read rate of better than 80% (all characters correctly read for 80% of readable license plates) at speeds up to 75 miles per hour.

Provide a system with an operator interface to include database remote query functionality.

ALPR Camera systems meeting the intent of these specifications will be considered as being in "Substantial Conformance."

9.2. Material

A. Camera

Furnish an ALPR camera that complies with the following:

- Self-illuminating Infrared (IR) illuminators utilizing driver safe non-visible light (greater than 750nm) and only activated when images are being captured.
- IR light-emitting diodes (LEDs) utilized must be "pulsed" to enhance license plate capture.
- IR camera illumination certified to be "eye safe" by an independent testing agency.
- Ultra high resolution with dual color/black & white image capture and digital signal processing to reduce color noise.
- Enhanced low light resolution (1.2 million pixels).
- Shutter speed of 1/10,000 sec exposure setting.
- Vibration resistance: 10G (20Hz-200Hz).
- Integrate the camera and ALPR processor into a single, sealed housing enclosure that is impervious to weather and environmental elements and tested to IP68 standards.

- Produces multiple license plate images, with no moving parts in the dual-lens cameras, per vehicle with varying flash, shutter and gain settings to ensure a high-quality image regardless of weather or lighting conditions. Lens must capture up to 60 frames per second.
- Integrated ALPR processor with hardware AES encryption to NIST FIPS 197 with optional hardware data encryption.
- ALPRs weighing no more than 16 lbs. (including housing) and operating on less than 25S, 48V DC power with an external trigger mode and a "self-trigger mode" to detect the presence of a commercial motor vehicle license plate in the camera's field of view.
- A camera with day/night capabilities is required. Night overview images will be black and white. Daylight images will be in color.
- Operates during typical rain and snow events.
- Triggered by embedded loops in the roadway.

B. ALPR System Software

Furnish ALPR System Software with the following requirements:

- Provide variants of the Optical Character Recognition (OCR) engine that are designed specifically for NC and regional license plates. Provide OCR updates for new plate designs as required.
- Utilizes internal camera controls to facilitate automated setting for optimum flash, gain and shutter configurations.
- Integrates into a wide variety of systems via relay output, RS232, TCP/IP Ethernet with socket and FTP protocols, as well as IP connectivity.
- Offer standard software JPEG compression, with optional hardware JPEG compression.
- Fully web-enabled and IP-addressable.
- Provide a feature to enable or disable, at the user's discretion, "fuzzy logic" plate matching to enable the system to match common number character issues (o/0 and 8/B) or unknown characters.
- Captures a live, corresponding color overview image of the vehicle and simultaneously displays the captured license plate, along with the date and time stamp of the image with 95% accuracy.
- Allow a minimum of 16 GB of optional compact flash storage to allow for buffering of data.
- Provides a permanent record of all interpretations and captured images in a chronological order rate of up to 45 images per minute as determined by the operator. The operator can directly input whether the interpretation is correct while viewing the image. The system must keep a record of the operator inputs.
- Operator interface that allows reviewing and modifying license plate records associated with each vehicle record.
- Decode license plate numbers into a digital string and associate the captured image and license plate number into a single vehicle record file.
- Provide a still image capture of each commercial motor vehicle for identification purposes; include the original image of the license plate number in the field of view.
- Attaches unique identifying information to each license plate number image capture to ensure data integrity and proper vehicle image association with other collection data.

- Provide an operator interface to include database remote query functionality.

C. Camera Housing

Furnish the camera housing to meet the following requirements:

- LPR camera enclosure must be rated IP-65 or higher.
- Fabricate from corrosion resistant aluminum, finished in a neutral color of weather resistant enamel or polyester powdercoat.
- Equipped with tempered glass front window.
- Equipped with sunshield.
- Equipped with surge suppressors on all underground conductors.
- Include mounting hardware to match mounting bracket. Provide mounting hardware specifically for vendor's ALPR.

D. Surge Suppression

Protect all equipment at the top of the pole with grounded metal oxide varistors connecting each power conductor to ground.

Protect cable from each camera with a surge protector at each end of the cable.

9.3. CONSTRUCTION METHODS

Comply with the manufacturer's recommendations for installation, conforming to these Project Special Provisions and following the following requirements:

- Install ALPR camera as directed by the Manufacturer to achieve the most accurate and desirable image.
- Install ALPRs with a fixed focal point or target distance.
- Furnish all cabling and camera connectors from the same manufacturer as the ALPR system.
- Use stainless steel banding to attach the ALPRs to the pole.
- Protect all equipment with a surge protector at each end of the cable and connecting each power conductor to ground. Integrate the camera and its output images into the ALPR system including the ALPR software and database search engines to form a part of the Automated Commercial Vehicle Processing System and credential screening system.

9.4. MEASUREMENT AND PAYMENT

Automated License Plate Reader System will be measured and paid as the actual number of Automated License Plate Reader Systems furnished, installed, and accepted. No separate measurement will be made for integration, database search engines, software, camera, camera assemblies, IR illuminators, cabling, connectors, Ethernet (3 foot or 6 foot) cables, attachment assemblies, condulets, grounding equipment, surge protectors, testing, training or any other equipment or labor required to install the ALPR system as these will be considered incidental to furnishing and installing the ALPR system.

Payment will be made under:

Pay Item	Pay Unit
Automated License Plate Reader System	Each

10. OVERVIEW CAMERA ASSEMBLY

10.1. DESCRIPTION

Furnish and install an overview camera assembly with all necessary hardware, cabling and software in accordance with these Project Special Provisions.

The overview camera located at the Advance Location captures side view images of each commercial motor vehicle as they travel past the location. Ensure the side view images are transmitted with the vehicle record from the roadside controller to the scale house server. Ensure the Overview images correspond with the matching ALPR images as discussed elsewhere in these Project Special Provisions.

Camera systems meeting the intent of these specifications will be considered as being in "Substantial Conformance."

10.2. Material

A. Dual Channel CCTV Camera

Furnish one side fired overview camera that complies with the following: The overview camera shall meet the following specifications:

- Dual Channel Design:
  - Color – Day
  - Black & White – Night (with a self-illuminating infrared [IR] light source)
- Lens:
  - 40-240mm afl (Day Channel)
  - 40-240 mm afl (Night Channel)
- Light Sensitivity:
  - 2 lux w/digital backlight compensation (Day Channel)
  - 0.6 lux (Night Channel) Faceplate
- Horizontal Resolution:
  - 480 Lines (Day Channel)
  - 570 Lines (Night Channel)
- Signal to Noise Ration:
  - 50dB (Day Channel)
  - 46dB (Night Channel)
- Geometric Distortion: None
- Video Output: 1.0 Vp-p NTSC Composite, 75 ohms/BNC
- Humidity: 100%
- Operating Temperature Range: -58° F to +140° F w/ sun shield
- Enclosure – all aluminum weatherproof enclosure complete with thermostat, heater, blower, and defrost/defogger

- Power Input:
  - 24 VAC +5%
  - 34 Watts (at night w/heater and blower engaged)

B. Camera Housing

Furnish the camera housing to meet the following requirements:

- Fabricate from corrosion resistant aluminum, finished in a neutral color of weather resistant enamel or polyester powder coat.
- Equipped with tempered glass front window.
- Equipped with sunshield.
- Equipped with surge suppressors on all underground conductors. Furnish video surge suppressors specifically for video transmission lines.
- Include mounting hardware to match mounting bracket.

C. Mounting Bracket

Provide the camera mounting bracket to be a horizontal arm that attaches to a vertical pole, which meets the following requirements:

- Maximum supported weight: 40 lbs.
- Mounted on a vertical pole.
- Attachment to pole: a minimum of two (2) stainless steel bands, approximately five (5) inches apart.
- Pan adjustment: unlimited (360 degrees).
- Tilt adjustment: +/- 75 degrees.
- All aluminum with polyester powder coat finish.

D. Cables

Provide a composite cable carrying power and video between the camera housing and the equipment cabinet. Size the power and video conductors to correspond to the load and the distance. Furnish cable recommended by the manufacturer for underground conduit installation. Furnish crimp-on type connectors. Terminate the video conductors in the equipment cabinet on surge protectors like those in the camera housing.

10.3. CONSTRUCTION METHODS

Mount the overview camera to metal poles to capture a side view image of the vehicle in accordance with the manufacturer's recommendations using stainless steel banding.

Ensure that the camera is aimed at providing optimum coverage. Adjust the camera's position as necessary until the Department agrees that the position is optimal from the point of view of the users. Adjust the light threshold for the color/monochrome video switch as necessary until the Department agrees that the threshold is optimal from the point of view of the users.

10.4. MEASUREMENT AND PAYMENT

Overview Camera Assembly will be measured and paid as the actual number of overview camera assemblies furnished, installed, and accepted. No separate measurement will be made for

integration, software, IR illuminators, cabling, connectors, attachment assemblies, condulets, grounding equipment, surge protectors, testing, training or any other equipment or labor required to install the overview camera assembly as these will be considered incidental to furnishing and installing the Overview Camera Assembly system.

Poles to support the overview camera assembly will be measured and paid for elsewhere in these Project Special Provisions.

Payment will be made under:

Pay Item	**Pay Unit**
Overview Camera Assembly	Each

11. CHANGEABLE MESSAGE SIGNS

11.1. DESCRIPTION

Furnish and install Changeable Message Signs (CMS) at the locations shown on the plans.

Changeable Message Signs meeting the intent of these specifications will be considered as being in “Substantial Conformance” where applicable.

11.2. Material

Furnish CMS that are UL-listed and have a minimum character height of 12 inches. Ensure the CMS meets the following minimum specifications:

- Sign Dimensions: 31” H x 128” L single faced display
- The Sign enclosure shall be watertight, painted matte black, with a matte black finish.
- The Sign shall be double stroke LED. Face
- Two lines of text.
- Message visibility: 30-degree cone centered about the optical axis.
- Up to a minimum of 13 characters per line
- The Sign shall have three levels of dimming controlled by photosensors. Dimming levels shall be for day, night, and over bright conditions.
- Operating Temperature of -40°F to 120°F
- Power requirements shall be no more than 120 VAC 2.5 A continuous and shall have a maximum inrush current of 7A.
- Polycarbonate shield with anti-glare coating covering the display face.
- Ensure the sign is accessible from the front and that the polycarbonate shield covering the display face and sign face panel and can be easily hinged up to allow access to the inner workings of the sign to perform maintenance and repair when needed. Ensure that the hinging system securely locks the polycarbonate shield covering display and sign face into a safe position so as not to injure the worker when performing maintenance on the signs.

Use parts made of corrosion-resistant materials, such as plastic, stainless steel, brass, or aluminum. Use construction materials that resist fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

11.3. Messages

Ensure each CMS is designed to display the following two (2) messages:

Message 1:	Message 2:
TRUCK **ENTER** WEIGH STATION	**TRUCK BYPASS** WEIGH STATION

The appropriate message will be activated for the truck being processed. A message shall be displayed for every commercial vehicle.

11.4. CONSTRUCTION METHODS

Install the CMS at the locations on the plans with a minimum height of 7 feet from the bottom of the CMS sign face to the highest point of the travel lane. It is the contractor's responsibility to verify the S-dimensions for the CMS to determine the proper post lengths. Install the CMS according to the manufacturer's recommendations. Refer to the Signing Plans for post type.

Label and identify all wires and cabling as to their intended function to aid in future servicing of the CMS. Provide a labeling method that is approved by the Engineer.

Install signal cable in continuous lengths between the roadside controller cabinet and the CMS. Route the signal cable to minimize the length of signal cable installed and the number of cables and conductors in each run. Pull 36 inches of additional signal cable into the roadside controller cabinet and the CMS sign structure for maintenance purposes.

Provide electrical equipment described in this specification that conforms to the standards of NEMA, UL, or Electronic Industries Association (EIA), wherever applicable. Provide connections between controllers and electric utilities that conform to NEC standards. Provide feeder conductors and disconnects to power the CMS that are sized in accordance with the NEC.

Inductive loops installed in the roadway at the CMS locations trigger the CMS system to turn on and off the sign in relation to the commercial vehicles' location in route to the weigh station.

Use the Roadside Equipment Cabinet to house electrical equipment and signal processing equipment necessary to operate the CMS. Install a new conduit between the Roadside Equipment Cabinet and the support structure base entrance using conduit stub-outs.

The CMS message will notify the commercial vehicle to "Bypass" or "Enter" the weigh station based on the screening criteria.

The CMS message will notify the commercial vehicle to "Bypass" (displayed in green text) or "Enter" (displayed in red text) the weigh station based on the screening criteria.

11.5. MEASUREMENT AND PAYMENT

Changeable Message Sign will be measured and paid as the actual number of Changeable Message Signs furnished, installed, and accepted.

Each Changeable Message Sign consists of a sign enclosure with the pre-identified messages, electrical and signal processing equipment, communications equipment, strapping hardware, conduit, fittings, couplings, sweeps, conduit bodies, condulets, wire, feeder conductors and disconnects, signal cable between the roadside equipment cabinet and the Changeable Message Sign enclosure, connectors, photo-electric sensors, tools, materials, all related testing, cost of labor, cost of transportation, incidentals, and all other equipment necessary to furnish and install the CMS system.

Foundation and sign supports are paid for under the Signing Plan.

Payment will be made under:

Pay Item	**Pay Unit**
Changeable Message Sign	Each

12. COMMUNICATIONS HARDWARE

12.1. DESCRIPTION

Furnish and install all equipment described below for a fully functional minimum 100/1000 Mbps Ethernet network for communication to the weigh station.

Furnish and install a hardened, field Ethernet edge switch (hereafter “edge switch”) for field devices. Ensure that the edge switch provides wire-speed, Ethernet connectivity at each device location to the managed Ethernet switch. Provide adequate number of copper ports for communication with the device at 100/1000 Mbps speed. Provide the switch with an adequate number of fiber ports and fiber-optic transceivers to communicate with the managed switch in the scale house.

12.2. Material

A. General

Ensure that the edge switches are fully compatible and interoperable with the Ethernet network interface and that the Ethernet switches support half and full duplex Ethernet communications.

Furnish edge switches that provide 99.999% error-free operation, and that complies with the Electronic Industries Alliance (EIA) Ethernet data communication requirements using single-mode fiber-optic transmission medium and copper transmission medium. Ensure that the edge switches have a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

Provide all SMFO jumpers required to connect the managed Ethernet switches and proposed edge switches with the connector panels of fiber-optic splice centers. Provide SMFO jumpers that are factory-assembled with Type LC connectors. Provide SMFO jumpers that are a minimum of 3 feet in length for edge switches inside equipment cabinets. Ensure SMFO jumpers meet the operating characteristics of the SMFO cable with which it is to be coupled.

B. Ethernet Edge Switch Standards

Ensure that the edge switches comply with all applicable IEEE networking standards for Ethernet communications, including but not limited to:

- IEEE 802.1D standard for media access control (MAC) bridges used with the Spanning Tree Protocol (STP)
- IEEE 802.1P standard for Quality of Service (QoS)
- IEEE 802.1Q standard for port-based virtual local area networks (VLANs)
- IEEE 802.1Q-2005 standard for MAC bridges used with the Multiple Spanning Tree Protocol
- IEEE 802.1w standard for MAC bridges used with the Rapid Spanning Tree Protocol (RSTP)
- IEEE 802.1x standard for port-based network access control, including RADIUS
- IEEE 802.3 standard for local area network (LAN) and metropolitan area network (MAN) access and physical layer specifications
- IEEE 802.3u supplement standard regarding 100 Base TX/100 Base FX
- IEEE 802.3x standard regarding flow control with full duplex operation
- RFC 783 – TFTP
- RFC 854 – Telnet Protocol Specification
- RFC 1112 – IGMP v1
- RFC 1541 – Dynamic Host Configuration Protocol for IPv4
- RFC 2030 – SNTP
- RFC 2068 – HTTP
- RFC 2236 – IGMP v2
- RFC 2865 – RADIUS
- RFC 3414 – SNMPv3-USM
- RFC 3415 – SNMPv3-VACM

Ensure that the edge switches have a minimum mean time between failures (MTBF) of 10 years, or 87,600 hours, as calculated using the Bellcore/Telcordia SR-332 standard for reliability prediction.

C. Ethernet Edge Switch Functional

Ensure that the edge switches support all Layer 2 management features and certain Layer 3 features related to multicast data transmission. These features shall include, but not be limited to:

- An STP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1D standard
- An RSTP healing/convergence rate that meets or exceeds specifications published in the IEEE 802.1w standard
- An Ethernet edge switch that is a port-based VLAN and supports VLAN tagging that meets or exceeds specifications as published in the IEEE 802.1Q standard, and has a minimum 4-kilobit VLAN address table (254 simultaneous)
- A forwarding/filtering rate that is a minimum of 14,880 packets per second for 10 megabits per second and 148,800 packets per second for 100 megabits per second
- A minimum 4-kilobit MAC address table
- Support of Traffic Class Expediting and Dynamic Multicast Filtering

- Support of, at a minimum, snooping of Version 2 of the Internet Group Management Protocol (IGMP)
- Support of remote and local setup and management via telnet or secure Web-based GUI and command line interfaces
- Support of the Simple Network Management Protocol version 3 (SNMPv3). Verify that the Ethernet edge switch can be accessed using the resident EIA-232 management port, a telecommunication network, or the Trivial File Transfer Protocol (TFTP)
- Port security through controlling access by the users. Ensure that the Ethernet edge switch has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network
- Support of the TFTP and SNTP. Ensure that the Ethernet edge switch supports port mirroring for troubleshooting purposes when combined with a network analyzer.

D. Physical Features

Mounting: Provide shelf mount edge switches. Optionally, if cabinet space dictates provide mounting kit to attach the edge switch to a vertical rack rail or a DIN rail in the cabinet. If the Contractor elects to use DIN rail mounting supply the DIN rail with the edge switch.

Ports: Provide 10/100/1000 mbps auto-negotiating ports (RJ-45) copper Ethernet ports for all edge switches. Provide auto-negotiation circuitry that will automatically negotiate the highest possible data rate and duplex operation possible with attached devices supporting the IEEE 802.3 Clause 28 auto-negotiation standard.

Optical Ports: Ensure that all fiber-optic link ports operate at 1310 or 1550 nanometers in single mode. Provide fully functional ports with Type LC connectors and the optics for the optical ports. Do not use mechanical transfer registered jack (MTRJ) or ST type connectors.

Provide 10/100/1000 mbps optical ports that consist of fiber pairs, one fiber will transmit (TX) data and one fiber will receive (RX) data. Provide optical ports that meet the following minimum requirements:

- Optical receiver sensitivity: -32 dBm
- Optical transmitter power: -15.5 dBm
- Typical transmission distance: 20 km
- Operating wavelength: 1310 nm

Copper Ports: Provide edge switches that include a minimum of six copper ports. Provide Type RJ-45 copper ports and that auto-negotiate speed (i.e., 10/100/1000 Base) and duplex (i.e., full or half). Ensure that all 10/100/1000 Base TX ports meet the specifications detailed in this section and are compliant with the IEEE 802.3 standard pinouts. Ensure that all Category 5e unshielded twisted pair/shielded twisted pair network cables are compliant with the EIA/TIA-568-B standard.

Port Security: Ensure that the edge switches support/comply with the following (remotely) minimum requirements:

- Ability to configure static MAC addresses

- Ability to disable automatic address learning per ports, known hereafter as Secure Port. Secure Ports only forward
- Trap and alarm upon any unauthorized MAC address and shutdown for programmable duration. Port shutdown requires administrator to reset manually the port before communications are allowed.

Network Capabilities: Provide edge switches that support/comply with the following minimum requirements:

- Provide full implementation of IGMPv2 snooping (RFC 2236)
- Provide full implementation of SNMPv1, SNMPv2c, and/or SNMPv3
- Capable of mirroring any port to any other port within the switch
- Meet the IEEE 802.1Q (VLAN) standard per port for up to four VLANs
- Meet the IEEE 802.3ad (Port Trunking) standard for a minimum of two groups of four ports
- Telnet/CLI
- HTTP (Embedded Web Server) with Secure Sockets Layer (SSL)
- Full implementation of RFC 783 (TFTP) to allow remote firmware upgrades.

Network Security: Provide edge switches that support/comply with the following (remotely) minimum network security requirements:

- Multi-level user passwords
- RADIUS centralized password management (IEEE 802.1X)
- SNMPv3 encrypted authentication and access security
- Port security through controlling access by the users: ensure that the Ethernet edge switch has the capability to generate an alarm and shut down ports when an unauthorized user accesses the network
- Support of remote monitoring (RMON) of the Ethernet agent
- Support of the TFTP and SNTP. Ensure that the Ethernet edge switch supports port mirroring for troubleshooting purposes when combined with a network analyzer.

E. Electrical Specifications

Ensure that the edge switches power on and operate properly with 115 VAC. Ensure that the edge switches have a minimum operating input of 110 VAC and a maximum operating input of 130 VAC. Ensure that if the device requires operating voltages other than 120 VAC, supply the required voltage converter. Ensure that the maximum power consumption does not exceed 50 watts. Ensure that the edge switches have diagnostic light emitting diodes (LEDs), including link, TX, RX, speed (for copper ports/RJ 45 only), and power LEDs.

F. Environmental Specifications

Provide Ethernet edge switches that adhere to the following environmental constraints as defined in the environmental requirements section of the NEMA TS 2 standard if located within a climate-controlled environment:

- Operating temperature range: -30°F to 165°F
- Storage temperature range: 14°F to 158°F
- Operating relative humidity range: 10% to 90%, non-condensing

Verify that the edge switch manufacturer certifies their device has successfully completed environmental testing as defined in the environmental requirements section of the NEMA TS 2 standard. Verify that vibration and shock resistance meet the requirements of Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard. Ensure that the edge switch is protected from rain, dust, corrosive elements, and typical conditions found in a roadside environment.

The edge switches shall meet or exceed the following environmental standards:

- IEEE 1613 (electric utility substations)
- IEC 6185003 (electric utility substations)
- IEEE 61800-3 (variable speed drive systems)
- IEC 61000-6-2 (generic industrial).

12.3. CONSTRUCTION METHODS

Ensure that all communications hardware is UL listed.

Verify that network/field/data patch cords meet all ANSI/EIA/TIA requirements for Category 5e four-pair unshielded twisted pair cabling with stranded conductors and RJ-45 connectors.

Provide a System Design Report identifying or mapping IP address for each device. Submit the System Design Report for approval along with submitting product submittal data prior to installing and configuring the computer and communications hardware.

Ensure that all project IP addresses are assigned as defined in the System Design Report. Ensure the as-built documentation includes the identification of all IP addresses and VLANs, and associated hardware devices and device locations. Configure the Ethernet network so the WIM equipment and other devices are in separate VLANs.

The Engineer will designate who their network administrator is for the LAN. Upon project completion, ensure that the network administrator will be able to manage remotely the Ethernet switches for switch configuration, performance monitoring, and troubleshooting.

Ensure that all project IP addresses and VLAN IDs are assigned as defined in the System Design Report. Ensure that at a minimum, the switch configuration includes the following features: SNMP, SNTP, Port Security, all required VLANs. Ensure unused switch ports are disabled.

Mount the edge switch inside each field cabinet by securely fastening the edge switch to the vertical rail of the equipment rack or to a shelf using manufacturer-recommended or Engineer-approved attachment methods, attachment hardware, and fasteners. Ensure that the edge switch is mounted securely in the cabinet and is fully accessible by field technicians without blocking access to other equipment. Use fiber-optic jumpers that are factory assembled and connectorized and are certified by the fiber-optic jumpers' manufacturer to meet the relevant performance standards required

below. Verify that network/field/data jumper cables meet all ANSI/EIA/TIA requirements for Category 5e 4-pair unshielded twisted pair cabling with stranded conductors and RJ45 connectors.

Connect the Ethernet Edge Switches to the managed ethernet network switch in the scale house via the new fiber optic cable.

12.4. MEASUREMENT AND PAYMENT

Ethernet edge switch will be measured and paid as the actual number of Ethernet edge switches furnished, installed, and accepted.

The Ethernet switches include all appropriate ports, cabling, grounding, redundancies, labeling, and any integration between the switches and the communications network as necessary to make a fully working installation. All power supplies, power cords, adapters, mounting hardware, DIN rail mounting brackets, DIN rails, connectors, serial cables, signs, decals, disconnect switches, installation materials, and configuration software necessary to complete this work, will be included and will be incidental.

No separate measurement will be made for SMFO jumpers, communication cables, Ethernet patch cables, electrical cables, mounting hardware, nuts, bolts, brackets, connectors, grounding equipment, or surge suppression, as these will be considered incidental to the pay items listed above.

Payment will be made under:

Pay Item	Pay Unit
Ethernet Edge Switch	Each

13. ETHERNET CABLE

13.1. DESCRIPTION

Furnish and install Ethernet cable to serve as interconnect between Ethernet edge switches and co-located devices in the equipment cabinet and to interconnect the Managed Ethernet switch to workstation computers and other peripheral devices in the Scale House.

Ensure Ethernet cable is rated for outdoor applications where it will be installed in conduits exposed to outside weather conditions or lashed to messenger cable.

13.2. Material

Furnish Category 5 Enhanced (5e) Ethernet cable that complies with ANSI/TIA 568-B-5 standards for four-pair shielded twisted copper for Ethernet communications. The cable shall meet all the mechanical requirements of ANSI/ECEA S-80-576. The Ethernet cable must be rated for medium-power, network-powered broadband communications circuits and must be Type BMU network-powered broadband communications medium-power cable.

Provide a minimum of 4-pair twisted copper Ethernet cable and connectors rated for an ambient operating temperature range of -30º F to 165º F. The cable shall be shielded, outdoor-rated and have a

UV-resistant jacket. The void between the insulated copper pairs and the polyethylene outer jacket shall be injected with a water-resistant flooding compound.

Furnish Ethernet cable with the following additional requirements:

- 24AWG (minimum) solid bare copper conductor
- High-density polyethylene insulation, PVC jacket
- UL/CSA listed
- Gel Filled
- Supports 10/100/1000 Mbps
- Mean Power Sum for Equal Level Fare End Crosstalk (ELFEXT): 45dB/kft (minimum) at 772kHz
- Worst Pair Power Sum for ELFEXT: 40dB/kft (minimum) at 772kHz
- Mean Power Sum for Near-end Crosstalk (NEXT): 42dB/kft (minimum) at 772 kHz
- Average mutual capacitance: 90nf/mile (maximum)
- Ensure the jacket is printed with foot markings at a minimum of every 3 feet.

Have the manufacturer factory test the Ethernet cable on reels for each pair's mutual capacitance, crosstalk loss, insulation resistance, and conductor resistance. Furnish the Engineer with a certified report for each reel showing compliance with these Project Special Provisions, the factory test results, and the manufactured date of the cable. The contractor shall not use Ethernet cable manufactured more than one year before the date of installation.

Pre-terminated cables in 3’ to 6’ lengths shall have their ends terminated at the factory. Long haul runs greater than 6’ shall have the ends terminated in a punch down female RJ-45 jack.

No Ethernet patch cable shall exceed 295 feet.

13.3. CONSTRUCTION METHODS

A. General

Install Ethernet cable on new or existing messenger cable and in conduits at locations shown in the Plans. Allow a minimum of 10 feet (3 meters) of cable slack.

Ethernet cables shall not be spliced.

All cables shall be labeled with waterproof, smear resistant labels that denote the equipment cabinets or housing they are run from and the device and identifier for that device to which they are connected.

B. Underground Installation

Install underground Ethernet cable in conduit described in these Special Provisions and as shown in the Plans.

The contractor shall not exceed 80 percent of the manufacturer's maximum pulling tension when installing underground Ethernet cable. Use a clutch device (dynamometer) so as not to exceed the

allowable pulling tension if the cable is pulled by mechanical means. Do not use a motorized vehicle to generate cable-pulling forces.

Keep tension on the cable reel and the pulling line at the start of each pull. Do not release the tension in the cable if the pulling operation is halted. Restart the pulling operation by gradually increasing the tension until the cable is in motion.

C. Equipment Cabinet and Scale House Cable Installation

For connections inside equipment cabinets to connect between switches and other co-located devices, provide pre-terminated jumper in 3’ to 6’ lengths.

Long haul cable terminations into RJ-45 jacks can have their ends installed in the field by qualified technician for connections between the Managed Ethernet switch and workstation computers and other peripheral devices.

13.4. MEASUREMENT AND PAYMENT

There will be no direct payment for work covered in this section, including, but not limited to terminating and testing of the cable, connectors, cable identification markers, and grounding. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered by this section. Include the incidental costs for furnishing and/or installing materials and equipment expressly required under the contract for successful completion of the contract, but whose measurement and payment is not specifically stated under any of the contract pay items, into the unit cost(s) for the various items in the contract.

14. COMPUTER HARDWARE AND PERIPHERALS

14.1. DESCRIPTION

Furnish and install all materials with the most recently developed and approved product versions that meet or exceed all applicable standards, specifications, and requirements before the system is considered for acceptance. Ensure that all equipment features, functions, and performance measures are met.

Furnish and install one server, one printer, and one computer workstation in each scale house.

Ensure that all workstations and servers can access the LAN and can be used to monitor, interact, and control all weigh station operations.

A. UPS

Furnish and install rack-mounted uninterruptible power supply (UPS) units as described in this Project Special Provision for the equipment cabinets, managed Ethernet switches, and servers in the scale house. The UPS shall also include any ancillary equipment or incidental items, such as required mounting hardware and cabling. Furnish and install monitoring software to provide email alerts. Furnish all materials with the most recently developed and approved product versions that meet or

exceed all applicable standards, specifications, and requirements before the system is considered for acceptance.

B. Equipment Rack

Furnish and install 19" EIA equipment racks with power cord hook-up and outlets to service equipment. Ensure outlets are surge protected. Ensure rack has sufficient space to accommodate all equipment required by this contract and has a minimum of an additional six spare rack positions available to house future equipment installations.

14.2. MATERIAL

A. Server

Furnish and install servers in the Northbound and Southbound scale houses as described in these Project Special Provisions. Connect the servers to a managed Ethernet switch. The server shall have the following minimum requirements.

- Rack Mounted Server Grade Machine
- Intel Xeon series 3.5 GHz 4 core 8 thread Processor
- 32GB of 2133 ECC RAM (Multi Channel)
- 4x 600GB 15K RPM 12-Gbps Server Grade HDD
- RAID controller with support for 4 pairs
- Hot Swappable Hard Drive Bays
- 4x USB Ports, minimum 2x USB 3.0 Ports
- Dual Power Supplies
- Dedicated Ethernet Management Port
- 2x 1Gbps onboard network ports
- 64-bit Windows Server 2016 Standard Edition with 5 device Client Access Licenses

The server shall integrate the workstations and allow video and data accessibility and exchange between various system components (i.e., WIM, ATMS, ALPR, Overview Camera, etc.).

B. Computer Workstation

Furnish and install computer workstations consisting of a CPU, monitor(s), keyboard, and mouse in each scale house scale room. The computer workstation should meet the following minimum requirements.

- 4 core 3.2GHz Processor
- 8GB of RAM
- 500GB SATA Hard Drive
- 4 USB ports
- HDMI/DP/VGA port
- 24" monitor

- Windows 10 Professional

The computer workstation will operate the central control software over the Ethernet network in the scale house. Each computer will be provided with one monitor.

C. Printer

Furnish and install one color laser printer in each scale house.

D. UPS

Furnish UPS units that produce uninterruptible power and power conditioning for the WIM equipment, managed Ethernet switch, and video monitor in the scale house.

For the UPS located in the scale house, size the UPS units to provide at least 20 minutes of UPS power. For the equipment cabinets, size the UPS units to provide at least four hours of UPS power. Provide the UPS with a 25% reserve of receptacles. Provide load calculations for each configuration of equipment connecting to a UPS.

a. Standards

Ensure that the UPS units comply with the following standards:

- ANSI
- ASTM
- CSA
- UL

b. Functional

Each UPS shall provide adequate capacity to run its respective equipment without commercial power for 20 minutes. Size the UPS units for the proposed loads. Provide load calculations for each configuration of equipment connecting to a UPS assuming a run time of 20 minutes.

Ensure that the UPS and its remote monitoring software perform the following functions:

- Remote environmental monitoring of temperature and humidity
- Data logging
- Event logging
- Fault notification
- Hibernation
- Radius authentication
- Protocols: HTTP, HTTPS, IPv4, IPv6, SMTP (v1-v3), Telnet, SSH v2, SSL
- Manage all network UPS units
- Operating system shutdown
- Load shedding to turn off selected devices or groups of devices
- Outlet control to turn off, reboot, or shutdown outlets
- Power event summary

- Recommended actions
- Risk assessment summary
- Run command file
- System event log integration.

c. Physical Features

Supply each UPS unit described above with 25 percent spare outlets. Ensure that the UPS meets the following material requirements:

- Rack-mounted and floor mounted as listed below in these Project Special Provisions
- Sealed AGM type, maintenance free batteries
- Minimum of nine NEMA 5-15R and two NEMA 5-20R outlets
- NEMA L5-30P input plug
- Ethernet network management card using 10/100/1000 Base TX communications
- USB interface port
- Remote environmental monitoring of temperature and humidity with telnet management
- Status lights: power on, power source and overload
- Alarms: audible and remote notification
- Manual power on/off switch
- Supply UPS unit with multi-pole noise filtering. Supply UPS with a terminal for connecting the UPS to a surge protection device.

d. Environmental Specifications

Verify that the UPS meets all specifications and can perform all of its functions during and after being subjected to:

- Operating temperature: 0° F to 104° F
- Operating relative humidity: 95%
- Storage temperature: 5° F to 113° F
- Storage relative humidity: 95%

14.3. CONSTRUCTION METHODS

A. General

Integrate all servers, workstations, and printers on the LAN so all applications will be fully functional. Install the operating system, software, and antivirus software to the NCSHP IS standards.

Furnish all tools, equipment, materials, supplies, manufactured hardware, and perform all operations and equipment integration necessary to provide a complete, operational network. All cabling shall be:

- Neatly tagged with permanent labels at both ends of every cable,

- Secured with wire ties and cable management hardware in the communications racks, and
- Grounded to rack grounding hardware.

Ensure that all project IP addresses are assigned as defined in the System Design Report. Ensure the as-built documentation includes the identification of all IP addresses and VLANs, and associated hardware devices and device locations.

B. Server

Install servers in the Northbound and Southbound scale houses. Install the software packages described in these Project Special Provisions.

Install all software necessary to support the central control software and to meet all of the data communications requirements described in these Project Special Provisions.

Connect the servers to the managed Ethernet switch. Furnish and install Ethernet patch cords between the Ethernet patch panel and the managed Ethernet switch in the scale house. Plug power supplies into outlets on separate circuits.

C. Computer Workstation

Install the computer workstations in the scale houses. Connect the workstation to the LAN by furnishing and installing Ethernet patch cords between the Ethernet patch panel and the existing managed Ethernet switch in the scale house. Perform the following operational tests for each computer component in accordance with the test plans. After the equipment has been installed, perform the following:

- Connect all components (monitors, mice, keyboards, existing printers, network cables, power supplies)
- Install all software required in these Project Special Provisions
- Configure network communications
- Map network drives and existing printers
- Run diagnostic utilities on the hardware
- Print test pages for each workstation on each existing printer to verify printer configuration.

D. Printer

Install laser printers in each scale house scale as directed by the Engineer. Connect the printer to the Ethernet network, set up the workstations on the network to use the printer and print a test page from each printer.

E. UPS

Install UPS units with the following equipment connected to them:

- Roadside cabinets housing roadside computers
- Workstations
- Servers
- WIM electronics equipment in scale room

14.4. MEASUREMENT AND PAYMENT

Server will be measured and paid as the actual number of servers furnished, installed and accepted.

Computer Workstation will be measured and paid as the actual number of computer workstations with monitor(s), keyboard, UPS, mouse, operating system, and software furnished, installed and accepted.

Printer will be measured and paid as the actual number of printers furnished, installed and accepted.

UPS will be measured and paid as the actual number of UPS furnished, installed and accepted.

No separate measurement will be made for coaxial cables, communication cables, electrical cables, mounting hardware, equipment rack, nuts, bolts, brackets, connectors, risers, grounding equipment, or surge suppression, as these will be considered incidental to the pay items for servers, and workstation computers.

No separate measurement and payment for any additional equipment or components not provided by the Engineer. These items will be considered incidental to the pay items for installing servers and workstation computers.

Ethernet Cable (3 foot) and Ethernet Cable (6 foot) will be considered incidental as addressed elsewhere in the Project Special Provisions.

Payment will be made under:

Pay Item	Pay Unit
Server	Each
Computer Workstation	Each
Printer	Each
UPS	Each

15. CENTRAL CONTROL SOFTWARE

15.1. DESCRIPTION

A. General

Furnish and install central control software in accordance with the Plans and these Project Special Provisions. The system will operate automatically and continuously, with limited human intervention, weighing vehicles, collecting vehicle data, interpreting tire anomalies, and screening trucks as an integral part of the system to form an Automated Commercial Vehicle Processing System, Credential Screening System and TSG Data Collection System.

Furnish a data collection system fully compatible with NCDOT's existing Traffic Data Management System (TDMS) developed by MS2 that auto-polls the WIM data into the TDMS. The bin definitions for both vehicle class and speed must be identical for all lanes to allow proper aggregation to directions and 2-way level. The Contractor shall contact MS2 (info@ms2soft.com) for more information and setup of the auto-polling process.

Operational requirements of the overall system are explained in Section 1 of these Project Special Provisions.

Ensure the Credential Screening System Software can capture WIM data, TSG Data, ATMS data and ALPR data for each commercial vehicle crossing the WIM system as they approach the weigh

station. Ensure the Credential Screening System Software uses an automatic screening algorithm to receive all captured data to determine the sort decision of pull in or bypass the Weigh Station.

Furnish and install software that distinguishes potential weight violators from the real-time traffic stream based on automatic weight measurements that exceed the established thresholds. Furnish and install software that identifies potential tire pressure anomaly's violators that exceed the established thresholds.

The specific major functions fulfilled by the baseline roadside operations software as part of the Credential Screening System are:

- Record all vehicle characteristics in a database
- Produce reports of recorded vehicle characteristics
- Screen vehicles for credential violations
- Screen conjunctionally commercial vehicles with in-cab devices and commercial vehicles with out in-cab devices for safety violations
- Screen commercial vehicles using operator defined hot lists
- Allow duly authorized operators to adjust screening criteria and bypass rates based on ALPR sensor data and allow the operator to view vehicle screening results and overview camera shot information.

The software must maintain a configurable number of months, minimum of 3 months, maximum of 12 months, of historical vehicle data for analysis and reporting including the Confirmation Database. Additionally, the system shall be supplied with a user definable Scheduler Program to purge this data from the system on a weekly basis (i.e., once per week the software will examine all of the vehicle records to determine which are older than the specified expiry period and delete them from the database). The day and time at which this purging takes place shall be configurable by a system administrator. Set the purging to occur normally during Saturday or Sunday or during some other time when the weigh station is not busy.

Furnish the Automated Commercial Vehicle Processing System and Credential Screening System (Central Software) to produce printed reports detailing vehicle activity at the weigh station. This function is known as vehicle reporting.

Ensure the Automated Commercial Vehicle Processing System and Credential Screening System can interface to the state CVIEW system to update the local credential and safety database. This function is known as the CVIEW interface.

Furnish a TSG Data Collection System with a vehicle record collection system that provides FHWA 13 classification bins, along with bins 14 & 15 for errors and unknown classification counts with a minimum capability to auto-polling the vehicle data collection every 15-minutes. The TSG Data Collection System shall auto-poll for vehicle count, vehicle classification, vehicle length, axle spacing, axle and gross vehicle weight, and vehicle speed.

Ensure the system can maintain or access a vehicle record for each vehicle entered into the system.

Conform to the NC Statewide Information Technology Standards and Policies as described at http://it.nc.gov

B. **Screening Criteria**

1. Operation Overview

Integrate the ALPR, with the existing CVIEW, SAFER, FuelTaCS, PRISM and NCIC programs currently in use by the NCSHP for commercial vehicle data screening and enforcement.

Provide the following major features:

- Snapshot screening database containing a local copy of NCIC, FuelTaCS, PRISM, CVIEW and SAFER data.
- Credential processing and screening software algorithms that include automated ALPR screening with PRISM status of the carrier and vehicle to determine if a Federal out- of-service order has been issued against the carrier or if the vehicle has been targeted; automated screening to retrieve the carrier safety information from the screening database, automated screening to check the FuelTaCS database of carriers who have delinquent fines; and automated screening to check the NCIC database of vehicles which have been reported stolen.
- Automatically alert system users through audible and visual alarms of real-time CMV violators passing the System through user defined thresholds and the screening databases described herein.
- Windows-based graphical user interface (GUI) for accessing the snapshots and credential screening components. Furnish a user-friendly system with one GUI for accessing all screening components.

The specific major functions fulfilled by the Automated Commercial Vehicle Processing System and Credential Screening System (Central Software) software are:

- Record all vehicle characteristics in a database
- Produce reports of recorded vehicle characteristics
- Screen vehicles for credential violations
- Screen vehicles for safety violations
- Screen vehicles using operator defined hot lists
- Allow duly authorized operators to adjust screening criteria and bypass rates
- Allow the operator to view vehicle screening results along with the details about the carrier from the screening database.

Furnish software allowing purging to be configurable by day of week and time of day by a system administrator. Confirm purging schedule with the Engineer.

2. System Characteristics

a. Roadside Operation Requirements

Provide the System with the following functions:

- Vehicle screening
- Vehicle display
- Vehicle reporting
- CVIEW interface

The System shall use a live/real time connection to a database of the following: CVIEW, SAFER, FuelTaCS, NCIC, PRISM, over a secured connection. Additionally, the system shall be designed with an Operator defined Scheduler to download these databases daily to use as a backup in case the live feed is disrupted. Upon re-establishing a live/real time connection the system shall be programmed to revert back to the prior status.

The System must produce printed reports detailing vehicle activity.

The System must maintain a vehicle record for each commercial vehicle passing the system.

Furnish the System vehicle record containing the following information about each commercial vehicle:

- Unique vehicle identifier
- Vehicle number
- Time and date stamp
- ALPR data
- Axle counts
- Vehicle ID number
- Overall vehicle weight
- Vehicle length
- Error code
- Carrier ID (USDOT number) from CVIEW data
- Vehicle speed
- Axle record type
- ESAL or MEPDG value
- Screening decision
- Vehicle classification
- Tire Pressure Anomaly
- Maximum gross vehicle weight
- Axle weights
- Axle spacing

Interface the System to the CVIEW and FuelTaCS databases for receiving commercial vehicle data over a secured connection, as described below.

b. Screening Requirements

Automatically screen the PRISM status of the CMV carrier and vehicle to determine if a Federal out-of-service order has been issued against the carrier or if the vehicle has been targeted.

Automatically screen and retrieve the carrier safety information from the screening database and provide an alert when the Gross Vehicle Weight exceeds the registered license weight.

Automatically screen against North Carolina's FuelTaCS database of carriers who have delinquent fines.

Automatically screen the NCIC database of vehicles which have been reported stolen. Uniquely display each vehicle record including all associated roadside sensor data.

Maintain an operator-defined hot list of carriers regardless of their weight or safety credential status.

Include a carrier hot list with an active date range for each entry defining the period in which the entry is valid.

Include the following information on the carrier hot list:

- Carrier ID
- License Plate data

- USDOT numbers
- Comments – the user can enter what action to take or any other information that would be useful
- Start date – when the hot list status starts
- End date – when the hot list status ends
- Jurisdiction – identifies registering jurisdiction.

Maintain an operator-defined hot list of vehicles regardless of their weight or safety credential status.

Program the System to maintain a local database of carrier snapshot data received from CVIEW, PRISM, and the FuelTaCS systems.

Program the System to permit the operator to override each specific credential/safety screening check on a carrier-by-carrier basis.

c. Display Requirements

Program the System to provide a Screening Results Display/snapshot screen that permits the operator to do the following:

- View the ALPR system data.
- View the credentials and safety scores that were used in screening a particular vehicle.
- Display which credentials and safety scores failed.
- Display which credentials and safety scores a vehicle is currently failing (if the operator requested updated snapshot data from CVIEW, the screening results may no longer be accurate).
- Search all system components by date, time and vehicle record and allow user- defined alarm notifications to be configured to meet multiple threshold levels.
- Specify which credentials and safety items to use to screen vehicles.
- Enable or disable each individual screening criteria.
- Enter a minimum/maximum allowable value to be used for each safety item while screening vehicles.
- Save a default configuration of screening criteria to be recalled at some point in the future.
- Quickly and easily return all credential and safety score screening criteria to their default values.
- Permit the operator to retrieve current vehicle and carrier snapshot data from the screening database and store it in the local screening results database.
- View snapshot data retrieved from CVIEW for any requested vehicle or carrier.
- Restrict access to system functions with a user identification and password scheme. The adjustment of screening criteria must be restricted to only personnel with the required privileges.
- Produce reports on vehicle data.
- Permit the operator to view all historical vehicle data for any vehicle that has passed the System in the last three months.
- Edit each of the hot lists.

d. Reporting Requirements

Program the System to produce the following reports:

- CLASS BY HOUR: showing the count of vehicles in each class for each hour of the day
- CLASS BY DAY: showing the count of vehicles in each class for each day of the week
- SPEED BY CLASS: showing the count of vehicles in each speed range for each class of vehicle
- SPEED BY HOUR: showing the count of vehicles in each speed range for each hour of the day
- FRONT AXLES: showing the count of all front axles recorded within different weight ranges for each vehicle class
- SINGLE AXLES: showing the count of all single axles recorded within different weight ranges for each vehicle class
- TANDEM AXLES: showing the count of all tandem axles recorded within different weight ranges for each vehicle class
- TRIDEM AXLES: showing the count of all tridem axles recorded within different weight ranges for each vehicle class
- QUADREM AXLES: showing the count of all quadrem axles recorded within different weight ranges for each vehicle class
- GROSS VEHICLE WEIGHT: showing the count of vehicles in each Gross Vehicle Weight range for each vehicle class. Display the total GVW in a separate column
- ERRORS: showing the hourly count of vehicle display errors reported by the system
- TOTAL ESAL: showing the hourly summary of Equivalent Single Axle Loads for each vehicle class
- LANE COUNT: showing the count of vehicles in each class for each lane at the weigh station
- WEIGHT VIOLATION BY CLASS: showing for each vehicle class, the total vehicle count, the number of valid vehicles, the number of warning vehicles, the number of violating vehicles, what percentage of the total was violating, the number of single axle violations, and the number of tandem axle violations
- WEIGHT VIOLATION BY HOUR: showing for each hour of the day, the total vehicle count, the number of valid vehicles, the number of warning vehicles, the number of violating vehicles, what percentage of total was violating, the number of single axle violations, the number of tandem axle violations and the number of GVW violations
- WEIGHT VIOLATION COUNT: showing for each hour of the day and each vehicle's class, the total vehicle count, the number of valid vehicles, the number of warning vehicles, the number of violating vehicles, what percentage of total were violating, the number of single axle violations, the number of tandem axle violations and the number of GVW violations

Program the System to produce specific reports that are based on data stored in the System:

- ALPR system data
- Number of vehicles traveling down each lane
- List of a carrier's vehicles passing the System during a specific time, include when the vehicle passes the weigh station.

e. Credential Enforcement Screening Requirements

The System must screen data from the CVIEW, SAFER, FuelTaCS, PRISM, and/or the NCIC systems currently in use by the NCSHP for credentials, safety and oversize/overweight enforcements listed below using the field data collected by the System. Ensure that the screening tool allows an operator to enable and disable the screening tools in the setup screen and the vehicle display screen.

At a minimum, include the following Credential Enforcement Screening Requirements:

- UCR Credentials
- HazMat Credentials – As a minimum, Identify the status of the carrier's registration credentials.
- IRP Credentials
- IFTA Credentials
- Safety Enforcement
- Oversize/Overweight Enforcement based on WIM data

3. External Interface Requirements

Provide a secure connection to allow the exchange of carrier and vehicle snapshot data in XML format from the State CVIEW system to the System.

Program the System to continue normal operation while receiving and processing files from the state CVIEW system and to support the processing of data at a rate to be determined, but which may be as often as an update every 15 minutes.

Provide a secure connection to allow the exchange of data in XML format from the PRISM, FuelTaCS, and NCIC to the System.

C. Operator Interface and System Controls

Ensure the system allows operators to view and control system operations through a LAN connection on their laptops or desktop computers. Using laptops or desktop computers, users will view vehicle data collected by each of the detectors and sensors in the system, the ALPR system, view and print reports, identify, and respond to system alarms, and view still shot images of violating vehicles. At a minimum, the user display screens will allow the users to view the following information:

a. ALPR Data

Display vehicle records for the lane collecting data in the System. Program the system to show data and images collected.

b. Vehicle Data

Program the system to show data collected by the in-road detectors.

c. Vehicle Data

Program the system to show data collected by the ATMS detectors.

d. Individual Vehicle Data

Program the System to display all information on a specific vehicle collected by the System. Program the System to allow operators to view snapshot photographs taken of vehicles via the overview camera.

e. Alarms

Program the system to allow operators to review alarms reported by the System and to allow operators to view snapshot photographs taken by the overview camera and the ALPR system of violating vehicles.

f. Summary Data

Program the system to allow operators to review summary data for each travel lane in the system. Have the summary data include total vehicle counts, vehicle classifications, vehicle speeds, gross vehicle weights (by category), axle weights and system violations (by type including weight, length, over-height, tire pressure anomalies and credentials).

D. System Reports

The software must provide the following reports:

- Targeted as Federal out-of-service
- Carrier safety information
- Delinquent fines
- Reported as stolen
- Violations
- Classification (by hour, by day of the month and by day of the week)
- Vehicle speed (by class and by hour)
- ESALs (Equivalent Single Axle Loads) or MEPDG (Mechanistic-Empirical Pavement Design) by Hour
- Weight violations (by hour and by class)
- Weight violations count
- Truck count (by day of the month and by day of the week)
- Truck count by gross vehicle weight
- Vehicle speeds (by class and by hour)
- System errors (errors reported by system diagnostics
- Vehicle lengths
- ALPR records
- ATMS records

E. Historical Search Queries

The software must provide an operator with the ability to perform historical data queries. Furnish the ability to view the results of historical database queries on the user's screen and to optionally print the database queries in a format acceptable to the Department.

The software must maintain a configurable number of months, minimum of 3 months, maximum of 12 months, of historical vehicle data for analysis and reporting. Purge this data from the system on a weekly basis (i.e., once per week the software will examine all of the vehicle records to determine which are older than the specified expiry period and delete them from the database). Furnish software allowing

purging to be configurable by day of week and time of day by a system administrator. Confirm purging schedule with the Engineer.

The historical search options shall include the ability to set selectable date/time range, search criteria and filter conditions. Search criteria shall include the following:

- Transponder number
- Carrier name
- Statuses set
- Statuses not set
- License plate & jurisdiction
- Minimum GVW
- Minimum length
- % of max GVW
- Sort decision
- Sign decision
- USDOT number
- Vehicle class range
- Error set, or no error
- Lanes
- Vehicle record number
- VIN
- Filter conditions include:
- Speed change
- Unequal axle count
- Tailgating
- Wrong lane (i.e., volunteer reporting to station after being told to bypass)
- Running scale
- Not WIM Lane (i.e., a commercial vehicle in the AVC lane)
- Overlength
- Over GVW
- Random
- Speed limit
- Credential fail
- Kingpin violation (when applicable)
- Credential hotlist
- Ramp backup
- ATMS alerts

Furnish the ability to view the results of historical search on the user's screen and to optionally print the historical search results list.

15.2. MATERIAL

Provide software licensing for all software packages, including third party applications such as database, report generation etc. if applicable. Provide an auto-setup executable file or application that will install all software packages with minimal human interaction.

All initial software system configurations shall be handled by the auto-setup application to the extent possible.

Furnish perpetual license for all software packages used throughout the system. Furnish all software pre-installed on controller hardware prior to installation.

Controller hardware used to run the software described in this Project Special Provision is accounted for in other specifications in this document.

Furnish a data collection system fully compatible with NCDOT's existing Traffic Data Management System (TDMS) developed by MS2 and allowing the data auto-polled into the TDMS.

Provide mockups for all operator screens and system reports prior to generating/developing the screens and reports. Update the report formats and screen views based on the Department's comments.

15.3. MEASUREMENT AND PAYMENT

Central Controller Software will be paid for at the contract lump sum price. No measurement will be made for the interface with the individual components of the system, including but not limited to the WIM systems as these will be considered incidental to furnishing and installing the Central Control Software. No measurement will be made for the interface with the individual components of the system, including but not limited to the ALPR, ATMS, inductive loops, and camera systems as these will be considered incidental to furnishing and installing the Central Control Software. No measurement will be made for software licenses and updates required during the System Warranty as these will be considered incidental to furnishing the System Warranty.

TSG Central Controller Interface will be paid for at the contract lump sum price. No measurement will be made for the interface with the individual components of the system, including but not limited to the WIM strip sensor card furnished and installed in the WIM cabinet and autopolling coordination with MS2 as these will be considered incidental to furnishing and installing the TSG Central Controller Interface.

Payment will be made under:

Pay Item	**Pay Unit**
Central Control Software	Lump Sum
TSG Central Controller Interface	Lump Sum

16. BUILDING MODIFICATIONS

16.1. DESCRIPTION

Make all necessary Scale House building modifications to install a new 24-fiber drop cable into the scale house. Remove the existing PVC riser and PVC box from the exterior of the scale house. Furnish and install a new 12" x 12" X 6" NEMA 3R galvanized box and 2"rigid galvanized riser in the same location. Install 2" PVC conduit from the junction box adjacent to the sidewalk to the scale house and install 24-fiber drop cable into the scale house. Install 1" liquid tight flexible non-metallic conduit with a 24-fiber drop cable in the ceiling to the existing rack. Furnish and install all necessary equipment, materials, hardware, and sealant necessary for the building modifications.

16.2. Material

Furnish and install all equipment, materials, hardware, and sealant at the Scale Houses for the building modifications as described above. Furnish 12" x 12" X 6" NEMA 3R galvanized steel box with approved anchors. Furnish 1" liquid tight flexible non-metallic conduit.

16.3. CONSTRUCTION METHODS

Furnish and install all equipment, materials, hardware, and sealant necessary at the Scale Houses for the building modifications required to install a new 24-fiber optic communications drop cable into the scale house.

Sawcut the existing sidewalk adjacent to the exterior of the rear of the building at the existing wall mounted PVC box and install new 2" PVC conduit from the junction box to the building. Remove the existing PVC box and conduit from the exterior of the building. Transition and install a new 2" rigid galvanized steel conduit and NEMA 3R galvanized steel box at the same location where the removed PVC box and conduit was located with approved anchors and straps. Core drill through the exterior of the building to the interior of the building. Install 1" liquid tight flexible non-metallic conduit with a 24-fiber drop cable in the scale house ceiling to the existing equipment rack. Terminate the 24-fiber cable drop in the existing equipment rack.

16.4. MEASUREMENT AND PAYMENT

Scale House Building Modifications will be paid for at the contract lump sum price for modifying the scale house buildings and sidewalk work to install and terminate a 24-fiber drop cable inside the scale house. Building modifications include, but are not limited to, saw cutting the existing sidewalk; installing a 2" rigid galvanized steel conduit and NEMA 3R galvanized box on the exterior of the building; core drilling into the building and installing a 1" liquid tight flexible non-metallic conduit inside the scale house. No measurement will be made for the installation of servers and communications equipment as they are paid for elsewhere in the Contract Documents.

No separate measurement will be made for the 24-fiber optic drop cable, termination or testing of the drop cable as it is paid for elsewhere in the Contract Documents.

No separate measurement and payment will be made for mounting hardware, anchors, straps, sealant, grounding equipment as these will be considered incidental to the Building Modifications.

No separate measurement will be made for the 24-fiber optic drop cable, termination or testing of the drop cable as it is paid for elsewhere in the Contract Documents.

No separate measurement and payment will be made for mounting hardware, anchors, straps, sealant, grounding equipment as these will be considered incidental to the Building Modifications.

Payment will be made under:

Pay Item	**Pay Unit**
Scale House Building Modifications	Lump Sum

17. TESTING AND ACCEPTANCE

17.1. DESCRIPTION

A. General

Test all equipment, cable and software furnished and installed under this Project. Conduct all testing in the presence of the Department. The Department reserves the right to perform any inspections deemed necessary to assure that the equipment conforms to the requirements required in these Project Special Provisions.

At a minimum, test the following items:

- ALPR
- WIM
- ATMS
- CMS
- TSG Data Collection
- Camera equipment, including frame grabber
- Infrared Illuminators

Develop detailed test procedures and obtain Department approval before the tests are conducted. Allow 20 days for the review period. Demonstrate through the test procedures that all requirements defined in these Project Special Provisions, including but not limited to, functional/system performance requirements, electrical requirements, data transmission/communication requirements, safety/password requirements, and interface requirements with other components of the System have been satisfied. During the testing, perform additional tests if the Department's representatives request such to confirm proper operation.

Compare the results of each test with the requirements specified in the Project Special Provisions and with the approved test procedures. Failure to conform to the requirements of any test will be considered as a complete failure and the equipment and software will be rejected. Make any corrections deemed necessary at no additional cost to the Department. Assume total responsibility for documenting the results of such tests and furnishing the documented test results to the Department.

The approval of test procedures and witness of such test will not relieve the Contractors of his responsibility to provide a completely acceptable and operating system that meets all requirements of these Project Special Provisions.

B. Operational Test

Conduct approved tests on all installed equipment and software. Perform these tests in the presence of the Department. The following separate tests are required:

- ALPR System (including the Overview Camera)
- Use real vehicles to test the system. Test the system in day and night conditions over a 3-hour period each in full daylight and dusk to night.
- WIM System
- Test the system's performance as described in the WIM System Specifications located in these Project Special Provisions.
- ATMS
- Test the system's performance as described in the ATMS Specifications located in these Project Special Provisions.
- CMS System
- TSG Data Collection System

Ensure during other tests that the CMS displays the correct message and that the diming features of the sign function properly.

C. Observation Period

After all equipment and software comprising the System has been accepted, satisfactory completion of the System acceptance test, and after training is complete, a 30-day observation period begins. The NCSHP will be responsible for operating the system during this period.

The following conditions apply to the observation period:

During the observation period, ensure the system monitors all components of the System and performs all functions described in these Project Special Provisions.

If any major component provided under these Project Special Provisions fails, repair the item at the Contractor's expense. If a failure occurs, the observation period would begin for the full 30-day duration. Major components are ALPR system, WIM system, TSG Data Collection System, ATMS system, CMS system, inductive loops, and fiber optic communications cable.

During the observation period, have personnel respond to the problem within 24 hours after being notified of a problem by the Department. Within two days, have personnel on-site, with replacement equipment, addressing and correcting any issues with the System.

If another problem is discovered, such as erroneous computations, the observation period will be suspended until the Contractors corrects the problem at his expense. Once the problem has been eliminated, the observation period will resume. If the problem was one that affected the entire system

rather than just one field device, the observation period will not resume until the system has performed properly for at least 72 hours. During this 72-hour period, demonstrate that any corrections or modifications made are valid, that the problems which restricted system operation have been corrected, and no new problems have resulted from the changes.

Total system “down time” may not exceed 30 hours during the observation period. Down time includes the time of suspension of the observation period as described in the previous paragraph.

Down time is a condition caused by failure of the central equipment, system software, field equipment or communications system, which causes the system to cease normal operation. If total system “down time” exceeds 30 hours, a full duration of the observation period will begin again.

Terminate the observation period if 10% or more of the total quantity of any individual hardware item fails. Commence a full observation period for that hardware item upon the repair of a failed hardware item.

Upon successful completion of the observation period, the Department will accept the system, providing that all errors and omissions in Contractors-supplied documentation have been corrected and all other requirements of the Project Special Provisions have been met. Final acceptance will be in writing from the Department.

The 30-day observation period is not considered part of the work to be completed by the project completion date.

17.2. MEASUREMENT AND PAYMENT

There will be no direct payment for the work covered in this section as it will be considered incidental to the work required herein.

18. DOCUMENTS AND SUBMITTALS

18.1. GENERAL

The submittals listed below complement requirements stated throughout these Project Special Provisions and do not replace them.

Submit for approval catalog cuts and/or shop drawings for materials proposed for use on the project. Allow 20 days for review of each submittal. Do not fabricate or order material until receipt of Engineer’s approval.

Submit 1 copies of each catalog cut and/or drawing and show for each component the material description, brand name, stock-number, size, rating, manufacturing specification and the intended use (identified by labeling all components with the corresponding contract line item number).

Present the submittals neatly arranged in the same order as the contract bid items. Electronic submittals of catalog cuts and drawings may be accepted in lieu of hard copies.

One hard copy and an electronic (PDF) copy of reviewed submittals will be returned to the Engineer.

Supplement each drawing by material cut sheets and parts list. Provide parts list in the following format:

Part ID	Source	Part number	Alternate source	Alternate Part number	Description

18.2. DRAWINGS AND DOCUMENTS' CERTIFICATION

Provide plans for the equipment cabinet, mounting description, and shop drawings with documentation and calculations approved by a Professional Engineer registered in the state of North Carolina that bears his/her signature, seal, and date of acceptance (where applicable).

18.3. MECHANICAL

This set of submittals includes, but is not limited to, material specifications and parts list.

18.4. ELECTRICAL

This set of submittals includes, but is not limited to, material specifications, parts list, and wiring diagrams within the equipment cabinet and any electrical service equipment required.

18.5. ELECTRONICS

This set of submittals includes, but is not limited to, material specifications, parts list, and schematic diagrams for all electronics assemblies and sub-assemblies used in the system.

18.6. BLOCK DIAGRAMS AND USER MANUALS

Provide block diagrams with the material submittals along with user and Instruction Manuals prior to training for approval.

18.7. PROPRIETARY PARTS

Provide a list of all proprietary, non-warranty electronic component parts, along with its associated cost, at which the vendor will supply for a three-year period after final project acceptance. Failure to supply this required proprietary part and price information may be grounds for rejection of the submitted item due to incomplete information. A part is considered to be a proprietary part if it is designed and manufactured exclusively for a specific hardware item and is not commercially available for sale to the general public. In addition, any item that is sole source (e.g., available only from the vendor or from a single known manufacturer) is considered to be proprietary and should be identified along with the sole source. Identify and quote a price for parts that are no longer being manufactured and identify the item as one that is no longer manufactured.

18.8. PROTECTION OF MANUFACTURER'S PROPRIETARY INFORMATION

NCDOT will use the above documentation (schematics, drawings, software, firmware, manuals, etc.) exclusively for the following purposes: diagnosing and performing repairs on malfunctioning equipment, equipment circuit boards, and malfunctioning systems; operational test of repaired equipment, circuit boards, systems; and performing authorized upgrades to equipment, circuit boards, and software supplied under this contract. NCDOT will not use or copy devices or software for any

purpose other than diagnosis, repair, and testing or to perform authorized firmware or software upgrades.

Upon notification by the manufacturer, the Department agrees not to divulge any proprietary or otherwise confidential information contained in the above required documentation. NCDOT agrees to protect and secure any proprietary documentation identified by the manufacturer as proprietary or confidential. Upon request by the manufacturer, NCDOT agrees to sign a binding non-disclosure agreement with the manufacturer or other business that is providing documentation it considers proprietary or otherwise confidential.

18.9. MEASUREMENT AND PAYMENT

No measurement will be made of this work as these will be considered incidental to the work required herein.

19. TRAINING

19.1. DESCRIPTION

Provide a one day, minimum of 6 hours' training covering the operation of the equipment and software being supplied as part of this project for up to 2 sessions, 10 people per session. Enlist the manufacturer's representatives or personnel approved by the Department to conduct the training course.

Include both classroom instruction and practical experience on the System operations. Provide both an introduction to the system and the theory of its operation in the training session. At a minimum, include the components of the system, central software operation, and the configuration of the central and field equipment. Provide each trainee with hands-on experience with the computer and controller system. The course should cover the operation of all software provided in this project. The course should also cover the proper operating techniques. The training shall include:

- System overview supplemented by a detailed block diagram,
- Data-flow diagram,
- Major system's components identification and operation,
- System's theory of operation,
- System administration
- Overview of major system software packages and dependencies,
- Software installation and configuration
- Hardware/software Error codes identification and interpretation
- Troubleshooting tips and procedures
- System startup and reboot
- Software/firmware update procedure
- Warranty claim procedure
- Technical support contact information for regular and after-hour business

At least 40 days prior to commencement of each training course, request and get approval on training dates from the NCSHP. Submit detailed course curriculums, draft manuals and handouts, and resumes

of the instructors. The Department will review and request modifications of that material as appropriate. Allow 20 days for review of each submittal.

Conduct all courses on weekdays at times to be specified by the Department. The Department will furnish the training facility.

Provide training material generated for each course including manuals and other handouts for each attendee that serves not only as subject guidance, but as quick reference material for future use. The course must utilize, to the greatest extent possible, the documentation described in these Project Special Provisions. Use the training courses to familiarize the students with all documentation that has been provided as part of this project. Deliver all course material, in reproducible form, to the Department immediately following course completion.

Video record each training session and deliver the DVD to the Department at the conclusion of the training.

19.2. MEASUREMENT AND PAYMENT

Training will be measured and paid for at the contract lump sum price for work detailed in this section. No measurement will be made for instructors, material, and other items required for the training as these will be considered incidental.

Payment will be made under:

Pay Item	Pay Unit
Training	Lump Sum

20. SYSTEM WARRANTY

20.1. DESCRIPTION

A. General

Unconditionally guarantee the performance of all systems and subsystems for a period of two (2) years from the successful completion of the 30-day observation period.

Provide the necessary labor, parts, materials, tools, test equipment and facilities required to address any warranty issues related to the system after it is installed.

The warranty coverage may be renewable on an annual basis for an additional four (4) years by mutual consent of both parties. Develop the cost for the renewable option through mutual agreement of both parties.

B. Scope of Warranty

Ensure the components of all systems are in good working condition and take appropriate action to remedy performance issues. Good working condition is defined under this project as equipment meeting the system specifications for acceptance, accuracy, and tolerances as defined in these Project Special Provisions.

Provide scheduled diagnosis and repair service and/or respond to repair malfunctioning equipment as outlined below:

- Complete scheduled preventative maintenance, diagnostic testing, and repairs (if needed) at six (6) month intervals. Preventative maintenance shall be completed in accordance with the equipment manufacturer's recommendations and standard practices. Provide routine checks on all major systems, system components and ancillary equipment and take any corrective action to ensure proper long-term operation.
- Check installation of grout and sealant for loops and sensors. Repair or replace as required.
- Perform visual inspection of detector housings and repair or replace as required.
- Clean the interior and exterior of the System electronics, power supplies, controllers and communications equipment in the equipment cabinet. Repair or replace as required.
- Check condition of all System cables and connectors, terminal strips, and back-up batteries. Repair or replace as required.
- Perform visual inspection of the equipment cabinet. Repair as required.
- Test and visually inspect equipment cabinet ventilation fan and filter, thermostat, light and fused switch. Repair or replace as required.
- Test and verify control and sequence of operation of interface components.
- Provide one (1) session of a System operations course one (1) month prior to the end of the warranty period. The sessions should be a minimum of 5 hours in length. Include in the refresher course a hands-on demonstration of system functionality. The Department will provide facilities for the refresher course.
- Provide emergency repair services, on an as needed basis. The response time for emergency repair service shall be as follows:
  1. 24 hours to acknowledge request
  2. 48 hours to respond to request
  3. 7 business days to repair any roadside equipment located in the equipment cabinet including any auxiliary support equipment located in either the equipment cabinet or in the Scale House and return System functionality. This excludes sensors located in the actual roadway as these items will require scheduling for lane closures and obtaining the proper equipment to replace the failed sensor. The repaired System shall function to the specifications defined in these Project Special Provisions for acceptance, accuracy, and tolerances. Document all activities performed under the warranty agreement, both preventative and emergency maintenance, in an electronic database that facilitates sorting the records by time period and/or device type.
- Submit for approval by the Department a maintenance and repair database proposal that tracks, at a minimum, the following events and information:
  1. Date and time of scheduled preventative maintenance
  2. All preventative maintenance activities completed.
  3. All parts repaired or replaced during preventative maintenance.
  4. Technician completing preventative maintenance work.
  5. Repair history for all systems and subsystems.
  6. Date and time of emergency maintenance request.
  7. Date and time of technician on site to respond to emergency maintenance request.
  8. Description of defective equipment or malfunctioning operations during emergency maintenance requests.
  9. Technician responding to emergency maintenance request.

10. Corrective actions taken during emergency maintenance request.
11. Date and time that operations restored after emergency maintenance request.
12. Model and serial number of any equipment repaired and replaced during emergency maintenance request.

Provide both electronic and hardcopy records of the updated database within ten (10) days of each maintenance activity.

Document all itemized material, equipment, and labor costs incurred to maintain the System during the warranty period. The cost records shall differentiate between preventative and emergency maintenance costs. Provide these records to the Department on a semi-annual basis within fifteen (15) days after the end of the six-month period. These records are for informational purposes only and will not be used as a basis of payments to the Contractors. Ensure that these cost records are complete and accurate. The Department may perform an audit to verify the accuracy of the cost records.

Provide software upgrades for all new software revisions completed during the warranty period at no additional cost to the Department. Identify a cutover procedure for all software upgrades, which ensures that there is no interruption of service or failure of any operation as a result of upgrading the software. Also develop a contingency plan to re-install older versions of software, by the Contractors (at no additional cost to the Department), if any operation fails or any system degradation is encountered as a result of a software upgrade.

C. Warranty Evaluation

Two (2) months prior to the end of the warranty period, the Department will inspect the system thoroughly for potential system defects with the contractor present. This inspection will be done by the Department's personnel or representative. Assist the Department's personnel or representative during this inspection. Two (2) weeks prior to the inspection, provide a summary report of all preventative and emergency maintenance records. This report shall document and certify that all components have been maintained fully in accordance with the Project Special Provisions and manufacturer recommendations and that all manufacturer warranties that extend beyond the Contractor's warranty have been in no way compromised.

Following the inspection, the Department will determine if there are any unresolved defects with equipment hardware or software. The Department will provide a punch list to the Contractors for the replacement or repair of defective components or repairs to system software. Replace or repair equipment and software identified in the punch list within thirty days of receipt of the punch list. Also replace any components whose manufacturer warranty has been voided or compromised by any action/inaction on the part of the Contractors. Document all repairs or replacements completed, providing the documentation to the Department within two (2) months of receipt of the punch list.

D. Correction of Work

Re-execute any work that fails to conform to the requirements of the Contract and that appears during the process of the work. Remedy any defects due to faulty materials or workmanship which appear within the warranty period. The provisions of this article apply to work done by subcontractors as well as direct employees of the Contractors.

E. Traffic Control

Traffic control for all maintenance activities requiring lane closures will be provided by NCDOT in accordance with NCDOT standards.

20.2. MATERIALS

All replacement materials and equipment provided under the warranty shall meet or exceed the requirements as defined in the Plans and the Project Special Provisions. If during the warranty period a part or component of a system or subsystem is no longer available to the Contractors, obtain equipment which ensures that the systems and subsystems meet or exceed the specifications and functionality as defined in these Project Special Provisions.

Provide all labor, tools, test equipment and other equipment necessary in the maintenance, repair and replacement of all components furnished under this contract during the warranty period.

20.3. CONSTRUCTION METHODS

In replacing equipment under the maintenance agreement, meet or exceed the construction requirements for each component as defined in the Plans and Project Special Provisions.

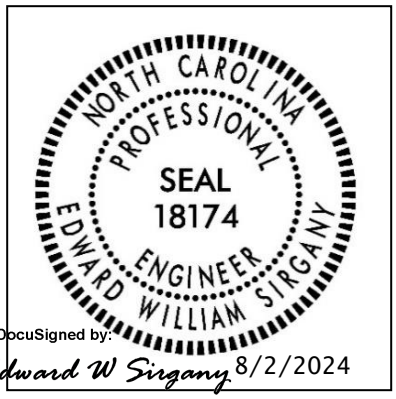
20.4. MEASUREMENT AND PAYMENT

System Warranty will be measured and paid for at the contract lump sum price for System Warranty. The System Warranty is not part of the Contract Time.

No measurement will be made for providing labor, parts, materials, shipping, vehicles, tools, test equipment, documentation and facilities as these will be considered incidental to furnishing the System Warranty.

Payment will be made under:

Pay Item	Pay Unit
System Warranty	Lump Sum



This seal is for section 21 only.

Document not considered final unless all signatures completed.

CONTRACT NO. DD00464
Signals and Intelligent Transportation Systems
Weigh-In Motion Upgrade
Project Special Provisions
(Version 24.1)

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Contents

21. METAL POLE SUPPORTS

21.1 METAL POLES

A. General

Furnish and install metal poles, grounding systems, and all necessary hardware. Work covered under this special provision includes requirements for design, fabrication, and installation of standard and custom/site-specific designed metal pole supports and associated foundations.

Comply with applicable sections of the *2024 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES*, hereinafter referred to as the *Standard Specifications.* Provide designs of completed assemblies with hardware equaling or exceeding AASHTO *LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals 1st* Edition, 2015 (hereinafter called 1st Edition AASHTO), including the latest interim specifications. Provide assemblies with a round or

near-round (18 sides or more) cross-section, or a multi-sided cross section with no less than six sides. The sides may be straight, convex, or concave.

For bid purposes, pole heights shown on plans are estimated from available data. Prior to furnishing metal poles, use field measurements and adjusted cross-sections to determine whether pole heights will meet required clearances. If pole heights do not meet required clearances, the Contractor should immediately notify the Engineer of the required revised pole heights.

Standard Drawings for Metal Poles are available that supplement these project special provisions. The drawings are located on the Department's website:

https://connect.ncdot.gov/resources/safety/pages/ITS-Design-Resources.aspx

Comply with article 1098-1(B) of the *Standard Specifications* for submittal requirements. Furnish shop drawings for approval. Provide copies of detailed shop drawings for each type of structure as summarized below. Ensure shop drawings include material specifications for each component. Ensure shop drawings identify welds by type and size on the detail drawing only, not in table format. **Do not release structures for fabrication until shop drawings have been approved by NCDOT**. Ensure shop drawings contain an itemized bill of materials for all structural components and associated connecting hardware.

Comply with article 1098-1(A) of the *Standard Specifications* for Qualified Products List (QPL) submittals. All shop drawings must include project location description, signal or asset inventory number(s) and project number or work order number.

Summary of information required for metal pole review submittal:

Item	Electronic Submittal	Comments / Special Instructions
Sealed, Approved ITS Plan/Loading Diagram	1 set	All structure design information needs to reflect the latest approved ITS plans
Custom Pole Shop Drawings	1 set	Submit drawings on 11" x 17" format media. Show NCDOT signal or asset inventory number(s), Contractor's name and relevant revision number in the title block. All drawings must have a unique drawing number for each project.
Standard Strain Pole Shop Drawings (from the QPL)	1 set	Submit drawings on 11" x 17" format media. Show NCDOT signal inventory number(s), Contractor's name and relevant revision number in the title block. All drawings must have a unique drawing number for each project.
Structure Calculations	1 set	Not required for Standard QPL Poles
Custom Foundation Drawings	1 set	Submit drawings on 11" x 17" format media. Show NCDOT signal or asset inventory number(s), Contractor's name and relevant revision number in the title block. All drawings

		must have a unique drawing number for each project. If QPL Poles are used, include the corresponding QPL pole shop drawings with this submittal.
Item	**Electronic Submittal**	**Comments / Special Instructions**
Foundation Calculations	1 set	**Submit copies of LPILE input, output, and pile tip deflection graph per Section titled Drilled Pier Foundations for Metal Poles of this specification for each foundation.** Not required for Standard Strain Poles (from the QPL)
Soil Boring Logs and Report	1 set	Report shall include a location plan and a soil classification report including soil capacity, water level, hammer efficiency, soil bearing pressure, soil density, etc. for each pole.

NOTE – All shop drawings and custom foundation design drawings must be sealed by a Professional Engineer licensed in the state of North Carolina. All geotechnical information must be sealed by either a Professional Engineer or Geologist licensed in the state of North Carolina. Include a title block and revision block on the shop drawings and foundation drawings showing the NCDOT signal or asset inventory number(s).

Shop drawings and foundation drawings may be submitted together or separately for approval. However, shop drawings must be approved before foundations can be reviewed. Foundation designs will be returned without review if the associated shop drawing has not been approved. Boring reports shall include the following: Engineer's summary, boring location maps, soil classification per AASHTO Classification System, hammer efficiency, and Metal Pole Standard Foundation Selection Form. Incomplete submittals will be returned without review. The Reviewer has the right to request additional analysis and copies of the calculations to expedite the approval process.

B. Material

Fabricate metal pole from coil or plate steel that meet the requirements of ASTM A 572 Gr 55 or ASTM A 595 Grade A tubes. For structural steel shapes, plates, and bars use, as a minimum, ASTM A572 Gr 50, AASHTO M270 Gr 50, ASTM A709 Gr 50, or an approved equivalent. Provide pole shafts of round or near round (18 sides or more) cross-section, or multi-sided tubular cross-section with no less than six sides, having a uniform linear taper of 0.14 in/ft. Construct shafts from one piece of single-ply plate or coil. For anchor base fabrication, conform to the applicable bolt pattern and orientation as shown on Metal Pole Standard Drawing Sheet M2.

Use the submerged arc process, or other NCDOT previously approved process suitable for shafts, to continuously weld pole shafts along their entire length. Finish the longitudinal seam weld flush with the outside contour of the base metal. Ensure shaft has no circumferential welds except at the lower end joining the shaft to the pole base. Use full penetration groove welds with backing ring for all tube-to-transverse-plate connections in accordance with 1st Edition AASHTO. Provide welding that

conforms to Article 1072-18 of the *Standard Specifications.* No field welding on any part of the pole will be permitted unless approved by a qualified Engineer.

After fabrication, hot-dip galvanize steel poles and all assembly components in accordance with section 1076-3 of the *Standard Specifications*. Design structural assemblies with weep holes large enough and properly located to drain molten zinc during the galvanization process. Galvanize hardware in accordance with section 1076-4 of the *Standard Specifications*. Ensure threaded material is brushed and retapped as necessary after galvanizing. Perform repair of damaged galvanizing in accordance with section 1076-7 of the Standard *Specifications. Ensure* all hardware is galvanized steel or stainless steel. The Contractor is responsible for ensuring the Designer/Fabricator specifies connecting hardware and/or materials that prevent a dissimilar metal corrosive reaction.

Ensure each anchor rod is 2-inch minimum diameter and 60-inch length. Provide 10-inch minimum thread projection at the top of the rod, and 8-inch minimum at the bottom of the rod. Use anchor rod assembly and drilled pier foundation materials complying with SP09_R005, hereinafter referred to as *Foundations and Anchor Rod Assemblies for Metal Poles*.

Ensure anchor bolt hole diameters are ¼-inch larger than the anchor bolt diameters in the base plate.

Provide a circular anchor bolt lock plate securing the anchor bolts at the embedded end with two (2) washers and two (2) nuts. Provide a base plate template matching the bolt circle diameter of the anchor bolt lock plate. Construct plates and templates from ¼-inch minimum thick steel with a minimum width of 4 inches. Hot-dip galvanizing is not required for both plates.

Provide four (4) heavy hex nuts and four (4) flat washers for each anchor bolt. For nuts, use AASHTO M291 grade 2H, DH, or DH3 or equivalent material. For flat washers, use AASHTO M293 or equivalent material. Ensure anchor bolts have required diameters, lengths, and positions, and will develop strengths comparable to their respective poles.

For each pole, provide a grounding lug with a ½-inch minimum thread diameter, coarse thread stud and nut that will accommodate #4 AWG ground wire. Ensure the lug is electrically bonded to the pole and is conveniently located inside the pole at the hand hole.

Provide a removable pole cap with stainless steel attachment screws for the top of each pole. Ensure cap is cast aluminum conforming to Aluminum Association Alloy 356.0F. Furnish cap attached to the pole with a sturdy stainless-steel chain that is long enough to permit cap to hang clear of the pole-top opening when cap is removed.

Where required by the plans, furnish couplings 42 inches above bottom of the pole base for mounting pedestrian pushbuttons. Provide mounting points consisting of 1½-inch internally threaded half-couplings complying with the NEC, mounted within the poles. Ensure that couplings are essentially flush with the outside surfaces of the poles and are installed before any required hot-dip galvanizing. Provide a threaded plug in each mounting point. Ensure the surface of the plug is essentially flush with the outer end of the mounting point when installed and has a recessed slot that will accommodate a ½ “drive standard socket wrench.

Metal poles may be erected and fully loaded after concrete has attained a minimum allowable compressive strength of 3,000 psi.

Connect poles to grounding electrodes and bond them to the electrical service grounding electrodes.

When field drilling is necessary for wire or cable entrances into the pole, comply with the following requirements:

- Do not drill holes within 2 inches of any welds.
- Do not drill any holes larger than 3 inches in diameter without checking with the ITS & Signals Structure Engineers.
- Avoid drilling multiple holes along the same cross section of tube shafts.
- Install rubber grommets in all field drilled holes that wire, or cable will directly enter unless holes are drilled for installation of weather heads or couplings.
- Treat the inside of the drilled holes and repair all galvanized surfaces in accordance with Section 1076-7 of the latest edition of the *Standard Specification prior to installing grommets, caps, or plugs.*
- Cap or plug any existing field drilled holes that are no longer used with rubber, aluminum, or stainless-steel hole plugs.

Install a ¼-inch thick plate for a concrete foundation tag to include the following information: concrete grade, depth, diameter, and reinforcement sizes of the installed foundation. Install galvanized wire mesh to cover gap between the base plate and top of foundation for debris and pest control. Refer to standard drawing M7 for further details.

Immediately notify the Engineer of any structural deficiency that becomes apparent in any assembly, or member of any assembly, because of the design requirements imposed by these specifications, the plans, or the typical drawings.

C. Design

Unless otherwise specified, design all metal pole support structures using the following 1st Edition AASHTO specifications:

- Use 700-Year MRI and 10-Year MRI wind pressure maps developed from 3-second gust speeds, as provided in Section 3.8.
- Ensure metal pole support structures include natural wind gust loading and truck-induced gust loading for fatigue design, as provided in Sections 11.7.1.2 and 11.7.1.3, respectively. Designs need not consider periodic galloping forces.
- Assume 11.2 mph natural wind gust speed in North Carolina. For natural wind fatigue stress calculations, utilize a drag coefficient (C_d) based on the yearly mean wind velocity of 11.2 mph.
- When selecting Fatigue Importance Factors, utilize Fatigue Importance Category II, as provided for in Table 11.6-1, unless otherwise specified.
- Calculate all forces using applicable equations from Section 5. The Maximum allowable force ratio for all metal pole support designs is 0.9.
- Conform to Sections 10.4.2 and 11.8 for deflection requirements. For CCTV and MVD support structures, ensure maximum deflection at top of pole does not exceed 2.0 percent of pole height.

- Assume the combined minimum weight of a messenger cable bundle (including messenger cable, signal cable and detector lead-in cables) is 1.3 lbs/ft. Assume the combined minimum diameter of the cable bundle is 1.3 inches.
- All CCTV and MVD metal poles shall meet the compact section limits per section 5.7.2 along with Table 5.7.2-1. Minimum thickness of CCTV and MVD pole shafts shall be ¼-inch.
- All CCTV and MVD poles shall use full-penetration groove weld tube-to-transverse plate connection with backing ring. Refer to Metal Pole Standard Drawing Sheet M9 for details. Fillet-welded tube-to-transverse-plate connections are not permitted.

Unless otherwise specified by special loading criteria, the following computed surface area for ice load on signal heads shall be used:

- 3-section, 12-inch, Surface area: 26.0 ft^2
- 4-section, 12-inch, Surface area: 32.0 ft^2
- 5-section, 12-inch, Surface area: 42.0 ft^2

Design a base plate for each pole. The minimum base plate thickness for all poles is determined by the following criteria:

Case 1 Circular or rectangular solid base plate with the upright pole welded to the top surface of base plate with full penetration butt weld, where no stiffeners are provided. A base plate with a small center hole, which is less than 1/3 of the upright diameter, and located concentrically with the upright pole, may be considered as a solid base plate.

The magnitude of bending moment in the base plate, induced by the anchoring force of each anchor bolt is $M = (P \times D_1) / 2$, where

M = bending moment at the critical section of the base plate induced by one (1) anchor bolt

P = anchoring force of each anchor bolt

D_1 = horizontal distance between the anchor bolt center and the outer face of the upright, or the difference between the bolt circle radius and the outside radius of the upright

Locate the critical section at the face of the anchor bolt and perpendicular to the bolt circle radius. The overlapped part of two (2) adjacent critical sections is considered ineffective.

Case 2 Circular or rectangular base plate with the upright pole socketed into and attached to the base plate with two (2) lines of fillet weld, and where no stiffeners are provided, or any base plate with a center hole that is larger in diameter than 1/3 of the upright diameter.

The magnitude of bending moment induced by the anchoring force of each anchor bolt is $M = P \times D_2$,

where P = anchoring force of each anchor bolt

D_2 = horizontal distance between the face of the upright and the face of the anchor bolt nut

Locate the critical section at the face of the anchor bolt top nut and perpendicular to the radius of the bolt circle. The overlapped part of two (2) adjacent critical sections is considered ineffective.

If the base plate thickness calculated for Case 2 is less than Case 1, use the thickness calculated for Case 1.

The following additional requirements apply concerning pole base plates.

- Ensure that whichever case governs as defined above, the anchor bolt diameter is set to match the base plate thickness. If the minimum diameter required for the anchor bolt exceeds the thickness required for the base plate, set the base plate thickness equal to the required bolt diameter.
- For all metal poles, use a full penetration groove weld with a backing ring to connect the pole upright component to the base. Refer to Metal Pole Standard Drawing Sheet M3 or M4.

The Professional Engineer is wholly responsible for the design of all poles. Review and acceptance of these designs by the Department does not relieve the said Professional Engineer of his or her responsibility.

D. Swinging Mast Arm Poles

Refer to Metal Pole Standard Drawing Sheets M2 through M5 for fabrication details and comply with all requirements of these Metal Pole Support Specifications – except as hereinafter noted.

Provide swinging mast arm assemblies.

Fabricate metal arm shaft from coil or plate steel to meet the requirements of ASTM A 595 Grade A tubes.

Provide arm shafts of round or near round (18 sides or more) cross-section, or multi-sided tubular cross-section with no less than six sides, having a uniform linear taper of

0.14 in/ft. Construct shafts from one piece of single-ply plate or coil, eliminating circumferential weld splices.

Use the submerged arc process, or other NCDOT previously approved process suitable for arm shafts, to continuously weld arm shafts along their entire length. The longitudinal seam weld shall be finished flush to the outside contour of the base metal. Ensure arm shaft has no circumferential welds except at the lower end joining the shaft to the arm flange plate. Use full penetration groove welds with backing ring for all tube-to-transverse-plate connections in accordance with 1st Edition AASHTO.

Provide welding that conforms to Article 1072-18 of the Standard Specifications, except no field welding on any part of the arm shaft will be permitted unless approved by a qualified Engineer.

After fabrication, hot-dip galvanize steel arm shafts and all assembly components per section 1076 of the Standard Specifications. Design arm shafts with weep holes large enough and properly located to drain molten zinc during the galvanization process. Provide hot-dip galvanizing on steel arm shafts that meets or exceeds ASTM Standard A-123, AASHTO M111, or an approved equivalent.

Perform repair of damaged galvanizing that complies with the following Standard Specifications article:

Repair of Galvanizing ..... Article 1076-7

Ensure metal arm shafts permit cables to be installed inside arm shafts. For holes in arm shafts used to accommodate cables, provide full-circumference grommets. Wire access holes for arm flange plates should be deburred, non-grommeted, and oversized to fit around 4-inch diameter grommeted wire access holes for shaft flange plates.

Provide a minimum of four (4) 1-1/2” diameter high strength bolts for connection between arm plate and pole plate. Increase number of bolts to a minimum of six (6) 1-1/2” diameter high strength bolts when arm lengths are greater than 50’-0” long.

Provide designs with a 6” x 12” hand hole with reinforcing frame for each pole.

Provide a terminal compartment with cover and screws in each pole encompassing the hand hole and containing a 12-terminal barrier type terminal block. Provide two (2) terminal screws with a removable shorting bar between them for each termination. Furnish terminal compartment covers attached to the pole by a sturdy chain or cable approved by the Engineer. Ensure chain or cable is long enough to permit cover to hang clear of the compartment opening when cover is removed and is strong enough to prevent vandalism. Ensure chain or cable will not interfere with service to cables in the pole base.

Have poles permanently stamped above the hand holes with the identification tag details as shown on Metal Pole Standard Drawing Sheets M2 and M4.

Provide a removable end cap with stainless steel attachment screws for the end of each mast arm. Ensure cap is cast aluminum conforming to Aluminum Association Alloy 356.0F. Furnish cap attached to arm with a sturdy chain or cable approved by the Engineer. Ensure chain or cable is long enough to permit cap to hang clear of arm end opening when cap is removed.

Provide pole flange plates and associated gussets and fittings for attachment of required mast arms. As part of each mast arm attachment, provide a cable passage hole in pole to allow passage of cables from pole to arm. Provide a grommeted 4-inch diameter cable passage hole on the shaft side of the connection to allow passage of cables from pole to arm.

Furnish all arm plates and necessary attachment hardware, including bolts and brackets. Provide two (2) extra bolts for each arm.

Provide arms with weatherproof connections for attaching to the pole shaft.

Provide hardware that is galvanized steel, stainless steel, or corrosive-resistant aluminum.

Install metal poles, hardware, and fittings as shown on the manufacturer’s installation drawings. Ensure the installed pole, when fully loaded, is within 1 degree 40 minutes (1°40') of vertical. Install poles with the manufacturer’s recommended “rake.” Where required, use threaded leveling nuts to establish rake.

Install horizontal-type arms with a manufactured rise preventing arm from deflecting below arm attachment height.

Ensure maximum angular rotation of the top of mast arm pole does not exceed 1 degree 40 minutes (1°40'). Ensure allowable mast arm deflection does not exceed that allowed per 1st Edition AASHTO. For all group load combination limit states specified under Section 3 of 1st Edition AASHTO, restrict tip of fully loaded arm from going below arm attachment point with the pole.

Design and construct the metal poles as shown on the Plans. The hinge assembly shall allow maintenance crews to swing the mast arm horizontally away from the roadway for servicing of equipment attached to the mast arm from the shoulder. A metal pole with swinging mast arm of this type can be purchased from:

Union Metal Industries Corporation
Maple Ave., NE
Canton, OH 44705
Tel: (833) 919-7653

Atlantic Technical Sales Inc 1432
14522 – K Lee Road
Chantilly, VA 20151-1639
Tel: (703) 631-6661

Millerbernd Manufacturing Company
622 6th Street So.
P.O. Box 98
Winstead, MN 55395
Tel: (320) 485-2111

E. Metal Poles

Refer to Metal Pole Standard Drawing Sheets M2, M3 and M9 for fabrication details.

Furnish hand hole covers attached to the pole by a sturdy chain or cable approved by the Engineer. Ensure chain or cable is long enough to permit cover to hang clear of the compartment opening when cover is removed and is strong enough to prevent vandalism. Ensure chain or cable will not interfere with service to cables in the pole shaft.

Have poles permanently stamped above the hand holes with the identification tag details as shown on Metal Pole Standard Drawing Sheets M2, M3 and M9.

Provide a 2-inch hole equipped with an associated coupling and weather head approximately 5 feet below top of pole to accommodate passage of cables from inside the pole to the ITS devices.

Provide a 2-inch hole equipped with an associated coupling and conduit fittings/bodies approximately 18 inches above base of pole to accommodate passage of cables from the equipment cabinet to inside of pole. Refer to Metal Pole Standard Drawing Sheet M3 for fabrication details.

Install metal poles, hardware, and fittings as shown on the manufacturer's installation drawings. Ensure the installed pole, when fully loaded, is within 0.5 degrees of vertical. Where required, use threaded leveling nuts to establish rake.

Comply with the following requirements for metal pole anchor bolts and base plates:

- Poles up to 40'-0" in height, provide a minimum of four (4) 2-inch diameter anchor bolts, and a minimum 2-inch-thick circular base plate. Provide anchor bolts of Grade 55 ksi, and base plate of Grade 50 ksi.

Obtain the Structural Engineer's approval for deviations from these requirements, prior to shop drawing(s) submission.

21.2 DRILLED PIER FOUNDATIONS FOR METAL POLES

Analysis procedures and formulas shall be based on AASHTO 1st Edition, latest ACI-318 code and the *Drilled Shafts: Construction Procedures and Design Methods* FHWA-NHI-10-016 manual. Design methods based on engineering publications or research papers must have prior approval from NCDOT. The Department reserves the right to accept or reject any method used for the analysis.

Ensure deflection at top of foundation does not exceed 1 inch for worst-case(Service Limit State) lateral load.

Use LPILE Plus V6.0 or later for lateral analysis. Submit inputs, results and corresponding graphs with the design calculations.

Calculate skin friction using the α-method for cohesive soils and the β-method for cohesion-less soils (**Broms method will not be accepted**). Detailed descriptions of the "α" and "β" methods can be found in *FHWA-NHI-10-016*.

Omit first 2.5 feet for cohesive soils when calculating skin friction.

Assume a hammer efficiency of 0.70 unless value is provided.

All metal pole drilled shafts shall be a minimum of 4'-0" diameter. Refer to Standard Drawing Nos. M7 and M8.

Design custom foundations to carry maximum capacity of each metal pole. For standard case strain poles with custom design, use actual shear, axial and moment reactions from the Standard Strain Pole Foundation Selection Table shown on Standard Drawing No. M8.

When poor soil conditions are encountered, which could create an excessively large foundation design, consideration may be given to allow an exemption to the maximum capacity design. The Contractor must gain approval from the Engineer before reducing a foundation's capacity. On projects where poor soil is known to be present, the Contractor should have foundation designs approved before releasing poles for fabrication.

Have the Contractor notify the Engineer if the proposed foundation is to be installed on a slope other than 8H: 1V or flatter.

21.2.1 Description

Furnish and install foundations for NCDOT metal poles with all necessary hardware in accordance with the plans and specifications.

Metal Pole Standards have been developed and implemented by NCDOT for use at signalized intersections in North Carolina. If the plans call for a standard strain pole, then a standard foundation may be selected from the plans. However, the Contractor is not required to use a standard foundation. If the Contractor chooses to design a non-standard site-specific foundation for a standard strain pole or if the plans call for a non-standard site-specific pole, design the foundation to conform to the applicable provisions in the NCDOT Metal Pole Standard Drawings and Section 19.2.2.4 (Non-Standard Foundation Design) below. If non-standard site-specific foundations are designed for standard QPL approved strain poles, the foundation designer must use the design moment specified by load case on Metal Pole Standard Drawing Sheet M8. Failure to conform to this requirement will be grounds for rejection of the design.

If the Contractor chooses to design a non-standard foundation for a standard strain pole and the soil test results indicate a standard foundation is feasible for the site, the Contractor will be paid the cost of the standard foundation. Any additional cost associated with a non-standard site-specific foundation including additional materials, labor and equipment will be considered incidental to the

cost of the standard foundation. All costs for the non-standard foundation design will be considered incidental to the cost of the standard foundation.

21.2.2 Soil Test and Foundation Determination

1. General

Drilled piers are reinforced concrete sections, cast-in-place against in situ, undisturbed material. Drilled piers are of straight shaft type and vertical.

2. Soil Test

Perform a soil test at each proposed metal pole location. Complete all required fill placement and excavation at each pole location to finished grade before drilling each boring. Soil tests performed that are not in compliance with this requirement may be rejected and will not be paid. Drill one boring to a depth of 26 feet within a 25-foot radius of each proposed foundation.

Perform standard penetration tests (SPT) in accordance with ASTM D 1586 at depths of 1, 2.5, 5, 7.5, 10, 15, 20 and 26 feet. Discontinue the boring if one of the following occurs:

- A total of 100 blows have been applied in any two consecutive 6-inch intervals.
- A total of 50 blows have been applied with < 3-inch penetration.

Describe each pole location along the project corridor in a manner that is easily discernible to both the Contractor's Designer and NCDOT Reviewers. If the pole is at an intersection, label the boring the "Intersection of (*Route or SR #*), *(Street Name)* and (*Route or SR #*), *(Street Name)*, _____ County, Signal or Asset Inventory No. _____". Label borings with "B- *N, S, E, W, NE, NW, SE or SW*" corresponding to the quadrant location within the intersection.

If the pole location is located between intersections, provide a coordinate location and offset, or milepost number and offset. Pole numbers should be made available to the Drill Contractor. Include pole numbers in the boring label if they are available. If they are not available, ensure the boring labels can be cross-referenced to corresponding pole numbers. For each boring, submit a legible (hand-written or typed) boring log signed and sealed by a licensed Geologist or Professional Engineer registered in North Carolina. Include on each boring the SPT blow counts and N-values at each depth, depth of the boring, hammer efficiency, depth of water table and a general description of the soil types encountered using the AASHTO Classification System.

Borings that cannot be easily correlated to their specific pole location will be returned to the Contractor for clarification; or if approved by the Engineer, the foundation may be designed using the worst-case soil condition obtained as part of this project.

3. Standard Foundation Determination

Use the following method for determining the Design N-value:

$$N_{AVG} = \frac{N_{@1'} + N_{@2.5'} + \ldots + N_{@Deepest\ Boring\ Depth}}{Total\ Number\ of\ N\ values}$$

$$Y = (N_{@1'})^2 + (N_{@2.5'})^2 + \ldots + (N_{@Deepest\ Boring\ Depth})^2$$

$$Z = N_{@1'} + N_{@2.5'} + \ldots + N_{@Deeepest\ Boring\ Depth}$$

$$N_{STD\ DEV} = \sqrt{\left(\frac{(Total\ Number\ of\ N\ values\ \times Y) - Z^2}{(Total\ Number\ of\ N\ values) \times (Total\ Number\ of\ N\ values - 1)}\right)}$$

Design N-value equals lesser of the following two conditions:

$$N_{AVG} - (N_{STD\ DEV} \times 0.45)$$

OR

$$Average\ of\ First\ Four\ (4) N\ values = \frac{N_{@1'} + N_{@2.5'} + N_{@5'} + N_{@7.5'}}{4}$$

Note: If less than four (4) N-values are obtained because of criteria listed in Section 2 above, use average of N-values collected for second condition. Do not include the N-value at the deepest boring depth for above calculations if the boring is discontinued at or before the required boring depth because of criteria listed in Section 2 above. Use N-value of zero (0) for weight of hammer or weight of rod. If N-value is greater than fifty (50), reduce N-value to fifty (50) for calculations.

If standard NCDOT strain poles are shown on the plans and the Contractor chooses to use standard foundations, determine a drilled pier length, "L," for each signal pole from the Standard Strain Pole Foundations Chart (sheet M8) based on the Design N-value and the predominant soil type. For each standard pole location, submit a completed "Metal Pole Standard Foundation Selection Form" signed by the Contractor's representative. Signature on form is for verification purposes only. Include the Design N-value calculation and resulting drilled pier length, "L," on each form.

If non-standard site-specific poles are shown on the plans, submit completed boring logs collected in accordance with Section 2 (Soil Test) along with pole loading diagrams from the plans to the Contractor-selected pole Fabricator to assist in the pole and foundation design.

If one of the following occurs, the Standard Foundations Chart shown on the plans may not be used and a non-standard foundation may be required. In such case, contact the Engineer.

- The Design N-value is less than four (4).
- The drilled pier length, "L", determined from the Standard Foundations Chart, is greater than the depth of the corresponding boring.

In the case where a standard foundation cannot be used, the Department will be responsible for the additional cost of the non-standard foundation.

Foundation designs are based on level ground around the metal pole. If the slope around the edge of the drilled pier is steeper than 8:1 (H:V) or the proposed foundation will be less than 10 feet from the top of an embankment slope, the Contractor is responsible for providing slope information to the foundation Designer and to the Engineer so it can be considered in the design.

The "Metal Pole Standard Foundation Selection Form" may be found at:

https://connect.ncdot.gov/resources/safety/Pages/ITS-Design-Resources.aspx

4. Non-Standard Foundation Design

Design non-standard foundations based upon site-specific soil test information collected in accordance with Section 2 (Soil Test). Design drilled piers for side resistance in accordance with Section 10.8 of the *2014 AASHTO LRFD Bridge Design Specifications, 7th Edition*. Use computer software LPILE version-6.0 or later manufactured by Ensoft, Inc. to analyze drilled piers. Use computer software gINT V8i or later manufactured by Bentley Systems, Inc. with the current NCDOT gINT library and data template to produce SPT boring logs. Provide a drilled pier foundation for each pole with a length and diameter resulting in horizontal lateral movement less than 1 inch at top of the pier, and horizontal rotational movement less than 1 inch at the edge of pier. Contact the Engineer for pole loading diagrams of standard poles used for non-standard foundation designs. Submit non-standard foundation designs including drawings, calculations, and soil boring logs to the Engineer for review and approval before construction.

21.2.3 Drilled Pier Construction

Construct drilled pier foundation and Install anchor rod assemblies in accordance with the *Foundations and Anchor Rod Assemblies for Metal Poles* Standard Special Provision SP09-R005 located at:

https://connect.ncdot.gov/resources/Specifications/Pages/2024-Specifications-and-Special-Provisions.aspx

21.3 POLE NUMBERING SYSTEM

Attach an identification tag to each pole shaft section as shown on Metal Pole Standard Sheet M2 "Typical Fabrication Details for All Metal Poles." For the swinging mast arm located on the I-95 NB Weigh Station ramp include ITS-0139 on the pole identification tag.

21.4 MEASUREMENT AND PAYMENT

Actual number of metal poles with swinging mast arms furnished, installed, and accepted.

Actual number of designs for metal poles with swinging mast arms furnished and accepted.

Actual number of soil tests with SPT borings drilled, furnished, and accepted.

Actual volume of concrete poured in cubic yards of drilled pier foundation furnished, installed, and accepted.

No measurement will be made for foundation designs prepared with metal pole designs, as these will be considered incidental to designing metal support structures.

Payment will be made under:

Pay Item	**Pay Unit**
Metal Pole with Swinging Mast Arm	Each
Mast Arms with Metal Pole Design	Each
Soil Test	Each
Drilled Pier Foundation	Cubic Yard