

<sup>A4</sup>**SECTION 26 50 00 - LIGHTING SYSTEMS**

**1.01 SUMMARY:** <sup>A4</sup>

- A. <sup>A17</sup>**Basic Function (Functional Requirement):** For the Works there are three basic functional requirements that are required to be met. The illuminations of all indoor and outdoor areas, the illumination of the chambers and the illumination of the fenced perimeter. The illumination shall provide for functional, safety and security illumination in all indoor and outdoor areas for all the types of activities that will be carried in the particular areas. All areas listed, and any other area that results from the development of the final design of the complex by the Contractor, shall be provided with functional, safety and security illumination under the same performance criteria required by this Section. It is required that the Contractor take special care to avoid introducing glare to the pilot's view that may interfere with the lockage operation. Special care shall also be taken in areas with intensive use of electronic displays, in order to achieve visual comfort.
- B. **Scope:** This Section contains the requirements for the design and construction of outdoor and indoor lighting for the Works. (Deleted text). The lighting systems shall provide for adequate illumination based on recommended minimum illumination levels prescribed in these specifications and in the IESNA Lighting Handbook. <sup>A17</sup>

<sup>A16</sup>**1.02 REFERENCES:** <sup>A16</sup>

- A. <sup>A7</sup>**American Society of Heating, Refrigeration and Air Conditioning (ASHRAE) Standard:** <sup>A7</sup>  
90.1 – 07                                      Energy Standard for Buildings Except Low Rise Residential Buildings
- B. <sup>A7</sup>**American Society for Testing and Material (ASTM) International Standards:** <sup>A7</sup>  
A-123-02                                      Specification for Zinc (hot dipped galvanized) Coatings on Iron and Steel Products  
A-572-07                                      Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
- C. <sup>A7</sup>**Federal Aviation Administration (FAA) Standard:** <sup>A7</sup>  
AC 150/5345-43F -06                      Specification for obstruction Lighting Equipment
- D. <sup>A7</sup>**National Fire Protection Association (NFPA) Publications:** <sup>A7</sup>  
70-08    National Electrical Code (NEC).  
101-06    Life Safety Code
- E. <sup>A7</sup>**Illuminating Engineering Society of North America (IESNA) Publication:** <sup>A7</sup>  
Ninth Edition - 06                          IESNA Lighting Handbook – Reference and Application

- F. <sup>A7</sup>**Underwriters Laboratories (UL) Standards:**<sup>A7</sup>
- |         |                                    |
|---------|------------------------------------|
| 50-03   | Enclosure for Electrical Equipment |
| 1598-06 | Luminaries                         |
- G. <sup>A7</sup>**U. S. Green Building Council (USGBC) Standard:**<sup>A7</sup>
- |         |   |
|---------|---|
| 189P-07 | Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings |
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### 1.03 REQUIREMENTS:

- A. **General:** The illumination system shall consist of energy efficient lighting fixtures designed and installed to provide the necessary illumination for the activity to be carried out in the particular area. The lighting system shall be designed to minimize the initial capital cost, as well as to minimize the overall operational maintenance cost. The lighting shall satisfy the illumination required for the activity to be carried out in the particular area while providing safety, security and a pleasant environment to the area and personnel. Lighting shall be provided for all indoor areas, including cross-unders, shafts, cable galleries, locks gate passageways, tunnels and elevators. Lighting shall be provided for all outdoor areas. Special consideration shall be given to avoid objectionable glare to the lockage operation, which translates to avoiding objectionable glare to the ship pilot. In addition, the light system shall be wired so that failure in a single circuit or a group of lighting units shall not leave the area with objectionable, unsafe dark areas or in total darkness.
- B. **Energy Efficiency:** The entire illumination installation shall conform to strict energy efficient standards in compliance with ASHRAE 90.1 and USGBC 189.
- C. **Redundancy and Standardization:** All locks shall have the same arrangement with the same type and make of equipment. All equipment shall be new commercially available standard manufactured products. It will not be required to provide a redundant lighting system. However, independent to the dual feeders supplying the lighting and power transformer and back up power available, there shall be provided emergency battery powered lighting fixtures to provide safety movement and egress in all building, as listed in Subparagraph 1.04 D., and others as necessary for a safe working and operating condition.
- D. **Design Life:** Illumination systems shall be designed for a life expectancy of no less than 25 years, with individual equipment life chosen to have the longest life expectancy and compatible with the overall life of the system.
- E. **Labeling:** Light fixtures shall be UL listed and labeled for the particular environment and application in which the fixture is installed.
- F. **Maintenance:** Lighting fixtures, poles, brackets, hardware and accessories shall be selected to minimize future maintenance, prolong the life of the equipment and maximize the functionality of the equipment.

- G. **Corrosion Protection:** Luminary lighting material and all associated hardware, including supporting hardware shall be corrosion resistant and adequate for the ambient in the location where installed. Gasket, filters shall be provided where necessary to avoid humidity and insects to penetrate the fixture. Lighting fixtures located outdoors shall be cast aluminum housing, with all accessories corrosion resistant to the humid tropical environment, sunlight and salt spray from prevailing winds in close proximity to the sea.

#### 1.04 DESIGN CRITERIA AND SYSTEM DESCRIPTION:

- A. **General:** The various lighting systems shall be designed to incorporate all the energy efficient equipment and conservation methods available, while conforming to the requirements of this Section. Equipment to be outdoors shall be of the enclosed, gasketed and filtered type. The minimum maintained average illumination for each area identified shall be as required in this Section. The Contractor shall use the normal calculation method for calculating the various illumination levels in accordance with IESNA Lighting Handbook and as required by this Section. The Contractor shall use the "Point By Point" method for computing illumination to confirm the required illumination and uniformity ratios.
- B. **Illumination Levels:** As listed in the following Table No. 1 the Contractor shall provide minimum average illumination level and minimum uniformity level (shown as ratio of average to minimum level) where shown in the list. Buildings or rooms provided in the Contractor's design that are not listed, shall also be provided with illumination following the criteria required for similar buildings listed.

Table No. 1 -- Illumination - Minimum Levels --					
	LOCATION	Specific Area	Lighting fixture type	ILLUMINANCE IN LUX	
				Average maintain	Average minimum uniformity
1	LOCKS				
		Zone 1	HPS-HM	100	3
		Zone 2	HPS-HM	50	3
		Zone 3	HPS-HM	None	
		<sup>A16</sup> Zone 4	HPS-CH	50/30	3 <sup>A16</sup>
2	Water-Saving Basin (WSB)				
		Zone 5	HPS-HM & HPS -RW on aluminum poles	<sup>A7</sup> 20 <sup>A7</sup>	<sup>A7</sup> 3 <sup>A7</sup>
3	Roadway				
		Access roads	HPS -RW on aluminum Poles	20	3
4	Perimeter				
		Perimeter fence	MH-P on concrete	10	2.5
5	Main Control Bldg. [CB]				
		Console (direct)	Type A recessed	750	
		(indirect)	Type B surface	300	3

**Table No. 1 -- Illumination - Minimum Levels --**

	LOCATION	Specific Area	Lighting fixture type	ILLUMINANCE IN LUX	
				Average maintain	Average minimum uniformity
		(surroundings)	Type AAA	contrast	
		Conference (direct)	Type A recessed	600	
		(indirect)	Type B surface	300	3
		(surroundings)	Type AAA	contrast	
		Office	Type A recessed	750	
		Toilet	Type C surface	200	
		Kitchenette	Type AA recessed	500	
		Cleaning	Type B surface	200	
		Electrical	Type AA recessed	300	
		Battery	Type F surface	200	
		Computer	Type AA recessed	500	
		Air condition	Type B surface	200	
6	<b>Machinery Room — Gates [MR-G]</b>				
		Machinery	Type MH Surface	300	
		Electrical	Type E surface	300	
		Battery	Type F surface	200	
		Control	Type E surface	300	
		Exterior			
7	<b>Machinery Room — WSB [MR-WSB]</b>				
		Machinery	Type D surface	300	
		Electrical	Type D surface	300	
		Battery	Type F surface	200	
		Exterior			
8	<b>Culvert Valve Machinery Room [MR-V]</b>				
		Machinery	Type D surface	300	
		Electrical	Type D surface	300	
		Battery	Type F surface	200	
		Exterior			
9	<b>Generator Room [GR]</b>				
		Generator set	Type D surface	300	
		Switchgear	Type D surface	300	
		Transformers	HPS- Surface	200	
		Battery	Type F surface	200	
		Telecomm	Type AA recessed	300	
10	<b>Spares Storage Bldg. [SS]</b>				
		Storage	Type MH Surface	300	
		Open storage	HPS on aluminum	200	
11	<b>Electrical Rooms [ELR-1] to [ELR-8]</b>				

**Table No. 1 -- Illumination - Minimum Levels --**

	LOCATION	Specific Area	Lighting fixture type	ILLUMINANCE IN LUX	
				Average maintain	Average minimum uniformity
		Equipment	Type D surface	300	
		Battery	Type F surface	200	
12	<b>Maintenance Building [MB]</b>				
		Workshop/crane	Type MH Surface	300	
		Tool and Storage	Type D surface	600	
		Office	Type AA recessed	600	
		Kitchenette	Type AA recessed	500	
		Toilet	Type B surface	200	
13	<b>Fire-Fighting Equipment Room [FER]</b>				
		General	Type D surface	300	
14	<b>(Reserved)</b>				
15	<b>Personnel Bldg. [PB]</b>				
		Lobby	Type AA recessed	300	
		Time Office	Type AA recessed	600	
		Janitor closet	Type D surface	200	
		Janitor lunch	Type E surface	300	
		Changing	Type E surface	200	
		Toilets & lavatory	Type E surface	200	
		Showers	Type E surface	200	
		Meeting/Instruction			
16	<b>Personnel Break Room [PBR]</b>				
		Dinning	Type AA recessed	500	
		Kitchenette	Type AA recessed	500	
		Toilets & lavatory	Type E surface	200	
		Storage	Type E surface	200	
17	<b>Parking Lots [PLE] &amp; [PLV]</b>				
			HPS-RW on poles	30	3
18	<b>(Reserved)</b>				
19	<b>Guardhouse [GH]</b>				
		Inspection	Type MH Surface	300	
		Workstation	Type AA recessed	500	
		Conf. & interview	Type AA recessed	500	
		Toilet & changing	Type C surface	200	
		Kitchenette	Type AA recessed	500	
		Cleaning	Type B surface	200	
		Server & other Equipment	Type AA recessed	300	
		Telecomm	Type AA recessed	300	
20	<b>Guard Booth [GB]</b>				

Table No. 1 -- Illumination - Minimum Levels --					
	LOCATION	Specific Area	Lighting fixture type	ILLUMINANCE IN LUX	
				Average maintain	Average minimum uniformity
		Inspection Area	Type AA recessed	300	
		Toilet	Type C surface	200	
21	Electrical Crossunder				
		Tray and walkway	Type F surface	200	
22	Water Pipe Crossunder				
		Pipe and walkway	Type F surface	200	
23	Crossunder Elevator				
		Cabin interior	Type G surface	200	
		Exterior landing	Type F surface	300	
		Machinery Room	Type E surface	300	
24	Wastewater Treatment Plant [WWTP]				
		Equipment room	Type D surface	300	
25	(Reserved)				
26	Rolling Gate	Passageway & access	Type F surface	200	

- C. <sup>A7</sup>**Outdoor Area Illumination Level, Configuration and Equipment.** <sup>A7</sup> <sup>A17</sup>The locks outdoor working area to be illuminated shall consist of five zones defined in Table No. 1, and drawing No.5801-400 "Illumination Zones", (Refer to Vol. VI, Part 1, for location of drawings). <sup>A17</sup> Also to be illuminated is the perimeter fence area surrounding the locks, the approach and circulation roads within the locks complex.

1. <sup>A7</sup>**Locks Working Area (Zones 1, & 2):** <sup>A7</sup>

- a. <sup>A17</sup>Zones 1 and 2 shall be illuminated by means of high pressure sodium (HPS) high mast lighting fixtures mounted on high mast poles. <sup>A17</sup> Circuit wiring shall be designed to enable the control room operator to shut off 100%, and 50% of the light fixtures during extended low activity in the area. Illumination level shall be as per Table No. 1.
- b. Zone 1 shall consist of a 70 m wide area extending from the edge of each lock wall face towards the east and west shore sides, and extending the overall length of the three chambers. Also, Zone 1 shall also extend along the approach walls, with a width of 50 m for the full length of each approach wall. Refer to <sup>A17</sup>drawing <sup>A17</sup>No. 5801-400 for details.
- c. Zone 2 shall consist of a 60 m wide by the longitudinal extension of the WSB, consisting of the area in the vicinity of the Machinery Room Gates Building [MR-G] housing the high voltage, rolling gates and culvert gates machinery and equipment, with the WSB area closest to the chambers. Refer to <sup>A17</sup>drawing <sup>A17</sup>No.5801-400 for details.

- d. Zone 3 shall consist of a future central area between the third set of locks and the future fourth set of locks. Neither design, nor work is required at this time for the illumination of this area. Refer to <sup>A17</sup>drawing <sup>A17</sup>No.5801-400 for details.

2. **Chamber Lighting (Zone 4):**

- <sup>A17</sup>a. The Contractor shall design and specify an illumination system to provide illumination to the dark pockets that are produced all along both sides of a large wide ship hull (starboard and port) and the walls of the chamber and down to the water level. The illumination shall permit the ship pilot to have a clear visual reference to correctly assess the position of his ship hull in relation to the walls of the locks and the water level. The lighted reference area may be discrete or continuous, along the chamber wall. The maintained average horizontal illumination at the low water level in the chamber shall be 50 lux with a minimum of 17 lux at the mid point between lighted areas along the water surface. For the purpose of the required calculations the Contractor shall use the Design Vessel described in Subparagraph 1.02 A. of Section 01 10 00 (*General Project Requirements*), with zero reflectance from the ship sides. In addition, with no ship in the chamber, the illumination inside the chamber, at the water level, shall have an average illumination not less than 30 lux originating from the high mast lighting installation. The operator in the Main Control Building [CB] shall be able to remotely control the illuminated area to on-off. Materials used to construct the chamber lighting fixture housing, shall not produce sparks if contacted or collided with a vessel or other obstruction. Construction of this system will be by the Employer. <sup>A17</sup>

3. **WSB Lighting (Zone 5):**

- a. Zone 5 shall consist of the entire area of the WSB, excluding the area covered by Zone 2. This area is approximately 140 m wide by the longitudinal extent of the entire WSB. This zone shall also include the areas for circulating vehicles and walkways in and around the WSB. <sup>A17</sup>This area shall be illuminated with HPS high mast lighting fixtures mounted on high mast lighting poles or roadway type poles. <sup>A17</sup> The roadway, walkways and the WSB areas illumination level shall be the same, as defined by Table No. 1 for Zone 5. Refer to Drawing No. 5801-400 for details. Lighting levels shall be as required by Table No. 1.

4. **Gate Lighting:**

- a. The gate shall be provided with reflective strips of paint, or other means to provide the pilot with additional reference, in addition to the illumination available from the high mast lighting. No exterior lighting fixtures are required on the gates.

5. **Special Lighting:**

- a. **Semaphores:** Semaphores shall be provided and installed at both entrances of the locks to signal the pilot that his ship can enter the chamber. Red colored fixtures for no entrance and green for authorized entrance. Design details, including location, height and visible range for an optimal function, shall be coordinated with the Employer's Representative.
- b. **Hazardous Cargo Signal Lights:** Strategically located red flashing lights shall be provided, to announce working personnel in the area that a ship approaching the locks, or inside the locks, is carrying hazardous cargo.
- c. **Gate Operation Signal:** Strategically located red flashing lights and audible signals shall be provided, to announce working personnel in the area that a gate is to be opened or closed. Refer to Section 01 81 19 (*Lock Gates*) for details.

6. **Perimeter Lighting:**

- a. (Deleted text). The area surrounding the perimeter fence shall be illuminated to permit visual inspection and CCTV cameras to clearly spot movement and intrusion in the area.<sup>A17</sup> The area to be illuminated shall be the entire longitudinal run of the fence and a distance in front and back of the fence of 5 m. Lighting levels shall be as required by Table No. 1.

7. **Parking Lots [PLE] & [PLV]:**

- a. <sup>A17</sup>The area designated for parking of vehicles shall be illuminated by means of high pressure sodium luminaries supported from aluminum poles and brackets.<sup>A17</sup> Luminaries shall be of the semi cut-off type. Pole sizes shall be selected to suit the required illumination and minimize cost of the installation. The illumination level shall be as defined by Table No. 1.

8. **High Mast Area Lighting.**

- a. <sup>A17</sup>**Poles:** The high mast poles shall consist of no less than 30 meter high poles to withstand 145 kilometers per hour (90 miles per hour wind), with a 1.3 wind gust factor. The poles shall be round or multi sided tapered sections. The pole shaft section shall be fabricated from high strength, low alloy steel plate conforming to ASTM A 572 with minimum yield strength of 55,000 psi. Shaft sections shall telescope into each other. Weld penetration shall be 100% at the overlapping areas and 60% minimum in other areas. The pole shaft and ring shall be hot-dipped galvanized in accordance with ASTM A123. The pole shall be provided with a luminary ring assembly to support the required amount



of fixtures, plus two CCVS cameras. The ring assembly shall **lock (latch)** at the top and be able to secure the hoisting cables at the bottom. Access to the wiring and accessories inside the pole shall be by means of a hand hole at the bottom of the pole. The portable power unit shall permit the remote operation by means of a connected cord so that the operator can operate the hoisting and lowering of the ring assembly from a safe distance. At least two portable power unit assemblies shall be supplied complete ready to operate. Pole foundation shall be reinforced concrete, with anchor bolts. All high mast poles shall be provided with a lightning arrester terminal and obstructions lights.<sup>A17</sup>

- b. **Lowering device:** The lowering device shall be lockable to serve as the prime holding device. For safety reasons the hoisting/lowering cable shall serve as a backup holding device.
- c. **HPS Lighting Fixtures (HPS-HM):** Lighting fixtures shall be rated for use with 1,000 watt HPS double arc tube lamps, to provide instant restrike capability after outages or voltage dip. The fixtures shall be supported on a ring assembly capable of being lowered with a drive motor having a remote cord operated device. The fixture shall be made of cast aluminum housing with all hardware made of corrosion resistant materials. **Fixture design and construction shall maximize luminaire dirt depreciation factor (LDD), (LDD = 1.0 – light loss due to dirt). The minimum acceptable LDD shall be 0.75, resulting at the end of a 5 year period or longer.** Fixture shall have IES distribution cut-off type with photoelectric cell receptacle and cell. Fixtures shall be individually fused.
- d. <sup>A7</sup>**Obstructions Light:**<sup>A7</sup> Obstruction light shall be double red LED lights with no less than 25,000 hours of life. The obstruction light fixture shall be suitable for outdoor wet location operation and certified by FAA. Obstruction lights shall comply with FAA AC 150/5345-43F, UL 50 and UL 1598. The obstruction light shall have **an independent photoelectric cell for control.**
- e. <sup>A7</sup>**Lightning Arrester:**<sup>A7</sup> Arrester shall be 0.90 m long copper air terminal, bonded and grounded to the pole shaft.
- f. **Ballast:** <sup>A17</sup>All ballasts shall be for operation from a 480/277 volt system, 60 Hz supply, of the high power factor type, with low total harmonic distortion, complying with ANSI and UL standards.<sup>A17</sup>
- g. **Wiring:** Distribution working voltages shall be 3 phase, 480/277 volts, 60 Hz. Two circuits shall feed the lighting fixtures on each pole, with provision of remote control from control room so that 50% and 100% of the light fixtures can be shut off during periods of extended low activity, or at will. Circuit breakers shall be provided inside the pole for protection and disconnecting power for routine maintenance. Cabling for power of the CCVS camera and data shall be provided in selected poles.

Specification of the CCVS cables and location of selected poles is specified in Section 28 23 00 (*Closed Circuit Video Systems*). However, the Contractor shall provide the required power, communication, video, etc. cables integral with each pole as required. The cables can be a composite cable or separate cables as required for the function. Proper terminals shall be provided inside the base of the pole for extending the cables.

- h. **Foundations:** Foundation shall be steel reinforced concrete for each pole, with anchor bolts, and designed in close coordination to the pole anchor base and the specified pole withstand capability. The foundation shall extend 150 mm above finished grade.
- i. **Grounding:** Pole shall be grounded to a copper ground rod located in the base of the pole, and extended/bonded to the locks grounding grid. Grounding shall be coordinated with proper corrosion control provisions. Ground resistance at the base of the pole shall be 5 ohms or less. Grounding and bonding shall meet the requirements of Section 26 05 26 (*Grounding and Bonding for Electrical Systems*).

9. **Chamber Lighting System:**

- a. <sup>A17</sup>**Reserved.**
- b. **Lighting fixture:** If the light source is a discharge type (type HPS-CH), it shall be HPS 250 watts, with enclosure classified explosion proof, as Class I, Division 1, Groups A, B, C, or D, as defined in the NFPA-70. The letters indicate the gas or vapor in the hazardous location. The light fixture shall be explosion proof type suitable for outdoor installation, with a submersible enclosure. Lighting fixtures shall be cast aluminum housing. <sup>A17</sup>
- c. **Ballast:** <sup>A17</sup>All ballasts shall be for operation from a 480/277 volt system, 60 Hz supply of the high power factor type, with low total harmonic distortion, complying with ANSI and UL standards. <sup>A17</sup>
- d. <sup>A7</sup>**Wiring and Control:**<sup>A7</sup> The niche wiring shall conform to the NFPA-70 requirements for hazardous area, classified as class I, Groups A, B, C, or D, as defined in the NFPA-70. The hazardous area classification shall include the lighting fixture, the electrical plunger for retracting the fixture and any other fire initiating device or material. Wiring circuits shall be designed such that a loss in any one circuit shall not leave dark areas. Chamber lighting shall be remotely controlled from the control room at the Main Control Building [CB], manually for “on-<sup>A17</sup>off” <sup>A17</sup> control in series with a photoelectric control. In addition, provide a manual override of the photoelectric control.

10. **Roadway Lighting System hardware:**

- a. **Poles:** Roadway poles shall consist of aluminum round tapered poles of height and aluminum bracket arms as required to achieving the required illumination and uniformity levels. Poles shall be provided with dampening device. Hand holes for ready access to the wiring shall be provided.
- b. **Lighting Fixtures:** Roadway <sup>A17</sup>lighting fixtures <sup>A17</sup> (HPS-RW), shall be HPS with die cast aluminum housing, completely sealed with filtered optics, cut-off type distribution, with photoelectric receptacle and cell for individual control.
- c. **Ballast:** <sup>A17</sup>All ballasts shall be for operation from a 480/277 volt system, 60 Hz supply of the high power factor type, with low total harmonic distortion, complying with ANSI and UL standards. <sup>A17</sup>
- d. **Wiring:** Distribution working voltages shall be 3 phase, 480/277 volts, 60 Hz. Wiring circuits shall be designed such that a loss in any one circuit shall not leave dark spots.
- e. **Grounding:** Pole shall be grounded to a copper ground rod located in the base of the pole, and extended, bonded, to the locks grounding grid. The grounding lug shall be readily accessible for inspection. Grounding shall be coordinated with the corrosion control requirements, as detailed under the corrosion protection paragraph. Ground resistance at the base of the pole shall be 5 ohms or less. Grounding and Bonding shall meet the requirements of Section 26 05 26 (*Grounding and Bonding for Electrical Systems*).
- f. **Foundation:** Pole foundations shall be steel reinforced concrete, with anchor bolts, and designed in close coordination to the pole anchor base and the pole loading and withstand capability. The foundation shall extend 150 mm above grade.

11. **Perimeter Fence Lighting:**

- a. **Poles:** Poles shall be round tapered concrete poles for direct sinking of base into the earth. Poles shall be installed inside the perimeter of the locks compound, with aluminum brackets capable of supporting two floodlights per pole and a center support position for a CCVS camera. Each pole installation shall include an incoming and outgoing conduit entrance for the electrical cables, in addition to an incoming and outgoing conduit for the CCVS and fiber optics cables.
- b. **Lighting Fixtures:** Fixtures (MH-P) shall consist of 250 watt MH aluminum floodlight fixtures, with die cast aluminum housing, with photoelectric receptacle and cell, for individual control. Light

distribution and positioning shall be such as to avoid light sources producing glare to the ship pilot.

- c. **Ballast:** <sup>A17</sup>All ballasts shall be for operation from a 480/277 volt system, 60 Hz supply of the high power factor type, with low total harmonic distortion, complying with ANSI and UL standards. <sup>A17</sup>
- d. **Wiring:** Distribution working voltages shall be 3 phase, 480/277 volts, 60 Hz. Wiring circuits shall be designed such that a power loss in any one circuit, or any one lighting fixture shall not leave dark spots.
- e. **Grounding:** Every pole shall be grounded to and copper ground rod located at the base of the pole, and extended. Grounding shall be coordinated with the corrosion control requirements, as detailed under the corrosion protection paragraph. Ground resistance at the base of the pole shall be 5 ohms or less. Grounding and bonding shall meet the requirements of Section 26 05 26 (*Grounding and Bonding for Electrical System*).

D. <sup>A7</sup>**Indoor Area Illumination Level, Configuration and Hardware.**<sup>A7</sup>

- 1. **General:** <sup>A17</sup>When metal halide fixtures are used provide a means for instant return of light, in case of voltage dips. Fluorescent lighting fixtures shall employ 1.2 m long fluorescent dual pin base tubes rated 32 watts or 2.4 m fluorescent single pin base tubes rated 59 watts, both of the cool white type having a color temperature of 4,100 °K and a CRI range within 78 and 86. Fixture and tube lengths are nominal lengths. All ballasts shall be of the high power factor type, with no more than 10% THD, complying with ANSI and UL standards. <sup>A17</sup> Perimeter of buildings shall be provided with wall mounted Type H luminaries to enhance lighting along the entrance/exit and circulation around the building. Control of these perimeter light fixtures shall be by means of photoelectric control devices.
  - a. **Lighting Fixtures:**
    - 1) **Type A:** Fluorescent lighting fixture shall be 60 cm wide by 120 cm long fluorescent, with 24, 10 cm deep cells parabolic troffers. The parabolic louver grid shall have specular finish. The unit shall be installed recessed in the type of ceiling specified.
    - 2) **Type AA:** Fluorescent lighting fixture shall be 60 cm wide by 120 cm long fluorescent, with non yellowing virgin acrylic refractive lens, VDT brightness control with a VCP higher than 75. The unit shall be installed recessed in the type of ceiling specified

- 3) **Type AAA:** Compact fluorescent down light fixture decorative type. The unit shall be installed recessed in the type of ceiling specified
- 4) **Type B:** Fluorescent lighting fixture shall be 120 cm long fluorescent strip lighting. The unit shall be installed surface in the type of ceiling specified.
- 5) **Type C:** Fluorescent lighting industrial fixtures shall be 120 cm long fluorescent suitable for rough service, for wet and humid locations. Housing shall be impact resistant, UV resistant, fiberglass reinforced polyester housing, with cold rolled steel wire way. Lens shall be <sup>A17</sup>high <sup>A17</sup> impact non-yellowing acrylic diffuser. The unit shall be installed surface in the type of ceiling specified.
- 6) **Type D:** Fluorescent lighting industrial fixture shall be 240 cm long fluorescent strip lighting. The unit shall be installed surface in the type of ceiling specified.
- 7) **Type E:** Fluorescent lighting industrial fixtures shall be 240 cm long fluorescent suitable for rough service, for wet and humid locations. Housing shall be impact resistant, UV resistant, fiberglass reinforced polyester housing, with cold rolled steel wire way. Lens shall be <sup>A17</sup>high <sup>A17</sup> impact non-yellowing acrylic diffuser. The unit shall be installed surface in the type of ceiling specified.
- 8) **Type F:** HID lighting fixture, explosion proof type, for hazardous locations classified as Class 1, Division 1. <sup>A17</sup>Light source shall be 50 watt high pressure sodium bulb. Fixture shall be suitable for wet location, provided with guard protection. Provide with high power factor dual tap ballast for operation on 120 or 277 volts AC. <sup>A17</sup>
- 9) **Type G:** Incandescent lighting fixture, explosion proof type, for hazardous locations classified as Class 1, Division 1. Light source shall be 50 watt extra long life incandescent bulb, rated 130 volts for use in 120 volt circuit, with no less than 5,000 hours life duration. Fixture shall be suitable for wet location, provided with guard protection.
- 10) **Type MH:** Metal halide lighting fixture, for high, medium or low bay lighting fixture as suitable for the type of ceiling of the building, suitable for indoor/outdoor use. Unit shall be enclosed filtered optical assembly. Lamps shall be pulse start <sup>A17</sup>metal halide <sup>A17</sup> lamps for short duration restrike of 4 minutes or less. Lighting fixtures shall be cast aluminum housing.

- 11) **Type H:** High <sup>A17</sup> pressure <sup>A17</sup> lighting fixture, for wet location outdoor surface mounting, with glass or UV stabilized refractors, 70 watts, high power factor ballast. Fixture units located at entrances and exits to buildings shall be provided with an additional DC operated lamp and DC circuit to light “on” in case of loss of AC power.
2. **Main Control Building [CB] Control Room:** The illumination in the Control Room area shall be a dual system, consisting of an indirect illumination lighting system and a direct illumination lighting system. The indirect illumination lighting system shall consist of fluorescent fixtures located in cove niches to give a uniform pleasant soft illumination in the main operating area where consoles and VDT are located. The maximum ceiling luminance shall be 400 cd/m<sup>2</sup> for the indirect lighting system. The direct illumination systems shall consist 0.60 m by 1.2 m (nominal dimensions) fluorescent lighting troffer fixtures to also give a uniform pleasant soft illumination in the main operating area. Dimming controls shall permit varying the lighting from “off” to the maximum average. The lighting installation shall be suitable for intensive use of VDT terminal. Accent lighting shall be provided with compact fluorescent down lights for a pleasant contrast in areas adjacent to the console and VDT basic operation. Emergency battery operated lighting fixtures shall be provided. The illumination levels shall be as defined by Table No. 1. Switching and dimming shall be provided to permit changing the lighting environment. Dimming controls and ballast shall not introduce electromagnetic interference or noise to the environment.
3. **Buildings [MR-G]; [MR-WSB]; [MR-V] to [ELR-1] to [ELR-8]:** The illumination levels and lighting fixtures shall be as defined by Table No. 1. Emergency battery operated lighting fixtures shall be provided. Switching control shall provide for 100% “on” and 50% “on” of the average illumination and “off”
4. **Buildings [GR]; [SS]; [FER]; [AC]; [PB]; [GH] to [GB]:** The illumination levels and lighting fixtures shall be as defined by Table No. 1. Emergency battery operated lighting fixtures shall be provided. Switching control shall provide for “on” and “off”.
5. **Maintenance Building [MB]:** The illumination levels and lighting fixtures shall be as defined by Table No. 1. The lighting installation shall be suitable for intensive use of VDT terminal in specific areas identified for such use. Emergency battery operated lighting fixtures shall be provided. Switching control shall provide for “on” and “off”.
6. **(Reserved)**
7. <sup>A17</sup>**Crossunder <sup>A17</sup> for Electrical/control and Water Pipe Utilities:** The illumination shall be as defined by Table No. 1. Half of the fixtures within the tunnel shall be supplied from an east side of the locks located panelboard and the other half of the fixtures shall be supplied from a west side of the locks located panel board. Lighting fixtures shall be wired alternately from the east and west

panelboard in order to minimize the extent of an area left without illumination in the event of loss of power from one panelboard source. Emergency battery operated, explosion proof type lighting fixtures shall be provided.

8. <sup>A17</sup>**Crossunder Elevator:** The elevator cabin, the elevator shaft and the elevator machinery room, shall be illuminated with explosion proof fixtures of the pulse start metal halide type for short duration start after loss of power. <sup>A17</sup> Switch and wiring shall be explosion proof in compliance with Class 1, Division 1. Emergency battery operated, explosion proof type lighting fixtures shall be provided. Refer to Section 01 86 13 (*Plant – Mechanical and Equipment*).
  9. <sup>A17</sup>**Crossunder <sup>A17</sup> Elevator Room [CER]:** The illumination shall consist of fluorescent lighting fixtures as per Table No.1. The illumination level shall be as defined by Table No. 1. Emergency battery operated lighting fixtures shall be provided.
  10. **Wastewater Treatment Plant [WWTP]:** The illumination shall consist of 2.4 m fluorescent lighting fixtures. The illumination level shall be as defined by Table No. 1.
  11. **(Reserved)**
- E. **Emergency Lighting:** Emergency lighting to maintain a minimum average in all egress passageways, including stairways, as required by NFPA 101. Emergency lighting units for all buildings shall be provided of the battery operated type upon loss of normal source of power. Batteries shall be 12 volt nickel cadmium type sized to provide not less than 90 minutes of continuous back up lighting upon loss of power, with self diagnostic indication. Emergency lighting for cross-under tunnels shall be explosion proof fixtures classified Class 1 Division 1. Exit lighting fixtures shall be provided in all buildings to designate the egress passageway. The units shall be mounted to provide clear visibility throughout the area. Exit lighting fixtures shall be LED type with battery backups to provide clear illuminated faceplates upon loss of normal source of power. Batteries shall be long life nickel cadmium batteries with self diagnostic indication.
- F. **Controls:** <sup>A17</sup>The entire high mast lighting fixture shall be independently controlled by **photocell**. **However**, a central control shall be provided at the Control Room located in the Control Building [CB], to permit the operator to manually control, “on” and “off”, 50% of the light fixtures mounted on the high mast poles, the other 50% of light fixtures shall have only automatic control. <sup>A17</sup> At each building, control shall be by local switches located for quick and convenient access.

**1.05 SUBMITTALS:** Shall be in accordance with Section 01 33 00 (*Submittal Procedures*).

- A. <sup>A16</sup>**After Commencement Date:** <sup>A16</sup>
1. <sup>A17</sup>General plan arrangement of each lock’s lighting system, including a written explanation of the lock’s lighting system design, and equipment selection. <sup>A17</sup> It shall contain a summary of the criteria for the background of the preliminary design. The justification for each major selection and design decision shall be

clearly stated, and include supporting calculations, when applicable. The preliminary design shall include but not be limited to the following:

- a. General plan arrangement drawing showing the contemplated illumination for all outdoor areas and zones.
- b. General description of the functional illumination contemplated for all indoor areas.
- c. General description of the functional illumination contemplated for indoor and outdoor life safety and security.

**B. <sup>A7</sup>Before Manufacturing and Construction.<sup>A7</sup>**

1. **Final Design Data:** After 100% completion of the design and prior to the procurement of materials or equipments, the Contractor shall submit to the Employer's Representative for his review, the final design data. The design data shall include, as a minimum, a description of the system or components, design calculations, design drawings, diagrams, design specifications, equipment data and material specifications.
  - a. **Indoor Areas Lighting Design:** It shall provide the final illumination arrangement in scaled drawings showing exact location of major components. It shall include wiring and details for a complete design drawing for construction.
  - b. **Outdoor Areas Lighting Design:** It shall provide the final illumination arrangement in scaled drawings showing exact location of major components. It shall include wiring and details for a complete design drawing for construction.
  - c. <sup>A7</sup>**Calculations, Parameters and Other:<sup>A7</sup>** The Contractor shall submit complete details of the lighting calculation method, calculations, parameters employed (mounting heights, work-plane, height above finished floor or grade, lamp type, light source wattage and lumen, light loss factors), and software used, for verification by the Employer's Representative. The information furnished shall include the photometric files for all the different types of luminaires. Photometric files to be delivered shall be in IES format, provided in a hard copy and electronic format. In addition, the Contractor shall deliver a copy of the illumination engineering software employed to perform the illumination calculations.

**C. <sup>A7</sup>Taking-Over Submittal:** Shall be in accordance with Section 01 77 00 (*Taking-Over Procedures*)<sup>A7</sup>

1. **As Built Drawings:** <sup>A17</sup>As built drawings <sup>A17</sup> and part list shall be submitted. Drawings shall include all the lighting plans, indoor and outdoor, luminaires' schedules, wiring details and material lists, which shall include all revisions.



2. **Final Report:** A final report shall be delivered to the Employer's Representative, describing the lighting system installation and complete testing results. <sup>A17</sup>A list of all luminaries, control devices and related hardware, with the manufacturer's complete address, telephone numbers, e-mail, web page, etc., shall be included in the report. <sup>A17</sup>

#### 1.06 <sup>A7</sup>QUALITY ASSURANCE:<sup>A7</sup>

- A. <sup>A7</sup>**Qualifications of Personnel:**<sup>A7</sup> The firm or persons that will perform the design of the illumination for the locks complex, shall have a minimum of 8 year experience record of successful in service performance designing illumination systems/installations. The responsible personnel for the design shall be a registered Professional Engineer.
- B. <sup>A7</sup>**Testing and Inspection:**<sup>A7</sup>
  1. **General:** For the purpose of testing and inspection, the Contractor shall provide a calibrated digital light meter to verify the illumination levels at the required working level for all areas.
  2. **Visual:** Visual Inspection: Inspect for compliance with the drawings and specifications.
  3. <sup>A7</sup>**Wiring and Controls:**<sup>A7</sup> For all areas, inspect wiring and control for conformance with design specifications and for satisfactory operation.
  4. **Field Tests:** The field testing shall be in accordance with <sup>A7</sup>Section 26 90 00 (*Field Testing Electrical Systems*)<sup>A7</sup> <sup>A17</sup>and 01 91 00 (*Tests on Completion and Tests After Completion*).<sup>A17</sup>
  5. **Test Records:** Prepare and maintain complete records of all tests and results. Include average, high and low values obtained.
  6. **Acceptance:** Illumination levels must meet all specified average, and uniformity levels specified.

**END OF SECTION**

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