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654-3   CONSTRUCTION REQUIREMENTS

The following paragraph was revised to read as follow:

654-3.16   Traffic Counts, Adjustment and Fine Tuning

a. Before placing the new traffic signals in operation, the Contractor shall conduct traffic counts at each signal controlled intersection to obtain the necessary data for adjusting and fine tuning the system. These traffic counts shall follow the format furnished by the Authority and shall:

   1. Cover 14 hour periods from 6:00 AM and 8:00 PM on three different weekdays, a Saturday and Sunday.

   2. Be summarized by 15-minute periods.

Add the following articles:

654-3.16   Traffic Counts, Adjustment and Fine Tuning

d. The contractor shall prepare an operational analysis report that include the traffic counts, existing programmed data and new program data for adjusting and fine tuning the system. This report shall be submitted for the review by the Authority. Upon review, if the Authority concurred with the report and recommend the new program data, the contractor shall proceed with the programming of the traffic signals controller. In case that the Authority does not recommend the propose program data, the contractor, at his own cost shall prepare and summit a new operational analysis report that include a new program data, in conformance with the recommendation of the Authority.

654-3.20   LED Internally Illuminated Street Name Signs

a. The work in this Section consists of furnishing and installing Internally Illuminated Street Name Signs in accordance with the details specified in the plans and these specifications. Acceptable LED Internally Illuminated Street Name Signs include that of any manufacturer, provided such equipment meets all qualifying specifications identified herein. The proposed equipment shall have a proven record of field use in Puerto Rico or other USDOT installations for at least one (1) year of service i.e., not including prototype field trials prior to installation.

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b. Use internally illuminated street name sign assemblies and associated mounting hardware meeting the requirements described in this specifications. Ensure all internally illuminated street name signs are marked with a permanently affixed ID plate or stamp, bearing the name or trademark of the manufacturer and the part number. In addition, ensure that the markings are visible after installation. Replace any component which the Engineer determines is damaged beyond repair at no additional cost to the Authority. Refer to specification 654-2.05 Warranties and Guarantees.

c. Free-swinging, internally illuminated signs and clamp-on cantilever arms mounted on the upright poles of mast arm assemblies or monotube signal structures may be accepted by certification and by shop drawings submittal and approval as stipulated in this section. For acceptance and approval of signs by Certification and by Shop Drawing Submittal, the requirements stipulated in this section shall be met.

d. The light source for the sign shall be LEDs (light emitting diodes). LEDs shall be mounted along both the top and bottom edges of the sign. The LEDs shall evenly illuminate a light panel that is the same dimensions of the sign face. The LEDs shall have a minimum projected life of 50,000 hours. A maximum of four LEDs per square foot shall be used.

e. The entire surface of the sign panel must be evenly illuminated with a minimum average brightness reading at the letters of 300 lux and a variation of no more than 40% for any reading from the average (minimum of 10 readings). Each background reading measured must not vary by more than 40% (minimum of 10 readings) from the average of the background brightness readings. The light transmission factor of the sign panel must provide a letter to background ratio of a minimum of 4:1.

f. The outer dimensions of the sign assembly shall be standard nominal heights of 15, 18, 20, 22, 24 inches, and standard nominal widths of 4, 5, 6, 7, or 8 feet.

    1. The maximum thickness of the sign shall be 1.60 inches

    2. The maximum weight shall not exceed:

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4' x 18": 44 lbs

6' x 18": 57 lbs

8' x 18": 72 lbs

4' x 24": 53 lbs

6' x 24": 71 lbs

8' x 24": 88 lbs

3. The long edges of the sign shall be made from a single section of 6000 series aluminum extrusion. The ends caps shall be affixed to the frame with stainless steel screws. The power supply shall be mounted internally in one of the end caps. The non-electrical end cap shall be removable to enable replacing panels and components.

4. The sign shall have a front panel that is UV, weather, abrasion and impact resistant.   The front panel shall be replaceable so that maintaining agencies have the option to supply their own sheeting and electrocut film for the sign faces.

g. The sign shall be designed and constructed to withstand 178 Km/h (110 mph) wind loads in conformance with the requirements of the AASHTO publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaries and Traffic Signals", 4th Edition 2001. A representative sample of the product shall be tested in accordance with the Standards for Electric Signs (UL 48).

h. The sign and power supply should be able to withstand and operate at temperature extremes of -22 deg F to +140 deg F.

i. Signs shall be tested and certified for the following environmental conditions:

1. Exclusion of Water Test

2. Strain Relief Test

3. Temperature Test

4. Dielectric Voltage-Withstand Test

j. Signs must rigid mount directly to the signal mast arm or to a sign mast arm with no moving parts.   Sign bracket must be able to be leveled to

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accommodate mast arms that are slightly off level. Sign bracket hardware must mount to Pelco Astro-Bracket AS-3009 or equivalent.

k. Secure the brackets to the street name sign housing in accordance with the manufacturer's instructions.

1. Single Sided Sign Assembly: Install as specified in the Contract Documents.

2. Double Sided Sign Assembly: Use a free swinging mounting method.

3. Two Point Support Assembly: Use a two point support assembly when the street name sign assembly is attached to a mast arm that is perpendicular to the street on which the sign is viewed. Use a two point mast arm mounting assembly consisting of the following.

    i.   Stainless steel band or cable type clamp
    ii. Clevis
    iii. Span wire adapter
    iv. Tri-stud hanger body (Ensure one of the hangers has a mechanism for the horizontal adjustment of the sign.)

4. One Point Support Assembly: Use a one point support assembly consisting of an articulated horizontal stainless steel band or cable type mast arm clamp, sign bracket and mounting hardware, when the street name sign assembly is attached to a mast arm that is diagonal to the street on which the sign is viewed. Do not use a one point support assembly for internally illuminated street name sign assemblies exceeding 4 feet [1.22 m] in width. Ensure the band or cable clamp is capable of horizontal rotation of 360 degrees.

5. Clamp-On Cantilever Arm: Attach the arm perpendicular to the street on which the street name sign assembly is viewed. Use a clamp and arm that are galvanized in accordance with ASTM A 123 [ASTM A 123M] unless otherwise specified in the Contract Documents. Ensure the arm has a cap secured in place. Use only clamp-on cantilever arms which meet all design and wind loading requirements as specified in the Contract Documents. Ensure the clamp is adjustable to accommodate various size poles.

l. The overall power requirement shall not exceed 4 Watts per square foot. Sign shall be UL listed and approved to UL 48 Standards. The outside of the sign shall be marked with the UL mark.

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   m. Electrical Wiring

      1. Install dedicated 14 A WG conductors to supply power to the sign.

      2. Connect the conductors to a dedicated 15 amp circuit breaker located either inside the controller cabinet or inside the electrical service disconnect. Using the same conduit system for both signal cables and internally illuminated sign conductors is permitted, unless otherwise specified.

      3. Install conductors in such a manner as to prevent damage to conductors or conductor insulation. Remove and replace all damaged conductors insulation at no additional cost to the Authority. Ensure drilled hole(s) through which conductor(s) pass through are fitted with a tight fitting rubber grommet.

      4. Install continuous lengths of conductors between the dedicated circuit breaker and internally illuminated street name signs. Do not splice conductors unless specified in the Contract Documents.

      5. Provide one photoelectric cell to turn on/off all internally illuminated street name sign at each intersection. Use an 'L' bracket to mount the photoelectric cell as specified in the Contract Documents.

      6. Connect the photoelectric cell to a contactor assembly inside the controller cabinet to provide switching of the internally illuminated street name signs.

654-3.21   **Wireless Communication Systems**

   a. The Contractor shall provide a wireless communication system that interconnects the traffic signal systems specified on the plans. The wireless system shall provide connectivity for local-to-local, local-to-master, local-to-center, and master-to-center. In addition, the system shall provide the means to communicate all devices including as part of the project (traffic controller, video detection cameras, surveillance cameras, microwave radar vehicle detection system and others).

   b. Provide wireless communication systems for traffic signal systems that are capable of providing Serial and Ethernet communication for interconnection between traffic signal controllers at intersections and the traffic control center. The Authority is interested in using radio links in place of other media to

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control the timings of traffic signals, and to gather data from traffic signals equipment.

c. Acceptable systems

1. Radio transceivers include that of any manufacturer, provided such equipment meets all qualifying specifications identified herein. The proposed equipment shall have a proven record of field use in Puerto Rico or other USDOT installations for at least one (1) year of service i.e., not including prototype field trials prior to installation. The complete wireless communication system consists of all hardware and software required to provide a complete operational system as specified, and as shown on the plans. The system shall include the following, but not be limited to: radio transceivers, access points, antennas, repeaters, network devices, surge suppressors to protect from lightning, power surges and router, network management software, and all other equipment necessary for operation. Refer to specification 654-2.05 Warranties and Guarantees.

2. Radio transceiver shall provide the following configuration:

    i.   Access point/Remote Dual Gateway
    ii. Remote Dual Gateway (both serial and Ethernet connections)

3. All items and materials furnished shall be new, unused, current production models installed and operational in a user environment and shall be items currently in distribution.

4. Communications equipment shall comply with Federal Communications Commission (FCC), Industry Canada (IC), and Underwriter Laboratories (UL) standards.

5. Acceptable wireless communication systems shall allow integration with the Authority's approved traffic signal control equipment. Using standard industrial grade equipment, the system shall be able to provide wireless connectivity for local-to-local, local-to-master, local-to-center, and master-to-center communications. The system shall allow communications through dedicated Serial and Ethernet connections.

d. The analysis of range, path, line-of-site, reception capability, and covertures of the wireless communication including all necessary hardware and devices

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(poles, battery backups, solar powered systems, etc) shall be a subsidiary obligation under the item of wireless communication systems.

e. Any equipment and associate hardware installed on poles exceeding forty (40) feet height shall be provided with a lowering mechanism system to facilitate maintenance.

f. Bandwidth Requirements – unless a higher value is specified in contract documents, provide a wireless communication system that can deliver over the air throughput of twenty five (25) megabits minimum of video and data from the traffic signal system, simultaneously, consistently, and reliably.

g. The contractor shall provide a frequency spectrum analysis for the wireless band selected, to guaranty low or no interference and minimize latency problems.

h. The wireless communication system shall:

1. Use broadband quality Frequency technology for licensed and non-licensed operation for frequencies in the 4.9 GHz or 5.8 GHz Band.

2. Wireless communication shall be attainable up to 30 miles range and from 25Mbps data rate for IP/Ethernet communications.

3. Include a new communication panel or equipment as per the latest revision for this type of hardware that communicates all traffic cabinet information and data to the Traffic Management Center via wireless radio.

4. Include all necessary software for operation under the new traffic management software that will replace the existing system for a centralized traffic management information system.

5. Provide a communications platform to receive and deliver all existing NTCIP protocols, and shall provide RS-232 serial communication ports and RJ-45 Ethernet port. In addition, the system shall be open for future upgrades to receive and deliver all NTCIP future applications.

6. Provide data encryption and multiple MAC Layer security mechanisms to prevent eavesdropping and unauthorized access.

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      7. When deemed necessary provide an integrated Serial Gateway to allow migration to IP from existing serial networks.

      8. When requested, allow wireless communication of video and Voice over IP (VoIP).

      9. All radio equipment shall have built-in remote management capabilities (WEB server or TELNET) to allow the Authority to remotely monitor and diagnose the RF condition of each transceiver on the system.

i.   The router shall have:

      1. Dual ports (minimum) 10/100 MBps to interconnect two IP networks.

      2. Firewall and ACI characteristics.

      3. Remote access via Telnet and CLI.

      4. SNMD support

      5. DHCP relay agent support (IP helper_Address)

      6. Statics routing support.

      7. OSPF/RIP2 support (minimum).

      8. Remote traffic monitoring capability.

      9. Rack mountable.

      10. Internal and external flash memory.

654-3.22   Video Image Detection Systems (VIDS)

a.   These technical specifications describe the minimum physical and functional properties of a video image detection system. The intent of the following specification is to describe the minimum requirements for providing a complete video image detection system (VIDS). At selected intersections, the system shall emulate loops (with selectable dimensions) to detect the presence of vehicles in user-defined zones in the areas outlined in the plans. The video image detection system shall be expandable without removing or replacing existing traffic detection systems. In addition, the system shall:

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1. Facilitate detector programming using a standard video lcd flat screen color monitor and keypad or mouse plugged into an usb port.

2. Store at least two (3) detector configurations and it shall be possible to switch between detector configurations manually or automatically by time of day.

3. Include an internal clock.

4. Delay or extend a detector zone output in combination with an input from the controller.

5. Detect wrong-way drivers and provide an alarm or event via communication board and output.

6. Provide an alarm and output when the user selected queue detection threshold of occupancy is exceeded for more than a user selected time threshold.

7. Distinguish three classes of detected vehicles based upon user selectable vehicle length thresholds.

b. Acceptable systems include that of any manufacturer, provided such equipment meets all qualifying specifications identified herein. The proposed equipment shall have a proven record of field use in Puerto Rico or other USDOT installations for at least one (1) year of service i.e., not including prototype field trials prior to installation. Using standard camera optics and in the absence of occlusion, the system shall be able to detect vehicle presence with 98 percent accuracy under normal conditions (days and nights) and 96 percent accuracy under adverse conditions. The system shall be able to detect vehicles with 98 percent volume accuracy and 95 percent speed (averaged over 20 vehicles) accuracy.

c. The video image detection system shall consist of video cameras inside pressurized environmentally protected enclosures, and mounting hardware assemblies for installation on poles, mast arms, or other structures as shown on the plans. The system includes necessary video image processors, extension modules, communications modules, cables, connectors, and wiring to traffic signal control systems. The video image processors plug directly to a TS-2/NTCIP, compatible with existing standard loop detector rack mount without any adapter. The system receives NTSC composite video 1 Volt P-P, 75 ohms of matching impedance, plugged using BNC connectors with circular

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crimping and RG-6, 100 percent reflective coaxial cable. Refer to specification 654-2.05 Warranties and Guarantees.

d. Video cameras shall be housed in environmentally sealed enclosures, waterproof and dust tight to NEMA standards. The enclosures shall be pressurized to prevent condensation and assure proper lens operation. In addition, housings shall include an adjustable sun shield with provision to divert water from the sensor field of view. The assembly shall have water tight connections for power, control, and video signal cable.

e. The video image detection system shall include hardware and software for set up and designing the necessary detection patterns or zones at the intersection or approach. The detection zones shall be created with a keypad or mouse, designed to allow a user to configure and calibrate a lane in less than fifteen (15) minutes. The system shall be capable of 99 virtual detection zones for presence or pulse operation, count, speed, and incident vehicle detection. The system receives and process a video signal generated by a video detection camera located on the traffic signal arm, its own pole, or other structure. The zone shall flash or change color on a viewing monitor whenever a vehicle is detected.

f. Each system shall include the means that allow the user to switch to any video detector signal at an intersection, and to look at four(4) cameras at the same time in a single screen. The system is to allow independent viewing of any scene while video recording any other scene without interfering with the operation of the system outputs. Switching video detectors shall not require the user to physically move the video wires or connectors to view multiple cameras. The system shall allow testing the video image detection system's performance as well as the video scenes and operation of the system from a remote location.

g. The system shall support a minimum of two separate detection patterns or zone arrangements defined by the user that can be automatically enacted by timed schedule from the traffic controller or by a remote operator over a network connection. To facilitate "fine tuning" of detection zones a minimum of 4 lines and maximum of 20 lines a may be adjusted within the confines of the detector. The system shall detect low-visibility conditions including heavy rain, fog, and inclement weather and respond by placing selected detection zones into a constant call mode when a video image quality factor falls below user-definable thresholds, for a defined time. Video image detection system outputs shall assume a fail-safe "ON" or "CALL" for presence detection in the event of loss of video signal or power failure and recover from a power failure by restoring normal operation within three (3)

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minutes without manual intervention. The system shall maintain the configuration and calibration information in memory while powered off for at least 90 days.

h. The system shall detect the presence of vehicles at the limit line and loop positions shown on the plans and provide corresponding video image detection system contact outputs. The system shall detect vehicle presence at the limit line with 98 percent accuracy for each approach over each one hour test period. The system shall not miss the detecting of more than 3 percent of the vehicles present and not indicate more than 5 percent false vehicle readings for any traffic movement. Detected vehicle presence shall be indicated in 0.25 seconds or less of occurrence and the video image detection system shall hold presence for vehicles stopped in a detection zone for up to 255 seconds.

i. The number of optically isolated detection outputs shall equal to the detection loops shown on the plans plus at least one spare output for every approach. Detectors may be linked to 24 outputs and 20 inputs using Boolean Logic features: AND, OR, NOT. It will be possible to generate conditional outputs based upon inputs from a controller in combination with the detector states. Output response time shall be less than 0.5 milliseconds after activation of the detector. It shall be possible to make a detector directional sensitive. Options will include an omni-directional detector or a detector that only senses movement: from right to left, left to right, up to down or down to up as you look at the monitor.

j. The system shall have communication ports that supports sensor unit setup including detector programming, diagnostics, and operation from a local Windows PC compatible laptop and from a remote location with a desktop computer using the monitoring system software and shall provide the means for data communications. The system shall compress the video images on a MPEG-4 format or higher for transmission to a remote location.

k. Associated software may be used with a PC to download data and export to a spreadsheet. Software will also be used to upload and download detector configurations, traffic data, technical events, send software versions upgrades and do remote setup of detectors. Have an optional password implementation. Different user-levels shall be available each having different rights. A minimum of 10 users can be defined for each user-level.

l. When called for in the plans queue length detector thresholds can be programmed to generate an output when the queue length is exceeded. The system shall delay and extend an alarm when the user selected queue length

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threshold is exceeded for maximum up to 10 seconds. When called for in the plans, traffic data collection shall include:

1. Volume (absolute numbers) per length class and per lane

2. Average speed (km/h or mph) per length class and per lane

3. Average gap time (1/10 sec) per length class and per lane

4. Average headway (m or feet) per lane

5. Occupancy (percent) per lane

6. Concentration (vehicles/km or mile) per lane

7. Average length (m or feet) per lane

8. Confidence level (0-10) per Lane

m. The system shall be capable of displaying detectors on the video image with associated outputs. Status of Outputs and Inputs will be indicated on the screen. Selectable overlay items will also include the ability to view raw video without any verbiage and detectors.

n. The system's front panel shall have indications for power, communication, and presence of video input for each video sensor as well as the real time detector output operation. A test switch shall be provided to allow the user to place either a constant or momentary call for each detector card. Provisions shall be made in software to allow the user to place either a constant or momentary call for each detector card or approach. The indications shall be visible in daylight from 1.5 meters away.

o. All detectors and parameters can be changed without interrupting detection. For example: when one detector is modified all existing detectors continue to operate, including the one that is being modified. When the new position is confirmed, the new detector will enter a learning phase. Once the new detector is in function it will take over the job of the old one. In this way, the detector is always fully operational with no interruption on any detector, even during modification. Learning phases for new detectors shall not exceed 6 minutes.

p. Six (6) detectors per camera may be used as queue length detectors. These detectors will detect and store data at user-defined intervals of 1, 2, 3, 5, 6, 10,

15, 30 and 60 minutes. Eight (8) data detection zones per camera on a VIP board may be used for collection of vehicle count, speed, classification, occupancy, density, headway, and gap time. These detectors will detect and store traffic data at user-defined intervals of 1, 2, 3, 5, 6, 10, 15, 30 and 60 minutes. Detectors available shall be presence, queue length, delay, extension, or pulse mode of either arrival or departure of vehicles. Delay and extension shall be defined between 0.1 and 99.9 seconds and pulse mode between 0 and 200 milliseconds in 33 milliseconds increments.

q. The acceptable system for video detection system shall comply with the following features: easy link connectivity for IP addressable broadband communications, web server interface for easy setup, streaming digital mpeg-4 video output, user definable password protection vehicle detection, traffic data measurement, speed, and incident detection, integrated color camera, zoom lens, and dual core processor for advanced image processing, direct real time iris and shutter speed control, fail safe detector outputs, non volatile memory data storage, high energy transient protection, technologically advanced faceplate heater and clear vision faceplate coating.

r. The detector module shall have the following features: compatible with TS-2 cabinets, rack mounted, supports up to 8 devices, easy link ip addressable connectivity, self diagnostics on power up, high energy transient protection, 14 MB/sec rated transceivers sufficient to transmit traffic data, alarms and mpeg-4 video simultaneously.

s. The Contractor shall furnish and install the programming devices and software required to provide a complete operational Video Image Detection System as specified and as shown on plans.

654-3.23   Computers

a. The proposed desktop or Laptop computer shall be including all the required software in the use of the video detection system and wireless communication system. The desktop or Laptop computer shall have the specifications indicated on plans.

654-3.24   Malfunction Management Unit

a. The malfunction management units shall comply with the following features: liquid crystal displays (lcd) show full intersection status with an active red, yellow, green and walk indicator for each channel. Event log, providing time, date, and event type, plus a replay of the screens prior to any fault. Records

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high and low voltage conditions. NEMA 16 channels. Dedicated reset button for simplicity.

654-3.25   9-port Ethernet switch device

a.   9-port Ethernet switch device for traffic signal controllers shall have the following features: designed to operate reliably in electrically harsh and climatically demanding environments, advanced networking features for create Ethernet networks, mission critical, real time and control applications, up to 9 ports: 6 base 10/100 base ports, long haul optics that allow large distances, single mode optical transceiver, industry standard fiber optical connectors: lc, sc, st, mtrj, multi level user passwords, immunity to emi and heavy electrical surges, simple plug and play operation, remote monitoring, rich set of diagnostics with logging and alarm sand fully integrated power supply.

654-3.26   Site Survey Kit for Wireless Communication

a. The wireless site survey kit shall provide a simple and accurate method of determining exact radio path signal strength values. The kit shall be battery operated and potable. The kit shall have the following features: simple and effective design tool, accurate radio path determination, 900 MHz and 2.4 GHz systems, quick and simple installation, 20 mile range, battery operated weather proof pelican case. The equipment shall obtain the following results: return signal strength indication, fade margin, data integrity test and spectrum scan. Also shall have remote management and programming. The site survey kit shall includes: mounting hardware, ac charger, dc charging cable, software, host radio, remote radio, antenna masts, rf coaxial cable, 2 yagi antennas and 1 Omni antenna.

654-3.27   Microwave Vehicle Detection, Data Collection and Translation System

a. These technical specifications describe the minimum physical and functional properties of a microwave vehicle detection, data collection and translation system. The intent of the following specification is to describe the minimum requirements for providing complete microwave vehicle detection, data collection and translation system. At selected locations, the system shall be able to detect the presence of vehicles at the locations specified in the plans. The microwave vehicle detection system shall be expandable without removing or replacing existing traffic detection systems. In addition, the system shall:

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1. Provide an alert to the Traffic Management Center, to mobile devices or to any type of traffic monitoring equipment determined by the Authority, when per lane vehicle speeds, lane occupancy and traffic volume exceeds the maximum or minimum parameters established.

2. Present information to the public about traffic conditions via internet websites, mobile devices, highway advisory radio, variable message signs and any other type of traffic conditions reporting devices.

3. Classify vehicles based on the Puerto Rico Highway and Transportation vehicle classification system.

4. Collect and store the specified traffic data using the microwave radar vehicle detection sensor (MRVDS) in a non-volatile internal memory from a minimum of 9000 interval data packets with the maximum number of lanes and approaches configured and all interval fields enabled. The MRVDS shall timestamp interval data using a real-time clock that maintains accurate time even when power is disconnected from the sensor for extended periods of time.

5. Display the status of the road network traffic conditions in computer terminals located in the Traffic Management Center, the Authority Regional Offices and any other type of facilities determined by the Authority.

6. Provide and present reports and graphics about volume counts, average speeds and vehicle classifications at the desired time intervals, including but not limited to hourly, daily, weekly, monthly, quarterly and yearly intervals.

7. Provide actual traffic conditions using a color coded map and display it in the Traffic Management Center Workstations, GPS enabled devices, mobile devices and Internet websites.

8. Collect the traffic data using specified data collection time intervals and transmit the data using specified data transmission intervals, including but not limited to 30 seconds, 1 minute, 30 minutes, 1 hour, daily, weekly and monthly time intervals.

9. Integrate, monitor and present information of different manufacturers and types of traffic data monitoring and reporting devices (microwave radar vehicle detection sensors, preformed loops, video detection

systems, surveillance cameras, variable message sings, highway advisory radio, etc.).

10. The field devices shall collect and transmit data wirelessly using solar power and in case of main source power failure it shall provide uninterrupted operation using battery stored power for a minimum of seven (7) days.

11. The field devices shall transmit the collected data and system configurations using the Puerto Rico Highway and Transportation Authority wireless communication system.

b. Acceptable systems include that of any manufacturer, provided such equipment meets all qualifying specifications identified herein. The proposed equipment shall have a proven record of field use in Puerto Rico or other USDOT installations for at least one (1) year of service i.e., not including prototype field trials prior to installation.

c. The contractor is responsible for the installation of the different components of the system (field-based and TMC-based equipment) and for providing full operational capabilities of all the features described in this specification.

d. The contractor is responsible for providing tamper-proof, waterproof, all-weather resistant and anti-vandalism field equipment.

e. Microwave Radar Vehicle Detection System

1. The microwave vehicle detection system (MRVDS) shall consist of microwave radar vehicle detection sensor inside an environmentally protected enclosure and mounting hardware assemblies for installation on poles or other structures as shown on the plans. The system shall include the necessary, lightning surge protection modules, wireless radio communications modules, electrical connections terminal block, solar power controller cables, connectors, solar panels and mounting hardware assemblies for installation of the solar panels on poles or other structures as specified on the plans, gel batteries, cabinets to house the communication modules, electrical modules and gel batteries, and the mounting hardware assemblies for installation of the cabinets on poles or other structures as specified on the plans.

2. The microwave radar vehicle detection sensor traffic data collection shall include, but not limit to:

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    a. Volume (absolute number) per length class per lane.

    b. Average speed (mph and kph) per length class per lane.

    c. Occupancy (percent) per lane.

    d. Classification (absolute number) per lane.

    e. Average headway (meters and feet) per lane.

    f. Average gap (1/10 sec) per length class per lane.

    g. 85th percentile speed (mph and kph).

    h. Speed bins counts (absolute number) per bin.

    i. Direction counts (absolute numbers) per direction.

3. The MRVDS shall detect and report information from up to 10 lanes with boundaries as close as 6 ft. from the base of the pole on which is mounted and in lanes located with a far boundary at 250 ft from the base of the pole on which is mounted. It shall be able to simultaneously detect and report information from equally, gore and unequally sized or spaced lanes locate from the minimum offset and from a lane located at the maximum range.

4. The volume accuracy data shall be within 5% of truth for any direction of travel during nominal conditions. Individual lane volume data shall be within 10% of truth during nominal condition. The percentage of missed detection and the percentage of false detections for each lane shall not exceed 15% during nominal conditions. Nominal conditions exist when average speeds are greater than 10 mph in every lane; when there is less than 20% truck traffic per lane; and when at least 50 cars per lane are counted in the interval.

5. The average speed data shall be accurate to within 3 mph for any direction of travel when there are more than five cars per lane in an interval. Average speed data for any individual lane shall be accurate to 3 mph when there are more than five cars per lane in an interval. The microwave radar vehicle detection sensor (MRVDS) shall provide per-vehicle speed measurement on 95% of vehicles that are not occluded by other vehicle or by barriers. The MRVDS shall provide

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per-vehicle speed measurements in which 90% of the measurements are within 5 mph.

6. Occupancy data shall be within 10% of truth for any direction of travel on a roadway during nominal conditions. Nominal conditions exist when true occupancy is less than 30% without merging traffic; when average speeds are greater than 10 mph in every lane; and when there is less than 20% truck traffic per lane.

7. The MRVDS shall correctly determine classification for 80% of detected vehicles when the classification bins are at least 10 ft wide and occupancy of all the lanes is below 30%.

8. The microwave radar sensor shall be housed in environmentally sealed enclosure, watertight and dust tight to NEMA 250 standards. It shall be able to withstand a drop of 5 ft. without compromising its functional and structural integrity. The enclosure shall include a connector that provides contacts for all data and power connections.

9. The MRVDS shall operate using solar power and have battery stored power to operate during a period of seven (7) days during low light conditions.

10. The MRVDS shall have a TS-485 port and a RS-232 port, and both ports shall communicate independently and simultaneously. The RS-232 port shall be full duplex and shall support RTS/CTS hardware handshaking for interfacing with various communication devices. The communication ports shall be support setup, diagnostics, and operation from a local Windows PC compatible laptop or from a remote location with a desktop computer and the means for data communications. The MRVDS shall be able to support the upload of new firmware into the MRVDS's non-volatile memory over either communication port.

11. The MRVDS shall be able to automatically define traffic lanes or detection zones without requiring user intervention. This auto-configuration process shall be executed on an internal processor of the MRVDS and shall not require an external PC or other processor. It shall define traffic lanes or detection zones by detecting the relative position of vehicles within the MRVDS field of view. Any authorized user shall also be able configure the MRVDS manually.

12. The MRVDS shall maintain accurate performance in all weather conditions, including but not limited to, rain, wind, dust, fog, changes

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in temperature and light, including direct sunlight at dawn and dusk. It should operate at a temperature range from -40°F and 165°F.

13. The MRVDS shall transmit the collected data to a PRHTA designated center, using a wireless communication network.

14. The MRVDS equipment and devices shall be guaranteed against defective parts and workmanship under manufacturers guarantees. The warranties shall be in accordance with customary trade practice but shall be for a period not less than one year from the date of initial start-up and placing in operation at the projects site, and shall cover the full costs of materials necessary to repair or replace the defective component.

15. Prior to system acceptance,

16. The Contractor shall guarantee the satisfactory installation and in-service operation of all the MRVDS components and the contractor shall perform a testing and validation session, in which the performance of the microwave vehicle detection devices shall be benchmarked against the data accuracy requirements established in this specification. Failure to meet the established accuracy requirements can result in penalties or equipment rejection. related components for a period of six months following the acceptance of the project by the Authority. During the warranty period the Contractor shall repair or replace , at no expense to the Authority, any equipment, materials or work that does not provide satisfactory operation due to equipment, materials and/or installation deficiencies.

17. Any items repaired or replaced within the above guarantee periods shall be guaranteed for an additional period, meeting the requirements specified above, from the date of acceptance of the repaired or replaced items by the Authority.

18. The Contractor shall deliver to the Engineer, prior to the acceptance of the project, the manufacturers and his warranties and guarantees required above.

f. Traffic Data Collection and Monitoring System

1. The traffic data collection system (TDCMS) shall be a server based data collection system. It shall be an off-the-shelf ATMS appliance that streamlines the collection, management, and dissemination of

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traffic detector data. The TDCS shall collect real-time data from traffic detectors and store this data in a SQL database. The distribution of this data shall be achieved using standard open XML Center-to-Center data sharing messages and direct access to the database.

2. The TDCMS shall collect data from a minimum of 25 vehicle detection devices (VDD) using a 30 second interval or greater. The data collection operation shall ensure that all the available data is retrieved in case of communication failure, unless the data collection operation is manually turned off. It shall provide a detailed history of at least the last 100 communication attempts.

3. The TDCMS shall allow the user to stop and start data collection from any of the VDD and maintain separate configurations for each individual VDD, including but not limited to collection frequency and time zone. It shall allow user to quickly run commands or change settings by performing batch jobs on selected sensors.

4. The TDCMS shall store real time data in a SQL database for a minimum of seven (7) days. The data collected shall include volume, occupancy, classification, speed, 85th percentile speed, gap, headway, speed bins, directions bins, and other common fields for each lane for each interval. The database shall contain flow direction information for each lane and collection frequency for each VDD. The data schema shall be open and available upon request.

5. The TDCMS shall provide an automated timer system that retrieves the configuration information from any and all VDD units assigned to the TDSC. The timer shall run the configuration retrieval process automatically in user defined time periods from (one) 1 to (twenty four) 24 hours without requiring user inputs. All changes shall be updated in the database automatically. The TDCMS shall also provide a method by which the user can at any time request an updated configuration from the VDD unit regardless of the current time remaining on the automated timer.

6. The TDCMS shall provide an automated timer system, which synchronizes the time of any and all VDD units assigned to the TDCMS with the TDCMS server time. The timer shall run synchronization tasks automatically in user defined time periods from one (1) to twenty four (24) hours without requiring user input. The system shall also include an option to detect incorrect times and automatically synchronize VDD clocks as needed. The TDCMS shall

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also provide a method by which the user can at any time run a time synchronization job with one or more VDD units manually regardless of the current time remaining on the automatic timer. It shall also provide a method for a user to request and display the current time of any and all VDD units attached to the TDCMS.

7. The TDCMS shall graph any data field for a sensor and create reports in XML, text, or SSM HD format. It shall have the capability to create validation reports, which provide quick verification that all data have been stored in the database. It shall allow users to view data in table form that can be customized and the saved in Excel, XML, or a text format.

8. The TDCMS shall export traffic data in intervals of including but not limited to 30 seconds, 1 minute, hourly, daily, weekly and monthly in the following formats: tab-delimited text, XML and XML format in compliance with the TMDD Traffic Detector specification.

9. The TDCMS shall communicate over standard TCP/IP based networks for the broadest amount of network compatibility. It shall also support the following forms of communication: serial communication by communicating via serial to TCP/IP converter, addressing a VDD by either IP address or host name, communication over phone line via modem to VDD. The TDCMS shall collect data from multiple VDD units communicating on a single serial communication channel.

10. The TDCMS shall provide a Web-based interface accessible through a local Web browser, which will list the VDD units currently attached to the TDCMS as well as their current status and configuration, snapshot of recent data packets, list the number of monitors in the system, with run time and status, and a list of recent alerts with their severity level from 1 to 100. The Web interface will also allow the user to view queries, perform manual operations such as time synchronization, configuration updates, or buffer clears, set timers for automated tasks, add or subtract new VDD units to and from the TDCMS, run a monitor manually at any time, add new monitors with parameters and schedules, modify or delete existing monitors, stop or pause existing monitors from continuing to monitor, adjust user subscriptions for alerts, and configure and view reports of system alerts and view a journal of recent actions performed by all users. It shall also be accessed by a user name/password combination, allowing user with varying levels of privileges to access some or all the functionality of the TDCMS and will also allow users to be added or subtracted from the system, or modified to have different permissions. The Web interface shall also allow VDD units to be arranged into groups, which

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can be assigned by user, allowing users to access only a subset of the total number of VDD units assigned to the TDCS.

11. The TDCMS shall provide allow drivers to be added for any manufacturer VDD unit protocols without having to reinstall or recompile the software elements of the TDCMS. The TDCMS shall auto-detect the presence of new drivers and make the available for use without rebooting the machine or interrupting the current collection processes.

12. The TDCMS shall be able to streamline monitoring, management, and dissemination of notifications regarding the current status of traffic data and equipment. It shall monitor real-time data from advanced traffic detectors stored in a relational database. The distribution of notifications shall be achieved using standard email, SMS and through a desktop information client application.

13. The TDCMS shall check data for values (speed, volume, occupancy, vehicle class) above and/or below user-defined thresholds and compare the data values with historical data, looking for values beyond a user-defined percentage difference. It shall check for traffic incidents based on difference of current data values with previous, adjacent, or expected data values. The TDCMS shall enable user to define specific parameters and check for missing data, based on either percentage missing over a period of time, or contiguous missing time intervals. It shall check routes for route congestion based on data thresholds on adjacent sensors, using user-defined parameters. The TDCMS shall enable users to stop or pause monitoring and support an unlimited number of alerts.

14. The TDCMS shall support the creation of custom reports based on one or more monitors, be capable of running reports automatically on a user-defined schedule, enable users to configure reports to cover a user-defined amount of time ranging from one (1) hour to one (1) month, enable users to run reports manually through web interface at any time, and store current and previous reports and make them accessible through the web at any time.

15. The TDCMS shall support the creation of routes, which are defined as user-defined sequences of adjacent sensors for congestion tracking. The route creation capabilities shall support assigning only certain lanes of a sensor to a route node and enable users to modify or delete routes through the web interface.

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16. The TDCMS shall feature a desktop message system that runs on a local workstation to notify users of alert status, support email notification of alert status on a per-user basis, send SMS to mobile devices, enable users to modify alert subscriptions according to alert levels, and allow users to choose whether to receive low, mid and or high level events. It shall enable users to subscribe to custom reports, and to system events, including error and warning messages created by the application. The TDCMS shall feature automatic XML output, which shall export alert data for compatible systems such as color-coded maps.

17. The TDCMS shall enable users to assign camera locations to specific sensors, with defined camera action, feature a desktop application that supports camera actions and enable user to create modify and delete camera actions through the web interface.

18. The TDCMS hardware shall consist of the following components:

    a. A server with quad-core Xeon processor (or equivalent).

    b.   Windows 2003 Server operating system (or newer).

    c. A minimum of 4 GB of SDRAM memory.

    d.   An array of three or more RAID 5 fault tolerant, hot swappable hard drives of more than 72 GB each.

    e. Dual power supplies.

    f. Dual 1000 Mbps Ethernet network card or better.

    g.   Firewall software for security.

    h.   Remote management software for remote maintenance and upgrades.

    i. 24 X or better CD-Rom drive.

    j. Two (2) year, next business day on-site maintenance warranty.

    k.   The TDCMS shall be warranted with 90 days of technical support that includes at a minimum: 30 hours of prepaid phone

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technical support, two days of prepaid on-site technical support, next business day on-site hardware service and included bug fixes, and minor application updates, version updates and software operation system updates.

l. The server hardware shall be from the following manufacturers approved list:

1. Dell

2. Toshiba

3. IBM

4. Gateway

5. Hewlett Packard

6. Sony Corporation

g. Traffic Data Translation System

1. The Traffic Data Translation System (TDTS) shall be a server based data translation system. It shall be an off-the-shelf ATMS appliance that makes possible the translation of traffic data formats and databases to be used by designated parties. The TDTS shall translate data types in an automated manner determined by scheduled start and stop times. Users shall be able to view status of scheduled translation jobs and receive notifications regarding job execution. Software Developers Kits shall be part of the TDTS and make possible the creation and adjustment of translation tasks.

2. The TDTS shall support the following databases: SQL Serves (2000 or higher), Oracle (8 or higher), Sybase (12 or higher), mySQL (4 or higher) and Access (2000 or higher). It shall copy data from one table to another based on user-defined mapping and copy subsets of data based on SQL queries.

3. The TDTS shall be capable of doing conversions involving XML, HTML & PDF, including XSLT transformations and be able to import and export delimited text files using user-defined delimiter. It shall deliver exported data by sending automatic emails to one or more

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addresses with the exported file attached and support automatic download or upload to or from an FTP site.

4. The TDST shall feature an utility that allows the creation of tasks from any local workstation and import an export from the TDTS server. The utility shall feature a visual design mode that allows for a clear design of a complete task, using flowchart elements to represent dataflow, and support step by step testing of each task in debug mode, with immediate error reporting should an error be found. It shall also allow new components and actions to be imported from custom modules without needing to install new software, user-defined parameters that the user can choose at run-time when crating a job, and support unlimited tasks.

5. The TDTS shall provide for the custom creation of trip times and delays of routes, using existing data sources and speed or occupancy values for the trip time/delay calculation. It shall also be able to combine multiple trip time/delay outputs into a single XML result file.

6. The TDTS shall support the automatic triggering of jobs at regular intervals of including but not limited to 30 seconds, 1 minute, hourly, daily, weekly and monthly, and allow users to designate the start and end times for which jobs will be run while supporting specific day/week/month designations to only run the jobs on certain days of the week. It shall also support file-based triggers, so that jobs start based on when certain files in the system are added, modified or deleted, socket based triggers for incoming messages over IP, and service-based jobs for continual processing and messaging, instead of only at regular intervals.

7. The TDTS shall provide a Web-based interface, accessible to any user with a Web browser and Internet connection, which will list the number of jobs in the system, with name and description of each; the next run time of each job; and the current status, either success or failure of each job. It shall also allow the user to run a task manually at any time, add new jobs by selecting a task and assigning a schedule, modify or delete exiting jobs, and view the history of each job with success/fail markers and errors. The TDST shall be accessed by a user name/ password combination, allowing users with varying levels of privileges to access some or all the functionality of the system and allow users to be added or subtracted from the system, or modified to have different permissions.

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8. The TDTS hardware shall consist of the following components:

    a. A server with quad-core Xeon processor (or equivalent).

    b. Windows 2003 Server operating system (or newer).

    c. A minimum of 4 GB of SDRAM memory.

    d. An array of three or more RAID 5 fault tolerant, hot swappable hard drives of more than 72 GB each.

    e. Dual power supplies.

    f. Dual 1000 Mbps Ethernet network card or better.

    g. Firewall software for security.

    h. Remote management software for remote maintenance and upgrades.

    i. 24 X or better CD-Rom drive.

    j. Two (2) year, next business day on-site maintenance warranty.

    k. The TDTS shall be warranted with 90 days of technical support that includes at a minimum: 30 hours of prepaid phone technical support, two days of prepaid on-site technical support, next business day on-site hardware service and included bug fixes, and minor application updates, version updates and software operation system updates.

    l. The server hardware shall be from the following manufacturers approved list:

        1. Dell

        2. Toshiba

        3. IBM

        4. Gateway

        5. Hewlett Packard

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6.   Sony Corporation

654-3.28   Road Weather Information System

a.   These technical specifications describe the minimum physical and functional properties of a road weather information system. The intent of the following specification is to describe the minimum requirements for providing a complete road weather information system. At selected locations, the system shall be able to collect weather related data, including but not limited to temperature, humidity, barometric pressure, wind speed and direction, rainfall, stream levels, roadway water accumulation, and visibility.

b.   Acceptable systems include that of any manufacturer, provided such equipment meets all qualifying specifications identified herein.   The proposed equipment shall have a proven record of field use in Puerto Rico or other USDOT installations for at least one (1) year of service i.e., not including prototype field trials prior to installation.

c.   The contractor is responsible for the installation of the different components of the system (field-based and TMC-based equipment) and for providing full operational capabilities of all the features described in this specification.

d.   The Road Weather Information System (RWIS) shall be compatible with the Microwave Vehicle Detection, Data Collection and Translation Software without affecting its operation.

e.   The RWIS shall identify adverse weather conditions and issue traveler advisories, identify roadway closures, suggest alternate routes and provide forecasts for roadway segments.

f.   The RWIS shall be able to communicate data with the National Weather Service.

g.   The RWIS shall be able to automatically update Variable Message Signs (VMS) with messages pertaining to road weather conditions, as well as any type of messages determined by the Authority. It shall also have the capability of permitting a remote user to select the type of messages being displayed in the VMS.

h.   The RWIS shall be able to send alerts, via email, mobile devices, SMS and to the Traffic Management Center computers, when weather conditions exceed

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the maximum or minimum thresholds, as determined by the user. It shall also present road weather conditions to public users via an Internet website, as well as the location and messages being displayed on the VMS connected to the system.

i. The RWIS field components shall meet the following specifications:

1. The cabinets, solar power panels, wireless radio communication modules, surveillance camera and atmospheric instrumentation shall be mounted on one 30 feet tower.

2. Each tower shall be constructed of aluminum or steel and shall be anodized, have a top elevation of 30 feet and sustain wind speeds of 90 mph with gust ratio of 1.3.

3. Each tower shall be designed for installation on a concrete footing with foundation as show on plans.

4. Each tower shall have a lightning rod and grounding rod, and the power line, communications modules, surveillance camera and atmospheric instrumentation shall be protected with surge protectors.

5. The RWIS shall be solar powered, and include voltage regulation, gel batteries, charging equipment and store backup power for a period of seven (7) consecutive days of heavy cloud cover.

6. The RWIS shall have a Remote Processing Unit (RPU) that gathers the data from all connected environmental sensors and remote pavement sensors and cameras at the site. The RPU shall then process, store and transmit the data to the Traffic Management Center computers.

7. Data transmission to the TMC computers shall occur at a user-configurable sampling interval between 1 minute and 24 hours, and shall include all information collected since last transmission.

8. Data shall be collected at the RPU in user-configurable bin sizes, including but not limited to 30 seconds, 1 minute, 15 minutes, 30 minutes, and hourly.

9. Control/configuration and data reporting capabilities for all field components shall be available via a direct connection to the RPU in the field, using a laptop computer. Software to enable field connection shall be provided.

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10. The equipment cabinets shall incorporate a "door open" alarm, which shall provide an alert to the TMC computers, capable of being directed to users of the RWIS system.

11. The cabinets shall be watertight and include a security lock.

12. Each travel lane shall be equipped with a road pavement surface sensor in the center of the lane. The pavement sensor shall distinguish the following conditions:

    i. Dry pavement

    ii. Wet pavement

    iii. Moist / Dew covered pavement

    iv. Road Temperature

13. Pavement Surface Sensors shall be designed for placement up to 2,500 feet from the RPU and support wireline and wireless communication with the RPU.

14. The RWIS shall be equipped with a stream level sensor that measures the depth and pressure of water in a stream and sends an alert when stream level exceeds user configurable thresholds.

15. The RWIS shall contain the following atmospheric instruments:

    i. Wind Sensor

        1) The wind sensor shall be capable of measuring wind speed and determine wind direction.

        2) The wind sensor shall measure average and peak wind speed.

        3) The wind direction sensor shall incorporate a compass to automatically determine magnetic bearing.

        4) The accuracy of the wind speed measurement shall be (+/-2) mph.

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   ii. Temperature sensor

   1) Temperature accuracy shall be (+/-1° F) over the range of -45° F and 130° F.

   iii. Humidity Sensor

   1) The humidity sensor shall have an accuracy of (+/- 5%) relative humidity in the 0% to 100% relative humidity range.

   iv. Barometric Pressure Sensor

   1) Sensor shall measure pressure in the range of 14.75 to 32.45 inches of Hg.

   2) The pressure sensor shall provide a (+/-1) mb / (+/-.03) inches of Hg accuracy in the 14.75 to 32.45 inches of Hg range.

   v. Visibility Sensor

   1) Visibility measurements shall be in the range of .06 miles to 5 miles, with an accuracy of (+/-10%) of the measurement.

   2) Visibility shall be recorded in the user's choice of distance units.

   vi. Precipitation Sensor

   1) The precipitation gage shall be capable of measuring the total precipitation with a rainfall accuracy of 0.04 inches and an instantaneous range of 0 to 2 inches, and measure the precipitation rate for rain with an accuracy of 4%.

j. The RWIS shall include the necessary software that provides remote access, control and collect data automatically at user configurable intervals from the field sites.

k. The RWIS software shall include a geographically correct map of Puerto Rico, including all the major highways and provide the user with the ability

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to access site control and data viewing directly from the map, including the variable message signs connected to the system.

l. The RWIS shall contain a self-diagnostic program for evaluating and informing field devices status. Any errors shall be reported to the Traffic Management Center computers.

m. The RWIS shall comply with the most recent National Transportation Communications for ITS Protocol (NTCIP) standards, including all recommended and approved amendments. All RWIS equipment shall be subjected to NTCIP acceptance testing.

n. The RWIS shall communicate with the data and allow for remote control and configuration of the field equipment using the Puerto Rico Highway and Transportation Authority wireless radio communication network.

h. The RWIS equipment and devices shall be guaranteed against defective parts and workmanship under manufacturers guarantees. The warranties shall be in accordance with customary trade practice but shall be for a period not less than one year from the date of initial start-up and placing in operation at the projects site, and shall cover the full costs of materials necessary to repair or replace the defective component.

i. The Contractor shall guarantee the satisfactory installation and in-service operation of all the RWIS components and related components for a period of six months following the acceptance of the project by the Authority. During the warranty period the Contractor shall repair or replace, at no expense to the Authority, any equipment, materials or work that does not provide satisfactory operation due to equipment, materials and/or installation deficiencies.

j. Any items repaired or replaced within the above guarantee periods shall be guaranteed for an additional period, meeting the requirements specified above, from the date of acceptance of the repaired or replaced items by the Authority.

k. The Contractor shall deliver to the Engineer, prior to the acceptance of the project, the manufacturers and his warranties and guarantees required above.

654-3.29   Traffic Signals System Training, Type_

- Type 1: Advance Traffic Controller Nema TS-2/NTCIP training,

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- Type 2: Video detection Cameras and Virtual Sensor training,
- Type 3: Internally Illuminated Street Name Signs training,
- Type 4: Microwave Vehicle Detection, Data Collection training,
- Type 5: Translation System and Road Weather Information System training,
- Type 6: Monitoring system software training.

a. The Contractor shall provide one (1) training seminar for a group of twelve (12) technicians from the Highway and Transportation Authority for the following:

1. Thirty (30) hours training including video detection cameras, virtual sensor and LED internally illuminated street name sign theory, cables, connectors, splicing, installation, testing, maintenance, restoration, safety and practice training laboratory and certification.

2. The Contractor shall provide audiovisual materials for classroom training, equipment, brochures and specification for discussion on class hours, and specially designed field trips for training and troubleshooting.

3. The training shall be given by manufacturer of the equipment or certified manufacturer personnel.

654-3.30   Surveillance Camera Assembly

a. All surveillance camera units shall be pressurized domes with 35x minimum optical zoom, interchangeable and easily removed from their housing: PTZ high speed IP cameras, outdoor pendant, NEMA ip66 and ip67 standard for vandal proof and weather proof domes. 35x optical zoom, minimum resolution of 704 x 576 NTSC. Frame rate of 4cif (common intermediate format 704 x 576 video resolution) or better up to 30 fps (frame per second). Rj45 ports for Ethernet communications 10/100/1000 base-t with support for http, TCP/IP and DHCP client protocols. State-of- the-art USB port and rs-232 serial port. Day/night feature with infrared mode. Very low light adjustment with 0.1 lux day /.001 lux night feature. H-264 or better video compression. Alarm inputs and outputs. At least 200 plus programmable presets, patterns and area names. Password protection, and privacy zones programming enable. Wireless communication ready. Purely internet protocol (IP) addressable cameras, no other communications interfaces shall be provided.

654-3.31   Surveillance Camera and Microwave Radar Vehicle Detection System Aluminum Pole

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a. The furnishing and installation of a Surveillance Camera and Microwave Radar Vehicle Detection System Aluminum Pole including their respectively foundations, except the Surveillance Camera and the Microwave Radar Vehicle Detection System, shall be performed in accordance with the details and requirements specified on **Aluminum Pole Standard** plans and this specification.

654-3.32   Monitoring system software

a. The monitoring system software shall integrate all devices included as part of the project (traffic controller, video detection cameras, surveillance cameras, microwave radar vehicle detection system and others).

b. Monitoring System software features:

1. Friendly, user configurable windows graphical user interface

2. Open client/server architecture design including NTCIP communications support for local controllers and other field equipment including the monitoring and configuration of the remote operated surveillance cameras or other devises

3. Multiple maps displays using either static image files or ESRI GIS map data

4. Interactive device programming

5. Highly configurable alarm monitoring

6. Flexible communications architecture including Ethernet

7. Multi user networked system can be scaled to fit the size of the operations center

8. Centrally commanded pattern changes

9. Scheduled log file retrieval

10. Export and report data easily adapted to Microsoft tools

11. Capability to monitor the status of thousands of devices

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12. Live volume and occupancy monitoring

13. Capacity to configure video detection system from central

14. User defined device groups and the complete training to use the program

654-3.33   Design and built of Monitoring Center

a. Monitoring Center features: The proposed Monitoring center shall comply with the details provides on plans. These technical specifications describe the minimum physical and functional properties of the required Monitoring center. These shall include the following:

   1. *Monitoring center cabinet:* The monitoring center cabinet shall be modular type with a TV stand per module attached as part of it. The TV stand shall be capable to support a 60" regular LCD TV. All materials used as part of the cabinet shall be durable, stain protected, humidity and impact resistant. Each module shall have an organizing and assessable wire conduit to protect all wiring used as part of the monitoring center. Also, each module shall include two (2) electrical receptacle outlets rated 20A, two (2) phone jacks input to the back, two (2) phone jacks output to front and shall be ready for land connections with one (1) Ethernet port input to the back and two (2) Ethernet port output to front. The cabinet shall include at least two (2) drawers and one (1) keyboard's movable stand per module.

   2. *Chair:* The chairs used as part of the monitoring center shall be ergonomic chair design for a heavy duty intensive use, for twenty four (24) hour applications. The monitoring center shall have at least one chair per module. The chair shall comply with the following;

      i.   350 lb. Capacity

      ii.   Sculpted back with pronounced lumbar support

      iii.   Standard height and width adjustable arm kits

      iv.   Soft pad 3N curved urethane arm-caps

      v.   Seat depth adjusts with the standard seat slider

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    vi.   Multi-tilt feature allows user to adjust both forward and rearward seat tilt with infinite lock and free floating back angle control

    vii.   Pneumatic Seat Height and Tilt Tension Control

3. *Projector:* The projector used as part of the monitoring center shall be roof mounted type and shall be remote control capable (the control shall be included). The projector shall comply with the following specifications:

    i.   16 x 10 native aspect ratio

    ii.   4:3, 5:4, 16:9, 16 x 10 supported aspect ratio

    iii.   Brightness: 3000 lumens

    iv.   2000:1 contrast ratio

    v.   Data compatibility: VGA (640x480), SVGA (800x600), XGA (1024X768), SXGA (1280x1024), SXGA+ (1400X1050), UXGA (1600x1200, WXGA (1280x800), WXGA+ (1440x900), WSXGA+ (1680x1050), WUXGA (1920x1200)

    vi.   Video Compatibility: Full NTSC, PAL, SECAM, 480i, 576i, 480p, 576p,720p,1080i, 1080p/60

    vii.   Native resolution: WXGA

    viii.   Lamp Wattage: 230 Watts

    ix.   Image Size: 3.25ft to 20.83ft

    x.   1.1:1 standard lens zoom

    xi.   6-36ft standard lens projections distance

    xii.   Inputs: One (1) USB port, one (1) HDMI v1.3 port, two (2) Component (RCA) ports, two (2) VESA (HD) (15-pin VGA) ports, one (1) S-Video (4-pin mini-DIN) port, one (1) Composite (RCA) port, stereo RCA jacks ports, stereo 3.5 mm mini-jack port.

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    xiii.   5 year warranty

Projector case and projections screen shall include as part of it. The projector case shall complies with the following: Black molded high density polyethylene approved transit case with telescoping retractable handle, rugged built-in "rollerblade" style wheels, key lockable latch, combination lock, customized interior foam, and molded-in case guards. Projector screen shall be comply with the following specifications:

i. General:

    1) 16:9 aspect ratio

    2) 92" diagonal dimension

    3) 82.2" view width

    4) 45.1" view height

    5) 84" screen overall width

    6) 58.5" screen overall height

ii. Screen Material:

    1) Max White 1.1 Gain black backed material

    2) 160° wide viewing angle

    3) Standard 4-side black masking borders

    4) Matte White material easy to clean

iii. Total Control:

    1) Standard Infrared (IR) remote control

    2) Detachable 3-way wall switch

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3) Includes Radio Frequency (RF) remote to operate from up to 100 feet away without the necessity of line of sight

4) Built-in 5-12 volt trigger input enables Drop/Rise operation to synchronize with the projector's power cycle

5) Low-voltage internal IR/RF receiversCAT5 cable wit RJ-45 connector for easy extension of the 5-12 volt trigger/IR "eye"receiver/3-way wall switch

6) Wireless 5-12 volt trigger

7) In-wall up/down switch

iv. Installation:

1) Durable metal casing for wall/ceiling installation

2) Bubble leveler included

3) Ships fully assembled with 3-prong power connection ready to plug & play

4) Built-in adjustable vertical limit switch to regulate drop/rise settings

5) Optional in-ceiling trim kit and 6", 12", 18" L bracket

v. Quality and Reliability:

1) Synchronous motor allows silent operation with extended operational longevity and low power consumption

2) 3-year parts and labor premium warranty

654-3.34   TRAFFIC SIGNALS BATTERY BACK-UP SYSTEMS

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a. The intent of the following specification is to describe the minimum requirements for providing a complete traffic signal battery back-up system (TSBBS) for use with Light Emitting Diode (LED) Traffic Signal Modules. These technical specifications describe the minimum physical and functional properties of a TSBBS.

b. The TSBBS shall be able to provide reliable power to a traffic signal system in the event of a power failure or interruption. The traffic signal intersection shall be able to function in normal operation while on batteries. The TSBBS shall be able to supply a minimum of 1000 Watts to LED traffic signals.

c. The traffic signal battery back-up system consists of an Inverter/Charger/Controller module with built-in software, a number of serial connected 12 VDC sealed batteries, a transfer relay, and a manual by pass switch enclosed in its own NEMA type 3 environmentally protected enclosure separated from the traffic signal cabinet using underground conduits. The system shall include mounting hardware assemblies, cables, and connectors necessary for operation. Acceptable systems include that of any manufacturer, provided such equipment meets all qualifying specifications identified herein. Using standard industrial grade equipment, the system shall be capable of providing power for full run-time operation of an LED-only intersection a minimum of twelve (12) hours with 80% minimum inverter efficiency.

d. The TSBBS shall be warranted against manufacturing defects in materials and workmanship for a period of two years from date of shipment. The supplier of the TSBBS shall provide all documentation necessary to maintain and operate the system.

e. The BBS shall have a proven record of field use in Puerto Rico or at other USDOT installations for at least six (6) months of service i.e., not including prototype field trials prior to installation.

f. Furnish and install battery back-up systems that are field upgradeable. The completed installation includes all the equipment and hardware necessary, installed inside its cabinet, mounted on its foundation and integrated into the traffic signal system. Materials and work necessary for operation of the system shall comply with the latest edition of the Authority's Standard Specifications for Road and Bridge Construction. The TSBBS shall be easily replaced and installed without any special tool for installation.

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g. The transitions from utility power to battery power and from battery power to utility power shall be seamlessly to provide continued normal operation of the intersection. The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 65 milliseconds. The same maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.

h. Electrical works required for system installation shall be performed by a licensed electrician.

i. A factory certified representative from the manufacturer shall be on-site during installation to supervise the installation and testing of the TSBBS. The factory certified representative shall make fully operational and test the system as indicated on the intersection drawings and this specification.

j. Two (2) days of training shall be provided to personnel of the Authority in the operation, setup, and maintenance of the TSBBS. Instruction and materials shall be provided for a minimum of five (5) persons and shall be conducted at a location selected by the Authority. Training shall be considered a subsidiary obligation of Traffic Signal Battery Back-Up Systems.

k. General specifications:

Input/Output Voltage (VAC) nominal	120
Input/Output Frequency (Hz) nominal	60
Input Current (A) maximum	20
Input Voltage Variation	-23 to +35 percent
Voltage Waveform	Pure Sine
Typical Line Efficiency	>95
Typical Output Voltage THD	< 3 percent
Battery Minimum Run Time continuous (Hours)	12 at 85 % of battery life maximum
Operating Temperature	-40 to +55 degrees Celsius
Outputs (minimum)	5 NO-NC dry contacts panel mounted
Active Output Power (Watts)	1000

654-3.35   Audible Pedestrian Signal Heads

a.   The audible pedestrian signal shall be designed to improve safety during street crossing by pedestrian who are blind or have low vision. This devices shall comply the requirements of ADA. The audible pedestrian signal shall

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have the following features: dynamic volume compensation so its signal will remain 5 decibels (db) above ambient street noise, sound active signal that emits a steady low-volume "clicking" sound to indicate when the audible signal unit is on and available for use, four "cuckoo" and peep walk sounds and four don't walk sounds, sound inhibit to disable the audible signal at sensitive periods of the day such as midnight to dawn, or during complex traffic phases and digital audio synthesizer that can play customized voice messages or sounds to 20 seconds long.

654-3.36   ACCESSIBLE PEDESTRIAN SIGNAL PUSH BUTTON STATION

a. The accessible pedestrian signal push button station shall be designed to improve safety during street crossing by pedestrian who are blind or have low vision. This device shall comply whit the latest ADA requirements. The Pedestrian Push Button shall provide information and cues via both, a vibrating arrow button and audible sounds (chirp, and/or standard voice message) during walk, standard locating tone, custom sound, or verbal countdown during PED clearance and standard locating tone during Don't Walk. All sounds shall emanate from the back of the unit via a weather-proof speaker protected by a vandal resistant screen, shall be automatically adjust to ambient over 60dB range, and shall have minimum and maximum volume independently set. In additions, the unit shall provide confirmation of button push via latching LED, sound, and vibrotactile bounce. The button shall indicate the direction of travel via an ADA compliant, raised tactile arrow on it. Each push button station shall be connects to a Control unit located inside its associated PED sign housing. A four wire cable connects the PBS to the power unit. The installations of this device shall complies with the Standard Specification 654-3.13 (*Pedestrian Push Button Detector Assembly*) and 723-6 (*Pedestrian Push Button Detector*)

654-3.37   IMSA Certification Training

a. The Contractor shall provide an IMSA (International Municipal Signal Association) Certification Training for a group of ten (10) Engineers or technicians from the Highway and Transportation Authority as indicated on plans. The training shall include audiovisual material for class room, one manual per person, equipment, brochures and specifications for discussion on class hours and specially designed field trips for the courses.

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654-4   **METHOD OF MEASUREMENT**

    The following paragraph was revised to read as follow:

654-4.07 Signal heads will be measured on the basis of each unit of each type furnished, installed and accepted. Basic types include standard traffic heads, back plate, fluorescent yellow retroreflective tape, optically programmed traffic heads, lane signals and pedestrian signal heads. These are further identified by the number and sizes of faces included in each unit. The completed installation includes all the equipment and hardware necessary, mounted on its traffic signal support structure and integrated into the traffic signal system.

    Add the following articles:

654-4.18 LED Internally Illuminated Street Name Signs will be measured by the number of signs furnished, installed and accepted. The complete installation shall include but is not limited to: the sign, clamp-on cantilever arm, support and hanger hardware, photoelectric cell, relay assembly, field wiring to the sign assembles and all miscellaneous materials as required by this specification.

654-4.19 Video System Communication modules will be measured by the number of modules furnished, installed and accepted.

654-4.20 Video detection cameras will be measured by the number furnished, installed and accepted. The complete installation shall include but is not limited to: camera with IR filter, lens, enclosure, sun shield, camera bracket, support pole, programming devices, software and all miscellaneous requirements established in this specification to provide a fully operational system.

654-4.21 Surge suppressors will be measured by the number furnished, installed and accepted.

654-4.22 Coaxial and power cable will be measured by the linear meter, to the nearest tenth of a meter, of cable of each class size and number of conductors or pairs specified installed and accepted.

654-4.23 Each video image processors will be measured by the number of modules furnished, installed and accepted.

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654-4.24   The wireless communication system will be measured on a lump sum basis. It shall include all hardware and software required to provide a complete operational system as required on plans and specifications. The system shall include but is not limited to: radio transceivers, access points, antennas, repeaters, network devices, surge suppressors to protect from lightning, power surges and router, network management software, and all other equipment necessary for operation, equipment, labor tools and incidentals necessary to complete the works as required by the plans and specifications.

654-4.25   The desktop or Laptop computer will be measured by the number furnished, installed and accepted. It shall include all the requirements or specifications established on plans and this specification.

654-4.26   The site survey kit for wireless communication will be measured on a lump sum basis. The system shall include but is not limited to: all hardware and software required providing a complete as specified, and as shown on the plans. The system shall include all equipment necessary for operation, equipment, labor tools and incidentals necessary to complete the works as required by the plans and specifications.

654-4.27   All traffic signal system training will be measured on a lump sum basis. It shall include the costs related for providing the training room, all related costs for any external instructor (including transportation, lodging, etc.) and all other requirements established in this specification.

654-4.28   The microwave radar vehicle detection system will be measured by the number furnished, installed and accepted. The complete installation shall include but it's not limited to microwave radar vehicle detection sensor, electrical connections terminal block, solar panels, gel batteries, sensor bracket, pole mounted cabinets, cabinets brackets, lighting surge protection module, grounding rod, solar power controller, cables, programming devices, software and all miscellaneous requirements established in this specification to provide a fully operational system.

654-4.29   The microwave radar vehicle detection system communication modules will be measured by the number of modules furnished, installed, and accepted.

654-4.30   The traffic data collection and monitoring server will be measured by the number furnished, installed and accepted. The complete installation shall include but it's not limited to the server, racks, cables, software, software

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literature, and all the miscellaneous requirements established to provide a fully operational system.

654-4.31   The traffic data translation server will be measured by the number furnished, installed, and accepted. The complete installation shall include but it's not limited to the server, racks, cables, software, software literature, and all the miscellaneous requirements established to provide a fully operational system.

654-4.32   The Road Weather Information System will be measured by the number furnished, installed and accepted. The complete installation shall include but it's not limited to atmospheric sensors, road pavement surface sensor, stream level sensor, electrical connections terminal block, tower, solar panels, gel batteries, sensor brackets, tower mounted cabinets, cabinets brackets, lighting rod, grounding rod, solar power controller, cables, programming devices, software and all miscellaneous requirements established in this specification to provide a fully operational system.

654-4.33   The road weather information system communication modules will be measured by the number of modules furnished, installed, and accepted.

654-4.34   The road weather information system training will be measured on a lump sum basis. It shall include the costs related for providing the training room, all related costs for any external instructor (including transportation, lodging, etc.) and all other requirements established in this specification.

654-4.35   The video detection cameras, virtual sensor and internally illuminated street name sign training will be measured on a lump sum basis. It shall include the costs related for providing the training room, all related costs for any external instructor (including transportation, lodging, etc.) and all other requirements established in this specification.

654-4.36   The VIDS Programming Devices and Software of the type specified, furnished, installed and accepted will be measured on a lump sum basis.

654-4.37   The malfunction management units will be measured by the number of unit furnished, installed and accepted.

654-4.38   The 9-port Ethernet switch device will be measured by the number furnished, installed and accepted.

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654-4.39   The Surveillance Camera and Microwave Radar Vehicle Detection System Aluminum Pole will be measured by the number furnished, installed and accepted.

654-4.40   **The Surveillance Camera will be measured by the number furnished, installed and accepted.** The complete installation shall include but it's not limited to the camera, mounting hardware assemblies for installation on poles or towers, wiring, connectors, software, and all the miscellaneous requirements to provide a fully operational system.

654-4.41   The Monitoring System software will be measured on a lump sum basis. It shall include all hardware and software required to provide a complete operational system as required on plans and specifications.

654-4.42   The design and built of Monitoring Center will be measured on a lump sum basis. It shall include the modular cabinets, chairs, projector and all the necessary equipment for a complete monitoring center. The computers and the monitors shall not be included as part of the monitoring center.

654-4.43   Inverter/Charger/Controller modules will be measured on the basis of each unit of the type furnished, installed and accepted.

654-4.44   Batteries will be measured on the basis of each unit of the type furnished, installed and accepted.

654-4.45   Transfer relays will be measured on the basis of each unit of the type furnished, installed and accepted.

654-4.46   Manual by pass switches will be measured on the basis of each unit of the type furnished, installed and accepted.

654-4.47   TSBBS Cabinets will be measured on the basis of each unit of the type furnished, installed and accepted.

654-4.48   Software installed and accepted is considered a subsidiary obligation of the Contractor under the various contract pay items of the TSBBS.

654-4.49   The IMSA Certification training will be measured on a lump sum basis. The training shall provide the audiovisual material for class room, one manual per person, equipment, brochures and specifications for discussion on class hours and specially designed field trips for the courses.

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654-4.50   The audible pedestrian signal will be measured by the number furnished, installed and accepted.

654-4.51   The accessible pedestrian signal push button station will be measured by the number furnished, installed and accepted.

654-5   **BASIS OF PAYMENT**

654-5.01   The accepted quantities determined as provided above which are in the contract will be paid per unit of measurement.

654-5.02   Payment will be made under:

Add the following pay items:

Pay Item		Pay Unit
LED Internally Illuminated Street Name Sign	………...	Each
Video System Communication Module	………...	Each
Video Detection Camera	………...	Each
Surge Suppressor	………...	Each
Coaxial and Power Cable	………...	Linear Meter
Video Image Processor	………...	Each
Wireless Communication System	………...	Lump Sum
Laptop or Desktop Computer	………...	Each
Site Survey Kit for Wireless Communication	………...	Lump Sum
Traffic Signal System Training, Type_	………...	Lump Sum
VIDS Programming Devices and Software	………..	Lump Sum
9-Port Ethernet Switch Devices	………...	Each
Surveillance Camera Aluminum Pole	………...	Each
Surveillance Camera	………...	Each
Malfunction Management Unit	………...	Each
Monitoring System Software	………...	Lump Sum
Design and built of Monitoring Centre	………...	Lump Sum
IMSA Certification Training	………...	Lump Sum
Audible pedestrian signal	………...	Each
Microwave Radar Vehicle Detection System	…………	Each
Microwave Radar Vehicle Detection System Communication Modules	…………	Each
Microwave Radar Vehicle Detection System Aluminum Pole	…………	Each
Traffic Data Collection and Monitoring Server	…………	Each
Traffic Data Translation Server	…………	Each
Road Weather Information System	…………	Each
Road Weather Information System Communication Modules	…………	Each

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INVERTER/CHARGER/CONTROLLER	…………	Each
BATTERY	…………	Each
TRANSFER RELAY	…………	Each
MANUAL BY PASS SWITCH	…………	Each
TSBBS CABINET	…………	Each
Advance Traffic controller	…………	Each
Accessible Pedestrian Signal Push Button Station	…………	Each