097.13 DPWH
03.09.2023

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
MANILA

MAR 09 2023

**DEPARTMENT ORDER** )
)
**NO.** 26 )
**Series of 2023** )
dA 3/9/2023

**SUBJECT: Revised DPWH Standard Specification for Item 624 – Roadway Lighting**

In order to ensure uniformity in application/adoption of the Pay Item of Work to be used/adopted by those who are involved in the preparation of the Design Plans and Quantities, Program of Works (POW) and Approved Budget for the Contract (ABC) for Infrastructures Project Nationwide, the attached revised DPWH Standard Specification for **Item 624 – Roadway Lighting** is hereby prescribed for adoption in Government infrastructure projects that require the utilization of such on the Program of Works.

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

This supersedes **Memorandum 097.7_092518** *(Proposed DPWH Standard Specification for Item 624 – Roadway Lighting)* issued on September 25, 2018

This Order shall take effect immediately.

**MANUEL M. BONOAN**
Secretary

14.1.2 MLL/JDV/RPF

Department of Public Works and Highways
Office of the Secretary
WIN3U01849

**Revised DPWH Standard Specification for**
**ITEM 624 – ROADWAY LIGHTING**

## 624.1 Description

This Item shall consist of furnishing of materials, equipment, and labor for the installation of roadway lighting which includes the luminaire, pole, concrete footing/foundation, power supply, and other necessary components, as shown on the Plans and as directed by the Engineer.

## 624.2 Material Requirements

All materials shall be brand new and shall be of the approved type. It shall conform with the requirements of the Philippine Electrical Code (PEC) and the products locally manufactured shall bear a Philippine Standard (PS) mark, while imported products shall bear Import Commodity Clearance (ICC) certification marks duly issued by the Bureau of Philippine Standards (BPS).

The light emitted by the luminaire shall have color temperature in the range of 2000 K – 2500 K (warm white), 3000K – 4500K (cool white) or 5500K – 6500K (daylight). For primary roads, warm white shall be used.

### 624.2.1 Solar-Powered LED Roadway Lighting

The LED modules, solar photovoltaic (PV) modules, controllers, and battery pack can be replaced independently and shall each have warranty certificate issued by the manufacturer or by the distributor certified by the manufacturer indicating a minimum of six (6) years warranty period.

#### 624.2.1.1 Light Emitting Diode (LED) Luminaire

Light Emitting Diode (LED) shall conform to the applicable requirements for LED Road Luminaires of the Roadway Lighting Guidelines of the Department of Energy, latest edition.

The luminaire shall have no risk linked to infrared, blue-light and UV radiation in accordance with IEC/EN 62471.

The LED housing assembly shall be suitable for outdoor use and shall be rated as IP65.

#### 624.2.1.2 Battery

The battery shall be deep cycle, lithium-ion type. It shall have low maintenance requirements, long service life (minimum of three years), and excellent capacity performance even in high temperature.

The battery pack shall have heat insulation and temperature detection for charging and discharging protection.

### 624.2.1.3 Solar Photovoltaic Module

Photovoltaic (PV) modules shall be made of crystalline high power/efficiency cells and shall be used and must be warranted for output wattage, which must be greater than 90% after 10 years and less than 80% after 25 years. The PV modules shall be provided a protective device against surges.

### 624.2.1.4 Charge Controller

The charge controller shall have automatic dusk-dawn circuit based on Solar Photovoltaic module as sensor for switching on/off the streetlight without manual intervention and as specified operation profile during project analysis. All this control shall keep the system operating at peak performance and increases the system's lifespan.

### 624.2.2 High Pressure Sodium (HPS) Luminaire

HPS luminaire, ballasts, controllers, and other necessary components can be replaced independently and shall each have warranty certificate issued by the manufacturer or by the distributor certified by the manufacturer indicating a minimum of six (6) years warranty period.

1. Luminaires shall be Type III and Medium semi-cutoff. Roadway shall be properly aimed and designed in such a way that it will not produce high discomfort glare or low illumination to motorists and pedestrians.

2. Luminaires shall be designed for roadway lighting with built-in ballast for use with a high-pressure sodium lamp. The luminaires shall bear the UL label. All luminaires shall be mounted with a zero-degree tilt from horizontal.

3. The luminaire housing, both upper and lower, shall be die-cast aluminum jointed by an integrally cast pin hinge at the mounting and a one-hand latch at the door enclosing the lamp and/or ballast.

4. The lens shall be a clear, tempered, high-quality, heat-resistant glass with no aberrations and shall be secured in the supporting frame.

5. The reflector shall be of drawn aluminum and have a highly reflective surface. The reflector edge shall have an elastomer gasket which seats firmly against the lens door to seal the optical system. The optical system shall have a filter permitting it to breathe during lamp heat-up and cool-down.

6. Ballasts shall operate within the range of voltage-current characteristic parameters that are compatible with the lamp used. Ballasts shall be capable of lamp starting at ambient temperatures down to minus 29°C.

### 624.2.3 Pole

The pole shall be constructed of hot dip galvanized GI pipe of 3 mm minimum thickness, a minimum lower and upper diameter of 200 mm and 75mm diameter, and a pole surface of matte or dull finished grade in able to prevent glare. The pole should have the provision to hold the weatherproof lamp housing individually per case, the battery box at an appropriate height, and as well as the Solar Photovoltaic panel, that shall be mounted on top of the pole.

Each Pole shall have an inspection door or hand hole and shall have a suitable gasketed screw cover. After the pole has been erected, sealed and fixed in the foundation block, a coat of finishing aluminum paint shall be applied. Pole shall be provided with galvanized steel anchor bolts threaded top end and with a hooked bent at an angle end at the bottom. Size of the anchor bolts shall be as indicated on the Plans.

Pole shaft shall comply with ASTM A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

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. Galvanized nuts, washer, and ornamental covers shall also be provided for anchor bolts. Galvanizing shall be in accordance with the requirements of ASTM A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware or AASHTO M 111M, Standard Specification for Zinc (HotDip Galvanized) Coatings on Iron and Steel Products, or ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

### 624.2.4 Electric Cables

The electric cable shall be twin core PVC insulated water and UV resistant copper cable of 1.5 mm minimum size.

### 624.2.5 Photo Electric Control/Timer Switch

Roadway lighting shall be provided with reliable photoelectric controls either internal or external to keep lights turned on/off automatically that conform to ANSI C136.10, Roadway and Area Lighting Equipment – Locking Type Photocontrol Devices and Mating Receptacles – Physical and Electrical Interchangeable and Testing, latest revision or equivalent and it shall be located as indicated on the Plans.

The timer switch shall be for prompt time of power switching off and on at the real-time for main light and advertising space in a separate time setting.

### 624.2.6 Conduit

Metallic conduit shall be standard rigid steel, zinc coated or galvanized steel conduit conforming to UL 6, Electrical Rigid Metal -Conduit Steel.

Non-metallic conduit or for ground and underground use without concrete encasement shall be rigid Polyvinyl Chloride (PVC) conforming to UL 651, Schedule 40, 80 Type EB and A Rigid PVC Conduit and Fittings.

### 624.2.7 Conduit Bodies, Boxes and Fittings

All conduit bodies, boxes and fittings shall be made watertight, dust tight and galvanized steel conforming to UL 514B, Conduit, Tubing and Cable Fittings. The terminal box on the module shall be designed for long-term outdoor operation in harsh environments with an opening for replacing the cable if necessary.

### 624.2.8 Roadway Lighting Pole Concrete Footing

Roadway lighting pole footing shall be Class A concrete conforming to the requirements of Item 405, Structural Concrete.

### 624.2.9 Electrical Conductors and Grounding

Entire system shall be grounded and bonded in accordance with the requirements of the latest edition of Philippines Electrical Code and shall conform to the applicable requirements of National Electrical Code of the Philippines Chapter 2, Use and Identification of Grounded Conductors.

Grounding wire shall be made of bare copper stranded, soft drawn wire and shall be installed in one continuous length without splice or joint. Ground rods shall be made of copper-clad steel of not less than 20 mm diameter x 3 m in length driven in full length into earth. The size of the ground rod and ground wells shall be as shown on the Plans and the resistance shall not be more than 5 ohms.

All conductors and grounding size shall not be less than the indicated sizes as shown on the Plans.

### 624.2.10 Programmable Logic Controller

Lighting system for tunnels shall be controlled and monitored by the Supervisory Control and Programmable Logic Controller (PLC). The PLC base unit power supply shall be 100-230VAC, I/O 16 nos., I/P; 8 nos. 24 VDC, Relay O/P; 8 nos., and shall have a program memory of 64000 steps RAM (internal). It shall also have all necessary accessories and operational manual.

### 624.2.11 Lighting Control Panel/Panelboard

All panelboards shall conform to the schedule of panelboards as shown on the Plans with respect to supply characteristics, ratings of main lugs or main circuit breaker, number, ratings, and capacities of branch circuit breakers.

Panelboard cabinets shall be designed and fabricated for pole surface mounted. Enclosures shall be fabricated to be watertight, dust tight, temper proof, dead front suitable for outdoor installation, and shall conform to the applicable requirements of the National Electrical Manufacturers Association (NEMA) 250, Enclosures for Electrical Equipment (1000 V Maximum), Type 3R, lockable with padlocks.

The panelboard cabinets shall be designed and fabricated for pole surface mounted and shall be given two coats of light gray color both interior and exterior cabinet.

Conduit entry shall be at the top and bottom. A directory holder shall be provided inside the panel and ground lug for ground wire connection. Nameplate of laminated plastic shall be attached by means of stainless-steel rivets or permanent adhesive showing panelboard number.

### 624.2.12 Circuit Breakers

All circuit breakers shall be plug in and thermal magnetic type, manually or electrically operated as required with ratings and capacity as shown on the Plans and shall be in accordance with UL 489, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

All circuit breakers shall have inverse-time tripping characteristics on overload and instantaneous trip on short circuits. It shall have quick make or break toggle mechanism, trip-free operating handle, and shall be equipped with arc quenches. Each multi-pole breaker shall be designed to have a common trip so that an overload or short on one pole will automatically cause all poles of the breakers to open.

### 624.2.13 Terminal Connector

Connectors for wiring shall be rated at least 600 volts and shall be of the following types:

For 5.5 $mm^2$ and smaller conductors/cables: Rugged material, such as phenolic, shall be mounted end-to-end without spacing. The pressure type tin plate copper connectors shall have non-flammable and self-extinguishing insulation with temperature rating equal to that of the conductor insulation.

For 8.0 $mm^2$ and above conductors/cables: Type of construction shall be one-piece and material shall be phenolic. Terminal configuration shall be done by binding screw terminals. Solderless type connector made of compact, high strength, high copper alloy, split-bolt, free running threads

and highly resistant to corrosion and cracking shall be used. Maximum pressure and assure/secure connection on all combinations of run and tap conductors shall be provided.

### 624.2.14 Emergency Lighting System

In case of power failure, a minimum lighting illumination level shall be immediately available from designated emergency light fixtures as well as from emergency exit signaling which are both deriving electric power from UPS Battery as indicated on the Plans.

The minimum lighting shall be available for 30 min to cover the necessary margin of elapsed time in-between power supply interruption and back-up power operation.

### 624.2.15 Main Feeder Distribution System

The main feeder distribution system shall be composed of conduit, electrical conductors and light control or panel board conforming to the material requirements specified herein.

### 624.2.16 Underground Electrical Works

Underground electrical works shall conform to the material requirements of Item 633, Cable Duct System.

### 624.2.17 Corrosion Protection

Ferrous metal raceways, cable armor, boxes, cable sheathing, cabinets, elbows, couplings, nipples, fittings, supports, and support hardware shall be permitted to be installed in concrete or in direct contact with soil. Corrosion protection shall be provided in areas subject to severe corrosive influences where made of material approved for the condition, or where provided with corrosion protection approved for the condition as indicated in the Plans or as approved by the Engineer.

### 624.2.18 System Protection

All roadway lighting systems shall be protected by an overcurrent device. The overcurrent device shall be size rated or setting not higher than the allowable ampacity of the conductor. The circuit breakers shall be of the thermal magnetic type having inverse-time tripping characteristics on overload and instantaneous trip on short circuits, shall be equipped with arc quenches, shall have quick-make and quick-break toggle mechanism, and shall have trip-free operating handles. Each multi-pole breaker shall have a common trip so that an overload on one pole will automatically cause all poles of the breakers to open.

### 624.2.19 Testing

A full type test for luminaire shall be in accordance with IEC 60598-2-3. For the humidity test, it shall be carried out at a relative humidity around 95% and at an ambient temperature of 28°C.

LEDs shall have test reports from IESNA LM80-08 and TM-21-11 qualified for relevant LED product testing.

## 624.3 Construction Requirements

All works shall be executed in the best practice in a workmanlike manner by qualified and experienced electricians under the immediate supervision of a duly Registered Electrical Engineer.

### 624.3.1 Roadway Lighting Poles

All roadway lighting poles shall be constructed of cold rolled mild steel of a sufficient gauge having yield strength of not less than 248.2 MPa and shall be followed with a prime coat of paint within 24 h. The prime coat of paint shall be compatible with the finish coat of paint.

Pole shall be threaded at the top end of the foundation and adjustment shall be provided for permanent vertical position with the bracket arm in proper position for luminaire location and size as shown on the Plans.

The pole shall be provided with a hand hole and grounding lug attachment at the elevation and a cable entry slot sized and located as shown on the plans. The slot shall be free of burrs and sharp edges.

### 624.3.2 Luminaire Assembly

Luminaire assembly shall be strongly constructed, weatherproof, hail proof, insect proof, corrosion proof, solar (including ultra-violet) resistant, and vandal resistant. It shall be mounted horizontally on a mast arm and shall be mechanically clamped to a 48-60 mm nominal diameter metal pipe end of the mast arm and adjusted to the required position using a clamping plate with at least two (2) – 9.5 mm minimum diameter hexagonal head clamping bolts if applicable. The luminaire shall pass the IEC 60598 vibration test.

The luminaire housing shall bear a nameplate that identify it as to type, rating, manufactured date, manufacturer and catalog data.

### 624.3.3 Ballast

Ballasts shall be of the encapsulated or vacuum impregnated type. The process of vacuum impregnation shall be such that the interstices of the windings are completely filled with the

impregnating material. Connections shall be brought out to a suitable brass screw terminal block mounted on the ballast housing. Terminal blocks with steel screws will not be acceptable.

### 624.3.4 Conduit

All electrical conduits and fittings shall be installed in their correct positions and locations as shown on the Plans. The conduits shall be directly embedded in earth, except under paved areas and roadways, the conduit shall be encased in concrete and end of conduits shall be plugged with patching compounds at all outlets, or boxes at the ends of conduits to keep the conduits dry. Trenches in which the PVC conduits are laid shall follow the alignment as indicated on the Plans. In trenches and sidewalks, the PVC conduit shall be laid on 10 cm sand bed and covered by a layer of sand, 20 cm on thick measured from the upper level of the bed. For trenches under paved areas the same procedures shall be followed except the concrete shall be used in the place of sand. After placing the concrete, the remaining part of the trench shall be backfilled up to the sub-grade level with soil compacted properly. Cables shall be installed in one length from point to point and no joints shall be permitted. Before the cables are pulled, the Contractor shall see to it that the conduits are continuous and clear of debris, stone, and sand. Sharp bends shall not be permitted. A minimum covering of 0.45 m under the pavement shall be required for the conduits under the roadway.

### 624.3.5 Conduit Boxes, Boxes and Fittings

Conduit boxes for pulling and splicing wires and outlet boxes shall be provided for installation of wiring devices and. As a rule, junction boxes or pull boxes in all runs greater than 30 m in length, for horizontal runs. For other lengths, boxes shall be provided as required for splicing or pulling. Pull boxes shall be installed in inconspicuous but accessible locations. Conduit boxes shall be installed plumb and securely fastened. They shall be set flush with the surface of the structure in which they are installed where conduits are run concealed.

All conduits shall be fitted with approved standard galvanized bushing and locknuts where they enter cabinets and conduit boxes. Junction and pull boxes of code gauge steel shall be provided as indicated on the Plans or as required to facilitate the pulling of wires and cables.

### 624.3.6 Roadway Lighting Pole Concrete Footing

The shape of Roadway lighting pole concrete footing shall be as shown on the Plans.

Excavation and backfill for foundation including disposal of surplus material shall be provided. Excavated holes for concrete footings shall be neat or properly formed and free from loose materials when the concrete is placed.

When placed, the concrete shall be wall consolidated to completely fill and devoid in the hole and around the pole when embedded. Concrete shall be moist wired and for not less than 4 days.

Anchor bolt circle dimensions shall be furnished and rigid template shall be used to center the anchor bolts in the foundation with exposed threaded ends, at least three (3) threads vertically positioned in concrete. Unless otherwise specified, the template shall be oriented so that the mast arm of the lighting standard is perpendicular to the centerline of the roadway. The top of the concrete foundation shall be constructed in level and only shims used to rake the lighting standard shall be permitted. Shims with break-away couplings shall not be permitted. Each foundation shall have an imprinted arrow/s on the top of the foundation to indicate the direction of the cable duct run.

### 624.3.7 Electrical Conductors and Grounding

All electrical conductors and grounding shall be furnished and installed by the Contractor with the sizes as indicated on the Plans. All connection shall be mechanically and electrically sound and secured by insulating tape. Solderless connectors of approved type shall be used for making connections of power cables. The insulations in then shall be built up again to normal thickness with rubber and vinyl plastic tapes. Splices in conductors shall only be made at pullboxes, handholes or cabinets. No kicks or abrasions in the insulation or protection covering shall be found in installed conductors.

All grounding system installation shall be executed in accordance with the Plans. Grounding system shall include ground rods and ground wire taps as shown in the approved design. The ground wire is connected to the top or side of the ground rod. The ground rod, ground wire connection is made by a thermo-weld process. The wire and ground rod are required to be free of oxidized materials, moisture, and other contaminates prior to inserting the wire and the ground rod into the properly sized mold. The welding material is required to sufficiently cover and secure the conductor to the rod. The completed connection is required to be nonporous. This connection includes a quick-disconnect type connector kit so that in the event of a pole knockdown the connection readily breaks without damage to the buried conductor.

### 624.3.8 Lighting Control Panel/Panelboard

All panelboards shall be installed by the Contractor at the locations indicated on the Drawings. All panels shall be of dead front construction furnished with trims for surface mounting. Electrical components shall be completely wired and installed in the enclosure in proper position and ready for operation. Power cables shall enter the panelboard enclosure through conduits. All branch circuit conduits shall enter the panelboard from the bottom.

### 624.3.9 Circuit Breakers

Circuit breakers shall be mounted so that any individual branch breakers can be removed without disturbing adjacent units or without loosening or removing supplement insulation.

### 624.3.10 Test and Guarantee

Upon completion of the electrical construction work, the Contractor shall provide all test equipment. The Contractor shall then submit copies of all test results to the Engineer.

After the installation of all cables, the Contractor shall test the insulation resistance of all feeders and connected equipment with a 600 V megger for grounds and short circuits. Testing shall include measuring of insulation resistance. These measurements shall be recorded by feeder and branch circuit number indicating the resistance values between phases and ground.

All effective and calibrated apparatus, materials and labor required for conducting tests shall be supplied and made available by the Contractor.

The Contractor shall guarantee that the electrical installation is done and in accordance with the Plans and Specifications.

## 624.4 Method of Measurement

The work under this item shall be measured either by pieces, set or lump sum, actually placed and installed as shown on the Plans.

The quantity of roadway lighting and electrical works to be paid for shall be the number of lighting poles of single and double luminaires to include all conduits, luminaires, all wirings, panelboard, nuts, washer, fasteners, conduit clamps, bolts, capacitors, coils and others including all necessary materials and accessories needed for moisture and fungus control, corrosion protections and all other incidentals needed to make the system operational and accepted to comply with the requirements of the latest edition of the Philippine Electrical Code, and any other ordinances including payment of necessary permits from local enforcing authorities.

The concrete footing will be measured and paid for as provided under Item 405, Structural Concrete. The quantity of structural concrete to be paid for shall be the final quantity placed and accepted in the completed structure.

Reinforcing steel bars will 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.

## 624.5 Basis of Payment

All works performed and measured and as provided for in the Bill of Quantities shall be paid for at the Unit Bid or Contract Unit Price which payment shall constitute full compensation including labor, materials, tools and incidentals necessary to complete this Item.

Payment shall be made under:

| Pay Item Number | Description | Unit of Measurement |
|---|---|---|
| 624 (1)a1 | Single Arm, 8m-Pole Roadway Lighting, LED, 60W-100W | Each |
| 624 (1)a2 | Single Arm, 9m-Pole Roadway Lighting, LED, 100W-125W | Each |
| 624 (1)a3 | Single Arm, 10m-Pole Roadway Lighting, LED, 125W-150W | Each |
| 624 (1)b1 | Single Arm, 8m-Pole, Roadway Lighting, HPS, 200W-250W | Each |
| 624 (1)b2 | Single Arm 9m-Pole, Roadway Lighting, HPS, 250W-300W | Each |
| 624 (1)b3 | Single Arm 10m-Pole Roadway Lighting, HPS, 300W-400W | Each |
| 624 (1)b4 | Single Arm 12m-Pole Roadway Lighting, HPS, >400W | Each |
| 624 (2)a1 | Double Arm 8m-Pole Roadway Lighting, LED, 60W-100W | Each |
| 624 (2)a2 | Double Arm 9m-Pole Roadway Lighting, LED, 100W-125W | Each |
| 624 (2)a3 | Double Arm 10m-Pole Roadway Lighting, LED, 125-150W | Each |
| 624 (2)b1 | Double Arm 8m-Pole, Roadway Lighting, HPS, 200W-250W | Each |
| 624 (2)b2 | Double Arm 9m-Pole, Roadway Lighting, HPS, 250W-300W | Each |
| 624 (2)b3 | Double Arm 10m-Pole Roadway Lighting, HPS, 300W-400W | Each |
| 624 (2)b4 | Double Arm 12m-Pole Roadway Lighting, HPS, >400W | Each |
| 624 (3)a | Undercarriage Luminaire, LED, 75W | Each |
| 624 (3)b | Undercarriage Luminaire, HPS, 150W | Each |
| 624 (4) | Warning Light, Complete with Conduits | Each |
| 624 (5) | Lighting Control Panel | Each |
| 624 (6) | Main Feeder Distribution System | Lump Sum |
| 624 (7) | Photoelectric Cells | Each |
| 624 (8) | Tapered, Solar LED Roadway Lighting, 8m height, 60W-100W | Each |
| 624 (9)a1 | Single Arm 8m-Pole Solar LED Roadway Lighting, 60W-80W | Each |
| 624 (9)a2 | Single Arm 9m-Pole Solar LED Roadway Lighting, 80W-125W | Each |
| 624 (9)a3 | Single Arm 10m-Pole Solar LED Roadway Lighting, 125W-150W | Each |
| 624 (9)a4 | Single Arm 12m-Pole Solar LED Roadway Lighting, 200W-300W | Each |
| 624 (9)b1 | Double Arm 8m-Pole Solar LED Roadway Lighting, 60W-80W | Each |
| 624 (9)b2 | Double Arm 9m-Pole Solar LED Roadway Lighting, 80W-125W | Each |
| 624 (9)b3 | Double Arm 10m-Pole Solar LED Roadway Lighting, 125W-150W | Each |
| 624 (9)b4 | Double Arm 12m-Pole Solar LED Roadway Lighting, 200W-300W | Each |
| 624 (10) | Underground Electrical Works | Lump Sum |
| 624 (11) | Roadway Lighting | Lump Sum |
| 624 (12) | Tunnel/Underpass Lighting | Lump Sum |
| 624 (13) | Lighting System | Lump Sum |
| 624 (14) | Built-In Advertising Display | Set |

*References:*

1. *Memorandum 097.7_092518, DPWH Standard Specification for Item 624 – Roadway Lighting*
2. *DPWH Standard Specifications for Highways, Bridges and Airports, Volume II, 2012 Edition*
   a. *Item 405 – Structural Concrete*
   b. *Item 633 – Cable Duct System*
   c. *Item 404 – Reinforcing Steel*
3. *American Society for Testing and Materials (ASTM)*
   a. *ASTM A153 -00 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*
4. *American Association of State Highway and Transportation Officials (AASHTO) M 111 – 19: Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products (ASTM A123) for the fittings*
5. *American National Standards Institute (ANSI)*
6. *Roadway Lighting Guidelines, Department of Energy, Philippines, 2017*
7. *National Structural Code of the Philippines, 2015 (NSCP)*
8. *Pacific Energy Center Factsheet Luminaire*
9. *US Brochure Circuit Protection According to UL 489 AND UL 1077*
10. *National Electrical Manufacturers Association*
11. *Philippine Electrical Code Part 1 and 2*
12. *DPWH Design Guidelines, Criteria and Standards*
13. *International Electrotechnical Commission (IEC)6241 / European Norm (NM) 6241: Photo Biological Safety of Lamps and Lamp Systems*
14. *IEC/EN 60598-1: Luminaires - General requirements and tests*
15. *IEC/EN 60598-2-3: Particular requirements - Luminaires for Road & Street Lighting*
16. *IEC/EN 62031: LED modules for general lighting – Safety specifications*