Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
Bonifacio Drive, Port Area Manila

BAGONG PILIPINAS

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DEPARTMENT ORDER)
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NO. 203)
Series of 2024)
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SUBJECT: DPWH Standard Specification for Item 623 – Traffic Signalization System

In line with the continuing efforts of the Department to improve the mobility and safety performance of the intersections along road infrastructures, the attached **DPWH Standard Specification for Item 623 – Traffic Signalization System**, is hereby prescribed for adoption in Government infrastructure projects.

The Standard Specification shall form part of the DPWH Standard Specifications for Highways, Bridges and Airports, Volume II and is now included in the Project and Contract Management Application (PCMA).

This Order shall take effect immediately.

MANUEL M. BONOAN
Secretary

Department of Public Works and Highways
Office of the Secretary
WIN4U02053

DPWH Standard Specification for
Item 623 – Traffic Signalization System

623.1 Description

This item shall consist of furnishing materials, equipment, and labor, including technical documentation, for the installation, testing and commissioning of a Traffic Signalization System, which includes the traffic signal controllers, traffic signal flasher controller, signal heads, vehicle detectors, pedestrian pushbutton assembly, countdown display, traffic signal poles, underground trenching, cabling and other necessary materials for operational fittings on site, in conformance with the requirements shown in the Plans.

623.2 Material Requirements

623.2.1 Traffic Signal Controller

The traffic signal controller serves as the brain of the traffic signal system, comprising both hardware and software components, designed to provide right-of-way clearance thru visual signal indications, with duration and sequence defined in a preset programming.

The traffic signal controller shall be modular in construction to the extent that optional features can be added with the minimum of mechanical/electrical modification.

The traffic signal controller shall be designed to operate within the following environmental and physical conditions:

a. Maximum ambient temperature of 65°C
b. Relative humidity range of 5% to 95% (without condensation)
c. Maximum operating temperature of 85°C
d. Maximum storage temperature of 125°C

The traffic signal controller shall be microprocessor-based capable of switching signal heads by means of solid-state devices or contactors. The controller shall utilize a minimum of 16-bit microprocessor technology.

The traffic signal controller shall be equipped to switch at least eight (8) signal groups, either vehicle signal groups or pedestrian signal groups. By the addition of appropriate plug-in modules for which pre-wired sockets are provided, the larger type housing shall be equipped with expandable sub-assemblies pre-wired for every additional sub-assembly. The largest version of the controller shall be capable of switching up to 32 signal groups, either vehicle or pedestrian.

The traffic signal controller shall be provided with sufficient memory to ensure the program runs efficiently and effectively, without noticeable delays in any function. The following minimum memory requirements shall be provided:

a. Random-Access Memory (RAM) - A minimum of 4 MB of Dynamic RAM (DRAM) organized in 32-bit words shall be provided. A minimum of 512 kB Static RAM (SRAM), organized in 16-bit words, shall be provided.

b. Flash Memory - A minimum of 4 MB of Flash Memory shall be provided. The Central Processing Unit (CPU) shall be equipped with all necessary circuitry for writing to the Flash Memory under program control.

The controller shall include a precise crystal-controlled Real-Time Clock (RTC) that accurately derives the date, day, and time down to the hour, minute, and second. The clock shall be used to manage the introduction of all timetables and the timing of all intervals.

The traffic signal controller shall be capable of operating in the following modes:

a. **Isolated Mode** whereby the controller operates without reference to the operation of any other controller. Phases may be fixed time or vehicle actuated and/or demand dependent as specified in the plan data with phase times and sequences under the control of local timetable selected plans.

b. **Cable-Linked Mode** whereby a number of adjacent controllers are coordinated via a linking cable. Phases may be fixed time or vehicle actuated and/or demand dependent similar to Isolated Mode.

c. **Areawide Traffic Control (ATC) Mode** whereby the duration and sequence of phases are controlled by an ATC central/master computer and coordination of adjacent controllers is affected by the central/master computer. Phases may be fixed time or vehicle actuated and/or demand dependent as defined in the master computer plan data. In the ATC mode, all local plan and timetable information can be ignored depending on the type of control strategy.

d. **Flashing Mode** operation of the signals shall be possible as a result of failure of the controller, manual selection of the mode, local timetable selection of the mode, or under the direction of an ATC central/master computer.

e. **Manual Control Mode** whereby an authorized person can (within limits) manually control the duration of the phases. Although not considered as a mode of operation, it shall be possible to switch the signals (but not the controller) off either manually, by timetable or by direction of an ATC computer.

f. **Synchronous Coordination Mode** whereby a group of two (2) or more controllers are coordinated by means of accurately synchronized clocks, similar to cable-linked mode but without the cable.

Vehicle actuation shall be possible in all modes except manual and flashing modes. As required by the individual site requirements, it shall be possible to specify any one (1) or more of the phases or signal groups to be demand-dependent and/or fully vehicle actuated. Vehicle actuation shall only be possible if the detector interface card is present with appropriate vehicle detectors connected. The absence of the card shall cause all phases to operate fixed time.

Demand-dependent phases shall only appear in the cyclic sequence if a demand for that phase exists. In the absence of demands for one (1) or more phases, the next demanded phase in sequence shall be introduced either at the time at which the current phase would normally terminate or after allowing the current phase to continue during the time which would have been allocated to the next no-demand phase as defined in the plan data. In the event of no other phases being demanded, the current phase shall remain in the rest period. Any phase

defined as demand-dependent shall have a demand automatically registered so that the phase or phases will be included in every signal cycle. The condition of demand for a phase or signal group shall not exist when that phase or signal group is green.

The operation of the vehicle-actuated phase or phases shall be by means of approach timers. At least two (2) sets of approach timers per phase shall be provided. A set of approach timers shall consist of a gap timer, a waste timer and a headway timer. It shall be possible to associate a set of timers with the vehicle actuation detectors on one or more approaches to the intersection.

The traffic signal controller shall be configured to the individual site requirements by data and tables entered in non-volatile memory RAM. This data area shall contain all the information required by the controller for operation at a specific site under four general categories.

a. Plan Data defining the sequence and duration of phases.
b. Timetable Data defining the times of introduction of plans and modes over the 7-day week.
c. Interval Time Settings which shall, separately for each phase, approach or signal group as appropriate, define the duration of the interval.
d. Site Characteristics which shall define at least the individual site attributes. The site characteristics shall be defined by means of coded entries into tables and coded condition strings which are stored in EPROM and interpreted by the main controller software to achieve the desired operation on site.

The probability of dangerous conflicting signal display shall be minimized with the provision of a supervisory conflict monitor, which shall, independently from the traffic controller microprocessor, ensure that the signal display output from the lamp switching is a safe, non-conflicting display.

The lamp status inputs to the conflict monitor shall be derived from the load side of the signal switching devices. In the event of the output being unsafe, the signals shall be switched to flashing mode. In this context, the absence of a green or red output at a time when it should be present shall constitute a dangerous conflicting signal. The conflict monitoring circuitry shall continuously check its own integrity and in the event of it sensing its own failure, the signals shall be switched to flashing mode.

Operator facilities shall be provided to enable authorized personnel to operate the controller, examine its status and examine and/or input data. There shall be two (2) levels of access, the lower level of police operations, the higher level for authorized technical personnel.

Access to the Police Operator Facilities shall be by means of a small lockable door. Within the cavity enclosed by the door shall be provided a robustly constructed three (3) position switch by means of which shall be possible to switch the signals to "NORMAL" operation, "FLASH" – invoking flashing mode, and "OFF" – removing the lamp supply from the signal switching devices and the flashing circuit.

Access to functions available for traffic signal controller in the field shall be by means of a laptop computer or a Personal Data Assistant (PDA). The interface with these data terminals shall be done thru a front panel connected dedicated Serial port and Ethernet port. A front panel USB port shall also be provided to allow bulk data/file transfer to and from a portable memory device thru a laptop computer or PDA device.

The controller, when equipped with a communications card, for which a wired socket shall be provided in all controllers, shall be capable of integration either into a centrally controlled, closed-loop or distributed controlled type ATC system. The controller shall provide at least one (1) communications interface slot. The communication card will be responsible for all the signal conditioning needed to adapt the controller to various transmission media such as phone lines, radio and optical fiber.

The entire controller unit shall be designed to allow complete disassembly. No welds, pop rivets, or other permanent fasteners shall be used that would prevent complete disassembly. It shall feature a motherboard layout where all functional modules plug into the motherboard assembly. Each module shall be equipped with connectors that prevent incorrect insertion. The motherboard shall be fully removable without requiring de-soldering or disconnecting individual wires.

All circuit modules shall be aligned with printed circuit card guides and be securely held in place by a captive screw or similar locking device when installed in the controller and all the components on the module circuit boards shall be easily accessible and shall be arranged in a functional grouping.

The traffic signal controller's power supply shall be removable as a unit and connected via a plug. It shall be designed to minimize the risk of damaging other equipment by limiting current, voltage, and power output. The power supply shall also minimize heat dissipation while providing voltage regulation to the sub-circuit printed circuit cards within the microprocessor module. It shall be exclusively intended to power the backup clock during power outages.

The controller shall in all ways be suitable for connection to the mains power supply anywhere in the Philippines and shall comply with all requirements of the power supply service provider.

The controller shall include a mains board on which shall be mounted, fully wired, and labeled:

a. One (1) main switch rated at not less than 30 amperes
b. One (1) main fuse, High Rupturing Capacity (HRC) rated at 30 amperes
c. One (1) equipment supply switch rated at not less than 15 amperes
d. One (1) flashing mode supply fuse rated at 20 amperes
e. One (1) equipment supply switch rated at not less than 15 amperes
f. Four (4) equipment supply fuses, each rated at 10 amperes
g. One (1) neutral link
h. One (1) earth link
i. One (1) switched socket outlet suitable for the connection of mains-operated tools and equipment

The main switch and fuse or circuit breaker shall protect and isolate all equipment from the mains supply. The supply to the normal lamp-switching devices shall be protected and isolated by the lamp supply switch and fuse or circuit breaker, but the flashing unit shall be separately isolated and protected by its own switch and fuses or an equivalent circuit breaker.

The earthing conductors shall be connected to the earth link, and all neutral returns shall be connected to the neutral link. Each link shall have sufficient capacity to accommodate all conductors without requiring more than one individual conductor to be inserted at each terminating point.

All components, insulation, and wiring that carry a power supply of 230V alternating current +15% and -20% at a frequency of 60 Hertz ±5% or come into contact with mains voltage shall meet the test requirements specified.

Field terminals shall be provided within the controller housing for terminating external signal cables, positioned conveniently and readily accessible.

The traffic controller cabinet shall be suitable for outdoor installation, weatherproof and vandal-resistant, typically made of durable materials, to protect internal components from environmental elements such as rain, dust, and temperature fluctuations. It shall be made from an aluminum alloy sheet with a minimum thickness of 2 mm at all points and reinforced where necessary. It shall be treated to ensure its surface bonds seamlessly with other metals it contacts and to facilitate proper adhesion of the specified enamel paint finish when cabinet color is specified. If the plans specify a cabinet color, all exterior surfaces of the cabinet shall be primed and finished with two (2) coats of high-grade enamel paint in the specified color. The interior surfaces for the cabinet shall match the exterior.

The traffic controller cabinet shall enclose the following main equipment items:

a. Microprocessor Module
b. Interfacing and/or lamp switching modules
c. Power Supply Module(s)
d. Main Switch Board
e. Field Terminals for incoming and outgoing cables
f. Flashing Module
g. Supervisory Conflict Monitor
h. Shelf Space for vehicle detector mounting
i. Traffic Police/Enforcer Operator Facilities

623.2.2 Traffic Signal Flasher Controller

The traffic signal flasher controller shall be microprocessor-based and shall be capable of controlling flashing signals for cautionary or warning purposes.

The flash rate of the traffic signal flasher dictates how often the signal flashes and is typically programmed into the controller's software to ensure proper visibility and shall be adjustable between 50 to 60 flashes per minute.

The enclosure shall be made of durable, weatherproof aluminum or stainless steel to protect internal components from environmental elements such as rain, dust, and other external factors. The exterior surface should be treated with a corrosion-resistant coating.

The Printed Circuit Board (PCB) shall be made of high-quality, fire-retardant fiberglass material. All wiring shall be insulated with flame-retardant materials.

623.2.3 Detector Card

It shall be possible by insertion of a suitable detector card, for which a pre-wired socket shall be provided in all controllers, to accept inputs from up to eight (8) vehicle and/or pedestrian detectors in the small housing and expandable with the addition of detector sub-assemblies pre-wired for every additional sub-assembly.

The detector card shall be designed to process signals from vehicle or pedestrian detection sensors and communicate the information to the traffic signal controller. It shall act as the intermediary between the physical detection devices and the traffic signal control system. These cards process inputs from sensors that monitor traffic flow, vehicle/pedestrian presence, and other relevant conditions.

623.2.4 Signal Heads

623.2.4.1 Vehicular Signal Heads

Vehicular signal heads shall consist of multiple signal units, each displaying a specific color (red, yellow/amber, green) to control vehicular traffic. All vehicular signal heads shall have a diameter of 200 mm for primary and secondary reference and, 300 mm for tertiary reference.

The vehicular signal head shall be fitted with 9 Volt Light Emitting Diode (LED) signal lamp/module. The LED signal lamp shall be a single, self-contained device, not requiring on-site assembly for installation into signal housing. The power consumption of the LED modules should be low, typically between 8 to 20 watts, and shall have internal surge protection to withstand power surges and spikes.

The vehicular signal head shall provide high luminous output and be capable of operating at high temperatures. It shall be clearly visible under all lighting conditions, including direct sunlight.

The vehicular signal shall be installed with reflectors, brackets, target boards and visors to prevent outside light source interference. It shall operate on standard traffic signal voltages with suitable voltage regulation, complying with the requirements set in the Philippine Electrical Code (PEC).

The modular housing of vehicular signal heads shall be made of durable, weather-resistant materials. The lens materials shall be UV-stabilized polycarbonate or equivalent material to prevent discoloration and degradation. Target boards shall be made of polycarbonate or powder-coated aluminum substrates.

Provisions may be added to configure four or more aspects and to use arrow mask depending on the need as shown on the Plans and as directed by the Engineer.

623.2.4.2 Pedestrian Signal Heads

Pedestrian signal heads shall be composed of one or more aspects and shall have the same luminous intensity and chromaticity requirements as vehicular signal heads. Pedestrian signal heads shall have a lens dimension of 300 mm. The pedestrian signal indications shall consist of an illuminated symbol of a walking person figure (green signal), symbolizing WALK and a standing person figure (red signal) symbolizing DON'T WALK.

623.2.5 Vehicle Detector Inductive Loop Type

The inductive loop detectors shall adhere to the comprehensive specifications outlined in NEMA TS 2 standards and the Federal Highway Administration (FHWA) Traffic Detector Handbook, conforming with the required environmental, electrical, and functional performance criteria.

The loop detector cable shall be constructed from high-conductivity copper and shall conform to the specifications of ASTM B3, Standard Specification for Soft or Annealed Copper Wire, and ASTM B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft. The insulation for the loop wire shall be made from polyethylene or cross-linked polyethylene (XLPE) and shall meet the requirements specified in ASTM D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable, and ASTM D4565, Standard Test Methods for Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable.

The loop feeder cable shall use stranded copper for high conductivity and flexibility. The conductors shall be insulated from each other and external sources of interference and shall be capable of withstanding temperature variations. which insulation materials shall be PVC, XLPE, or Polyethylene for electrical insulation and thermal resistance. The cable shall be flexible enough to handle installation without damaging the conductors or insulation and strong enough to withstand installation stresses and handling. It shall also be abrasion-resistant.

The detector electronics enclosure shall provide strong protection against environmental factors to ensure reliable operation. The enclosure shall be made from high-impact plastic or metal with a corrosion-resistant coating and shall meet a minimum protection level of IP65 according to International Electrotechnical Commission (IEC) 60529 Degrees of protection provided by enclosures (IP Code), ensuring protection against dust and water ingress.

The saw slot joint sealant used to protect and encapsulate the loop detector cable within the pavement cuts must be a flexible and weather-resistant material complying with ASTM D5893M, Standard Specification for Cold-Applied, Single-Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

623.2.6 Vehicle Detector Video Camera Type

Video Vehicle Detector shall conform to the applicable requirements of the Federal Highway Authority: Traffic Detector Handbook. Other internationally accepted standards and specifications offering equal or better functionalities may also be accepted.

Video Vehicle Detectors shall use Video Image Processors (VIP) to detect and report vehicle presence and provide traffic flow data across several lanes and in multiple areas in one lane, as shown on the Plans and as approved by the Engineer.

The VIP shall consist of Video Cameras with Infrared Radiation (IR) Filter, lenses, enclosures and sunshields, detection module, image monitoring and storage module, mast arm brackets, surge suppressors, software, power cables, and all other necessary hardware and software for operation.

The VIP shall be able to accurately detect vehicle presence with 98% accuracy under normal conditions (day and night), and 96% accuracy under adverse conditions (i.e., torrential rain, fog, high winds) at a distance of 60 meters from the spot on the pavement surface directly under the camera.

623.2.7 Pedestrian Pushbutton Assembly

Pedestrian pushbuttons shall be capable of being mounted to the traffic signal poles and shall allow manual operation by pedestrians using a non-locking, jam-proof switch housed in a durable, weather-proof and corrosion-resistant housing.

The front of the pushbutton assembly must feature a combined visual and tactile arrow, clearly indicating the direction of the associated crossing to pedestrians. This arrow should be distinctive both in appearance and feel.

623.2.8 Countdown Display

The countdown display shall be operated in conjunction with all signal heads. This shall have a maximum 300 x 300 mm dimension with the same luminous intensity and chromaticity requirements as vehicular signal heads.

623.2.9 Traffic Signal Pole and Mast Arm

Poles and mast arms shall conform to the applicable requirements of Item 712, Structural Metal.

The anchor bases shall be provided with hot-dipped, galvanized steel anchor bolts with double nuts and washers, threaded at the top end and bended at 90 degrees at the bottom end or as shown on the Plans. Galvanized nuts, washers, and ornamental covers shall be provided for the anchor bolts. The galvanizing shall be done in compliance with ASTM A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware, or ASTM A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

The pole and mast arms shall be designed in a way that it accommodates the necessary traffic signalization equipment at an appropriate height and shall conform with the provision of the AASHTO LTS-6, Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

The mast arms shall accommodate various loads, including dead loads from the weight of the mast arm and attached equipment, live loads resulting from dynamic effects such as wind, and other environmental loads. Wind loads must be calculated based on site-specific conditions, ensuring the mast arm can withstand specified wind pressures, which are determined by local wind speed and exposure categories stipulated in the latest edition of the National Structural Code of the Philippines (NSCP). Mast arm shall have a minimum of 4 m length, a 7 mm minimum thickness and a 114 mm minimum diameter. Pole thickness and diameter shall conform to Table 623.1 Pole Dimensions.

Table 623.1 Pole Dimensions

Type of Pole	Wall Thickness, Min. (mm)	Diameter, Min. (mm)
Type A (For tertiary signal heads)	8	219
Type B (For primary signal heads)	4	108
Type C (For secondary signal heads)	4	108

Type of Pole	Wall Thickness, Min. (mm)	Diameter, Min. (mm)
Type D (For pedestrian signal heads)	3	88

Reinforced concrete used for foundations and pedestals for traffic signal poles shall be Class A (24.1 MPa) and shall conform to the requirements of Item 405, Structural Concrete. The steel reinforcement shall conform to Item 710, Reinforcing Steel and Wire Rope. Additionally, the materials used for concrete bollards and local controller footings shall conform to the same requirements.

623.2.10 Traffic Signal Conduit Trenching

High-density polyethylene (HDPE) pipes shall be used for conduits placed in trenches to house the wiring for the traffic signals. It must be durable, flexible, and resistant to environmental factors that will help protect the wiring from moisture, corrosion, and physical damage, and enhance the overall longevity and effectiveness of the traffic signal system.

The materials for the restoration of all surfacing to its original condition and appearance shall conform to Plans and comply with the material requirements for Item 311, Portland Cement Concrete Pavement, Item 310, Bituminous Concrete Surface Course, Hot-Laid, and Item 601, Sidewalk.

The materials for backfilling shall conform to Plans and comply with the backfilling requirements of Item 500, Pipe Culverts, Storm Drains, and Lined Canal.

623.2.11 Traffic Signal Cabling

Traffic signal cabling refers to the network of cables used to connect various components of a traffic control system, facilitating communication and power supply between devices for the complete operation and management of the traffic signal system.

All traffic signal cables shall adhere to the National Electrical Manufacturers Association (NEMA) and Federal Highway Administration's Traffic Detector Manual. Other internationally accepted standards and specifications offering equal or better functionalities may also be accepted

Traffic signal cables shall include a combination of signal and control wires, with each core individually insulated and often twisted together to reduce electromagnetic interference. Each core shall be color-coded to facilitate identification and installation. The cable shall be flexible enough for installation and resistant to mechanical stress, including abrasion and tensile forces. It shall also comply with standards for UV resistance, temperature tolerance, and chemical resistance. Traffic signal cables are specialized cables designed for the communication systems in traffic signal installations. These cables shall meet specific performance, durability, and safety standards to ensure reliable operation in various environmental conditions.

The entire system shall be grounded and bonded in accordance with Grounding and Bonding requirements of the latest edition of the Philippine Electrical Code (PEC).

Electrical underground works shall conform to the applicable requirements of Item 633, Cable Duct System, while the electrical conduit, conductors, and control panel shall conform to the applicable main feeder distribution system requirements of Item 624, Roadway Lighting.

623.2.12 Traffic Signal Handhole

Load-bearing concrete hollow blocks (CHB) and structural concrete shall be used as the materials for the handhole or as shown on the Plans. The cover of the handhole shall be framed with a 6 mm thick angular bar and secured with a steel hook and U-bolt as shown on the Plans.

623.2.13 Protection Cage for Traffic Signal Controller

This cage is used as a protective enclosure designed to safeguard the controller and its components from environmental factors, vandalism, and accidental damage. It will be assembled from wire mesh, ¼" x 1 ½" x 1 ½" angular bars, ¼" metal plate, and 12 mm diameter anchor bolts.

623.2.14 Battery Back-Up System

The battery backup system shall provide reliable emergency power to the traffic signal system in the event of a power failure or interruption. Individual components shall comply with the electrical specifications and standards of the Transportation Electrical Equipment Specifications (TEES) Chapter 4 – Backup Battery System, or any applicable standards as agreed upon and subject to the approval of the Engineer.

1. The battery backup system shall provide a minimum of two (2) hours of full runtime operation.

2. The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized Backup Mode line voltage, shall be no greater than 40 milliseconds. The same maximum allowable transfer time shall also apply when switching from Backup Mode line voltage back to utility line voltage.

3. The battery backup system shall have an integral charger. The charger shall be a 3-step "Smart Charger" utilizing bulk, absorption and float charging techniques, appropriate for the battery type. The charger must prevent destructive discharge and overcharge.

4. An external cabinet shall be used for housing the battery backup system, which includes batteries, inverter/charger unit, power transfer relay, manually operated bypass switch, any other control panels and all wiring and harnesses.

623.2.15 Paints

Metal parts shall have an anti-corrosive protection which shall be in accordance with the applicable requirements of Item 709, Paints.

623.3 Construction Requirements

These requirements refer to the specific guidelines and standards, as shown on the plans, that must be followed during the installation, construction, and implementation of traffic signal systems to ensure that the system will operate safely and meets the needs of the traveling public.

1. The traffic signal system shall be designed to facilitate easy installation, servicing, and possible future expansion, upgrades, and additions.

2. The traffic signal system shall be designed to ensure that maintenance and repairs can be performed easily, without the need for extensive dismantling to access critical components. The system shall be set up and installed appropriately in safe and suitable locations to ensure the operational efficiency of traffic signal systems.

3. The initial setup of traffic signal equipment shall involve phase configuration, wiring and testing to verify the functionality of traffic signal equipment according to standards, as shown on the Plans and as directed by the Engineer.

4. Testing and commissioning for traffic signal systems shall be conducted in the presence of the Engineer and the end user to ensure that the system is fully operational, equipped with all modules and sub-units, and accepted. The traffic signal system equipment that requires testing and commissioning includes, but is not limited to: traffic signal controllers, signal heads, detection devices, communication systems, power supply units, cabling, and emergency vehicle preemption systems, as stated in Sections 623.2.1 to 623.2.11.

   Testing and commissioning shall be part of the installation work to ensure they operate correctly and effectively contribute to a safe and efficient traffic signal system. The requirement is to ensure that the equipment is tested with maximum power dissipation occurring within the controller housing, and that the operation of the system is monitored during the test procedures when the main power is connected, along with the battery backup system.

623.3.1 Traffic Signal Controller

The traffic signal controller shall be installed and mounted in accordance with the approved plans.

1. The traffic signal controller shall be located as far as practicable from the edge of the roadway within the road right-of-way and shall not obstruct the sidewalk or access from the sidewalk to the crosswalk.

2. The traffic signal controller shall be positioned so that it is adjacent to the curb and oriented such that the door opens away from the carriageway. It shall be installed to allow convenient access to the equipment within the housing, with a smaller door providing access to the mode control switch and the manual control pushbutton. No part of any sub-unit, terminal assembly, or switchboard shall be less than 150 mm above ground level.

3. The traffic signal controller shall be mounted on a reinforced concrete footing, anchored using anchor bolts capable of withstanding wind loads and vibrations. All conduits attached to the traffic signal controller shall pass through the base of the concrete footing and

directly to a communication pit in the controller apron. The cables then enter the controller base and run to a support bar as they connect to the controller.

4. Adequate ventilation shall be provided to ensure sufficient cooling and prevent condensation within the housing under all weather conditions.

5. The enclosure for traffic signal controller shall feature a secure locking mechanism to prevent unauthorized access. The housing shall allow convenient access to all removable sub-assemblies (such as computer assembly, power supplies, lamp switch modules, etc.). Visual indicators and fuses shall be unobstructed and reachable without removing any sub-assembly. All removable sub-assemblies should be connected to the housing wiring using suitable high-quality connectors.

6. Doors and openings for traffic signal controller housing shall effectively prevent the ingress of water and insects. It should be designed such that when closed and locked, the gaskets provide an effective seal on all faces. The gaskets to be used shall be made of quality materials that prevent leakage from the joined surfaces under compression, and they shall be fixed so that they can be readily replaced when required.

   All doors shall be hinged with stainless steel pins or equivalent corrosion-resistant material and equipped with a doorstop to maintain the door in a fully open position of at least 90 degrees under all weather conditions. Each main housing door shall be equipped with two key-operated locks that securely hold the door against the gaskets to ensure a weatherproof seal. All hinges shall be supplied with effective lubrication sufficient for at least 12 months under normal operating conditions, with provisions made for easy renewal of the lubricant.

7. The following equipment documentation shall be submitted for the specific brand and model of traffic signal controller to be furnished:

   a. Controller Hardware Manual
      The controller hardware manual shall contain a detailed mechanical and electrical description of all components of the controller and shall include drawings, circuits diagrams, charts, tables, and photographs. Details shall be included of all logic and interface functions including logic circuits timing diagrams and all aspects of the operation of the circuit needed to diagnose and rectify equipment faults. Circuits and drawings shall be fully dimensioned and show all parts numbers, values and tolerances.

   b. Controller Software Manual
      The controller software manual shall contain a full description of the software functions including flow charts or equivalent, block diagrams, memory maps and source program listings properly commented. If the microcomputer utilizes a real time executive program, this shall also be fully documented. The software documentation shall contain sufficient information to allow the Client to become fully conversant with the controller programming.

      In particular, the method of specifying the site data for storage in EPROM shall be fully documented and supported by several examples to illustrate all the features available. The method of operation of any specialized equipment required to prepare the data or load it into the EPROM shall be fully described.

c. Operator's Manual
The operator's manual shall fully describe the functional operation of the controller and the use of the data terminal for the use of the end-user. The operator's manual shall also fully describe the method of specifying and entering the site data in EPROM.

d. Individual Site Documents
The individual site documentation shall include a complete listing of the site data, together with tabulation of the field terminals, signal groups, detectors numbers and their inter-relationship. This documentation shall be sufficient to allow the Client to install the controllers at the particular sites and make all necessary cable terminations and the data entries necessary to achieve the required operation, should the Client so desire.

8. A suitable notice or diagram, resistant to fading with age, shall be prominently placed inside the traffic signal controller housing. This diagram shall clearly depict the function of all necessary modules, sub-units, and printed circuit boards, including their individual type numbers, titles, and their correct locations within the housing assembly.

623.3.2 Traffic Signal Flasher Controller

The traffic signal flasher controller shall be constructed in accordance with the approved plans.. All equipment documentation shall be submitted for the specific brand and model of traffic signal flasher to be furnished.

623.3.3 Detector Card

Detector card installation varies depending on the equipment and manufacturer. Detector card shall be compatible with the local controller model. Always follow safety protocols when locating the designated slot for the detector card within the controller. Securely insert the detector card into the slot, ensuring it is properly in place.

Ensure that the necessary wiring from the detector card to the traffic signal system is properly connected, including the input/output connections for detectors, loops, or other sensors. Follow the wiring diagrams provided by the manufacturer to ensure correct terminations. Configure the detector card settings according to the specific requirements of the traffic signal system as shown on the Plans.

623.3.4 Signal Heads

623.3.4.1 Vehicular Signal Heads

All vehicular traffic signal heads, including the target boards and mounting brackets, shall be installed and located as shown on the Plans and as directed by the Engineer. A minimum of two (2) traffic signal heads shall be installed for each individually controlled movement. The location for signal heads and corresponding lens dimension shall conform to Table 623.2 Lens Dimension and Signal Head Location.

Table 623.2 Lens Dimension and Signal Head Location

Type	Lens Dimension (mm)	Location
Tertiary	300	right-hand side of the carriageway on the far-side of the intersection
Primary	200	near the right-hand end of the stop line
Secondary	200	left-hand side of the carriageway on the far side of the intersection (on the median if the road is divided)
Dual Primary	200	left-hand side of the carriageway on the approach side of the intersection (on the median if the road is divided)

These standard positions shall only vary if there are visibility and traffic signal pole placement issues as shown on the Plans.
Traffic signal heads may be arranged vertically or horizontally in order indicated in the latest edition of Manual on Uniform Traffic Control Devices (MUTCD). If arrow aspects are used, it shall be mounted on the same direction it shows. Those showing left turns shall be mounted on the left, and those showing right turns shall be mounted on the right side of the circle aspects. This shall be reflected as needed in the Traffic Management Plans (TMP).

The orientation and height requirements shall be in accordance with the Plans and drawings. The signal heads shall face the direction of approaching traffic. The lamps to be installed shall be of the size and type indicated in the contract and plans, with positive electrical contacts in the signal headlamp holders. They shall be fitted with visors as per the design drawings and adjusted for maximum visibility and focusing prior to the final tightening or sealing of hardware.

Signal heads shall be positioned to ensure that visibility requirements for drivers from various approaches and angles are met appropriately. Testing shall be conducted to ensure the proper functionality and alignment of the signal heads with the traffic control system before the equipment is accepted. The installation process should adhere to relevant standards, regulations, and safety requirements.

623.3.4.2 Pedestrian Signal Heads

The required location, height, and lateral distance for the installation of pedestrian signal heads shall be placed in appropriate locations relative to the crosswalk and pedestrian waiting areas to ensure clear sightlines and shall be positioned directly in front of the crosswalk and facing approaching pedestrians.

623.3.5 Vehicle Detector Inductive Loop Type

Construction and installation of inductive loops shall conform to the approved plans and shall adhere to the requirements of ASTM E2561-07a, Standard Practice for Installation of Inductive Loop Detectors, NEMA TS 2, and the FHWA Traffic Detector Handbook.

Sealed loop detectors shall only be installed on pavement in good condition. If the existing pavement with embedded loop detectors will be overlaid with asphalt, both the affected

pavement and detectors shall be removed and replaced or alternative video detector cameras that comply with Subsection 623.2.6 shall be provided.

Any construction requirements for sensors not specifically mentioned above shall be subject to the approval of the Engineer. This includes the installation of loop detector cables for underground detectors, loop feeder cables, loop sealant, splicing kits, and other components.

623.3.6 Vehicle Detector Video Camera Type

Installation of video camera detectors, including location and placement, shall be as shown on the plans and shall adhere to the guidelines set forth in the FHWA Traffic Detector Handbook.

All utilities and facilities affecting pole locations and camera views, both overhead and underground, shall be specified on the Plans. Camera Sight triangles (elevation view) shall be included to show the location of detection zones and any occlusions such as, but not limited to, signal heads, mast arms, span, tether, and overhead utilities.

Cameras shall be placed at a necessary height to achieve the needed detection distance. If cameras are mounted on the far side of the approach or the secondary poles, it shall be placed laterally on an extension of the lane line separating the left and through lanes of the approach. If the cameras are mounted on the near side or over the lanes to be detected, it shall be laterally aligned over the center of the approach. Any construction requirements for sensors not specifically mentioned above shall be subjected to the approval of the Engineer.

623.3.7 Pedestrian Pushbutton Assembly

The pedestrian pushbutton assembly shall be attached to the traffic signal pole using pre-drilled holes provided in the pole, or by drilling and tapping new holes into an existing pole. It shall be mounted at a minimum height of 1.10 meters and a maximum of 1.22 meters above the sidewalk. It shall be installed parallel with the curb of the corresponding crossing or aligned with the pedestrian crossing markings as shown on the Plans. The single-headed arrow disc shall point in the direction of the pedestrian travel. On each pole where a pedestrian push-button assembly is installed, a self-adhesive explanatory label shall be affixed above it.

623.3.8 Countdown Display

The countdown display should be installed at a position and location that ensures clear visibility to all approaching vehicles and pedestrians. It must be securely mounted on traffic signal poles or other structures, with appropriate brackets or supports to withstand environmental conditions. The display should be weatherproof and designed to resist moisture, dust, and debris, ensuring functionality in various weather conditions.

623.3.9 Traffic Signal Pole

The traffic signal poles shall be installed and located as shown on the Plans or as directed by the Engineer. It shall be perpendicular to the through lanes of traffic being served. Unless otherwise stated, no signal poles shall be erected until all other equipment needed for the completion of the signal installation is available and until the necessary channelization and trenching have advanced to a stage where all components can be installed without creating a traffic hazard.

The mast arms shall be fabricated as stated on the plans. After the pole has been erected, sealed, and fixed in the foundation block, a coat of finishing aluminum paint shall be applied.

All foundations for traffic signal poles, pedestals, and concrete bollards shall be cast-in-place at the locations shown on the Plans. The foundations shall also include conduits, elbows, anchor bolts, and grounding wire connections.

623.3.10 Trenching Works

The saw-cut trench and excavation width, length, depth, and location shall conform to the Plans. The trench shall be backfilled with suitable material, and the surface shall be restored as prescribed in the Plans.

The installation of ducts which serves as the conduit for housing the electrical and traffic signal wiring, shall be installed to a minimum depth of 750 mm below the finished grade, as per Plan. After laying cables in ducts, backfilling shall conform to the applicable backfilling requirements of Item 500, Pipe Culverts, Storm Drains, and Lined Canal.

623.3.11 Traffic Signal Cabling

Ensure that traffic signal cabling is properly installed, reliable, and conforms to the approved plans while complying with all relevant standards. Maintain required clearances from other utility lines to prevent interference and ensure safety. Follow recommended practices for pulling cables to avoid damage; use lubricants if necessary. Properly terminate cables in cabinets and ensure secure connections to avoid faults. Additionally, ensure proper grounding of signal equipment and enclosures to prevent electrical surges and enhance safety. Double-check that all connections are continuous and functional and confirm that all signals operate correctly after installation. Clearly label all cables at both ends and in junction boxes for easy identification and maintenance.

The complete installation of underground electrical wiring shall adhere to the specifications, standards, and details shown on the approved plans.

623.3.12 Traffic Signal Handhole

The Traffic signal handholes shall be constructed according to the Plans. The dimensions of a traffic signal handhole vary depending on its type (A or B). Type A (3 covers) handhole is located nearest to the traffic signal local controller, while Type B (2 covers) handholes are used in other designated areas.

The traffic signal handhole shall be positioned in a secured location, adjacent to the controller cabinet, each signal pole, and each detector location as shown on the Plans and as approved by the Engineer.

623.3.13 Protection Cage for Traffic Signal Controller

The Protection Cage for a traffic signal controller must be constructed conforming on the plans that will provide protection for the traffic signal controller, with adequate airflow to prevent overheating of the equipment while still offering robust protection.

The cage should be securely mounted and should not obstruct access to the controller or interfere with the operation of the traffic signal system. There should be sufficient clearance

for connectors and wiring. It must be properly grounded to prevent electrical hazards and ensure safety during operation.

The Wire mesh should be of a size and material that prevents unauthorized access while maintaining visibility of the controller.

623.3.14 Battery Backup System

The battery backup system shall be installed and located as shown on the Plans and as directed by the Engineer.

The cabinet base of the battery backup system shall be suitable for bolting to a concrete foundation.

623.4 Method of Measurement

The work under this item shall be measured either by lot, each, set, slot, zone, unit, linear or meter, actually placed, installed and accepted.

The quantity to be paid for traffic signalization system shall be the number of traffic signal controller, traffic signal flasher, detector cards, signal heads, vehicle detectors, pedestrian pushbutton assembly, countdown display, traffic signal poles, including all conduit trenching, traffic signal cabling, testing and commissioning and all other incidentals needed to make the system operational and accepted as indicated in the Plans.

The concrete footing, concrete pedestal, and concrete bollards shall be measured and paid for under Item 405, Structural Concrete. The quantity of structural concrete to be paid for shall be based on the final quantity placed and accepted in the completed structure.

Reinforcing steel bars shall be measured and paid for as provided under Item 404, Reinforcing Steel. The quantity to be paid for shall be the final quantity placed and accepted in the completed footing, pedestal, and bollards.

623.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 623.4, Method of Measurement, shall be paid for at the Contract Unit Price which price and payment shall be full compensation for furnishing, installation, testing and commissioning of all materials, including all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
623 (1)a	Traffic Signal Controller (8 Signal Group)	Lot
623 (1)b	Traffic Signal Controller (16 Signal Group)	Lot
623 (1)c	Traffic Signal Controller (32 Signal Group)	Lot
623 (2)	Traffic Signal Flasher Controller	Lot
623 (3)a	Detector Card/Board - 8 Channel	Each

Pay Item Number	Description	Unit of Measurement
623 (3)b	Detector Card/Board - 16 Channel	Each
623 (4)a	Vehicular Signal Head, LED Type (200 mm - 3 Aspect)	Set
623 (4)b	Vehicular Signal Head, LED Type (200 mm - 4 Aspect)	Set
623 (4)c	Vehicular Signal Head, LED Type (200 mm - 5 Aspect)	Set
623 (4)d	Vehicular Signal Head, LED Type (200 mm - 6 Aspect)	Set
623 (4)e	Vehicular Signal Head, LED Type (300 mm - 3 Aspect)	Set
623 (4)f	Vehicular Signal Head, LED Type (300 mm - 4 Aspect)	Set
623 (4)g	Vehicular Signal Head, LED Type (300 mm - 5 Aspect)	Set
623 (4)h	Vehicular Signal Head, LED Type (300 mm - 6 Aspect)	Set
623 (5)	Pedestrian Signal Head, LED-type	Each
623 (6)	Vehicle Detector Inductive Loop Type	Slot
623 (7)	Vehicle Detector Video Camera Type	Zone
623 (8)	Pedestrian Pushbutton Assembly	Each
623 (9)	Countdown Display	Each
623 (10)a	Traffic Signal Pole Type A	Unit
623 (10)b	Traffic Signal Pole Type B	Unit
623 (10)c	Traffic Signal Pole Type C	Unit
623 (10)d	Traffic Signal Pole Type D	Unit
623 (11)a	Traffic Signal Conduit Trenching on Concrete Pavement (100mm Diam. Single Barrel)	Linear Meter
623 (11)b	Traffic Signal Conduit Trenching on Concrete Pavement (100mm Diam. Double Barrel)	Linear Meter
623 (11)c	Traffic Signal Conduit Trenching on Asphalt Pavement (100mm Diam. Single Barrel)	Linear Meter
623 (11)d	Traffic Signal Conduit Trenching on Asphalt Pavement (100mm Diam. Double Barrel)	Linear Meter
623 (11)e	Traffic Signal Conduit Trenching on Concrete Sidewalk (100mm Diam Single Barrel)	Linear Meter
623 (11)f	Traffic Signal Conduit Trenching on Concrete Sidewalk (100mm Diam. Double Barrel)	Linear Meter

Pay Item Number	Description	Unit of Measurement
623 (11)g	Traffic Signal Conduit Trenching on Earth Surface (100mm Diam. Single Barrel)	Linear Meter
623 (11)h	Traffic Signal Conduit Trenching on Earth Surface (100mm Diam. Double Barrel)	Linear Meter
623 (12)	Traffic Signal Cabling	Lump Sum
623 (13)	Traffic Signal Handhole	Unit
623 (14)	Protection Cage for traffic signal controller	Unit
623 (15)	Battery Backup System	Lot