2.11 STOP BAR SYSTEM

2.11.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the stop bar system for every taxi-holding position light that serves the runways 17 and 35.

2.11.2 SYSTEM CONFIGURATION

a. CONTROLLABLE STOP BAR SYSTEM

The controllable stop bar lighting system shall consist of six (6) sets of single row of surface lights, the supplemental elevated lights installed on both sides of the row, the associated taxiway center line lights (lead-in lights) located between the holding position and the runway, and the aircraft sensors, the timers and remote units.

b. UNCONTROLLABLE STOP BAR SYSTEM

The uncontrollable stop bar lighting system shall consists of six (6) sets of single row of surface lights inset at the exit taxiway.

2.11.3 OPERATIONAL REQUIREMENTS

a. All controllable stop bar lights shall be switched on, and the taxiway centerline lights located beyond the taxiway holding position shall be switched off when the Runway Visual Range (RVR) condition is less than 550 m.

b. After an air traffic controller (ATC) gives the direct-speech clearance to proceed onto the active runway, the system shall be so programmed as to make the stop bar lights turned off with the stop bar position symbol manipulated on the touch screen at the Tower to gives clearance to the aircraft waiting at the holding position. The stop bar lights shall be extinguished, and the taxiway center line lights installed beyond the stop bar for at least the first 90 m segment shall be illuminated.

c. While the aircraft proceeds to the runway across the stop bar lights, the sensor(s) shall detect the passing aircraft, and then stop bar lights shall be re-illuminated, and taxiway center line lights installed beyond the stop bar for the first 90 m segment shall be extinguished automatically.

d. When the aircraft proceeds and reaches up and/or starts for take-off, the taxiway center line lights installed 90 m beyond the stop bar lights and the end on the runway shall be extinguished automatically by the presetting timer(s).

e. When the aircraft or vehicle invades onto the runway beyond the illuminated stop bar lights, then the alarm shall be actuated with a sound and a flickering lamp. The sound warning shall be canceled by a touch on the reset symbol on the touchscreen, but the lamp flickering shall continue until the aircraft incursion risk is properly processed and the reset switch becomes operative.

f. If the ATC switches off the stop bar lights within the pre-setting time after another stop bar light which is concerned with the same runway is switched off, the system shall automatically execute such protective mode so as not to allow both

stop bar light and touchscreen symbol to be extinguished, simultaneously with an alarm function to warn the ATCs on duty.

g. During the stop bar lighting operation, the taxiway center line lights installed on the entrance taxiway shall not be illuminated in the direction of runway.

2.11.4 CHARACTERISTICS

a. Stop bars lights shall consist of lights spaced at interval of 3 m across the taxiway, showing red in the intended direction(s) of approach to the taxi-holding position.

b. Supplemental stop bar lights shall consist of two (2) pair of the elevated lights, and shall be located 3 m from the taxiway edge, showing red in the intended direction(s) of approach to the taxi-holding position, but shall be visible to an approaching aircraft up to the stop position.

c. Stop bar light (surface type), and supplemental stop bar light (elevated type) shall be unidirectional and show red in the direction of approach to the runway.

d. The performance of both surface and elevated type stop bar lights shall be in accordance with the standards of ICAO, Annex-14 Volume 1, Appendix 2, Figures from 2-1 to 2-17 as appropriate.

e. Taxiway center line lights beyond the taxi-holding positions shall be the bi-directional surface inset type except rapid exit taxiway center line lights, and shall show green in the direction of approach to the runway, and opposite side shall show green and yellow alternately from the beginning of or near the runway center line to the taxi-holding position. The light nearest to perimeter shall always show yellow.

f. Installing intervals of taxiway center line lights beyond the taxi-holding position shall have the same installing intervals as those of other taxiway center line lights as specified in the Specification.

g. A sensor shall be installed with controllable stop bar lights.

h. A sensor shall be located about 15 m beyond the taxi-holding position and outside about 10 m from both sides of the taxiway pavement edge.

i. A sensor shall be able to detect all types of aircraft and vehicles going to taxiway onto the runway passing through the taxi-holding position, but shall be designed not to detect the aircraft and vehicles taxing on another taxiway, and vehicles running or parking close to the taxi-holding position.

j. Furthermore, a sensor shall have no interference each other.

k. A sensor shall detect the target which is taxiing at a speed of less than 50 km/hr.

2.11.5 LIGHT FITTINGS, SENSOR AND REMOTE UNIT

2.11.5.1 SURFACE TYPE LIGHT FITTINGS

a. Surface inset type stop bar light shall be an unidirectional type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 65 watts and a minimum lamp life of 1000 hours for controlled surface lights, and 100 watts with

a minimum lamp life of 500 hours for uncontrolled surface lights both for continuous use at 100 % intensity. The red filter shall be of a dichroic type.

b. Each stop bar light shall be fitted with a factory molded one (1) 2-pole plugs for plug-in to the receptacle of its own nearby remote unit.

c. Each stop bar light shall be in less than 15 mm vertical projection above the surrounding surface and shall be consistent with the required photometric characteristics.

d. All the metal parts including their contact surfaces with other metals shall resist corrosion.

e. All bolts, studs, nuts, lock washers, and other similar fasteners used in The light shall be fabricated from 18-8 stainless steel or silicon bronze or better materials.

f. All edges above the pavement shall be rounded to not less than 1.5 mm radius, and the cover of the lights that meets with the base unit box shall provide good heat transfer and water-tight sealing, sufficiently resistant against all stress of torsion and horizontal shearing in any direction imposed by impact, rollover and static load of present-day aircraft without damage to light, to aircraft and to vehicle tires.

g. Each stop bar light shall be suitable for a shallow base type installation.

h. The light fittings including cover and base plate shall be made of aluminum alloy, properly finished to resist corrosion.

i. The outer prism should be mechanically clamped through replaceable gaskets and would allow fast and easy replacement of the prism. No water built up in front of the lens would be allowed to avoid beam deflection during heavy rainfall.

j. The transformer box shall be made of cast iron or steel plate, properly finished to corrosion-proof, and shall have sufficient room for housing the isolating transformer, connecting devices, remote unit, etc.

2.11.5.2 ELEVATED TYPE LIGHT FITTINGS

a. Elevated type Stop bar light shall be unidirectional type light, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 200 watt and a minimum lamp life of 1000 hours for controlled surface lights, and 500 hours for uncontrolled surface lights both for continuous use at 100% intensity. The red filter shall be of a dichroic type.

b. Each elevated type stop bar light shall be composed of a light-weight unidirectional fittings consisting of an optical assembly unit, supporting pipe, base plate and a frangible coupling, suitable for mounting on the concrete base block, and with beam angle adjuster of the vertical plane from zero to 15 degrees from the horizontal plane.

c. Each stop bar light shall be fitted with a factory molded one(1) 2-pole plug to plug for the receptacle of its own designated nearby remote unit.

d. Each stop bar light shall be in less than 350 mm vertical projection above the ground and shall be designed to be broken or distorted on impact so as to present minimum hazard to aircraft.

91

e. All the metal parts including their contact surfaces with other metals shall resist corrosion.

f. All bolts, studs, nuts, lock washers, and other similar fasteners used in the light shall be fabricated from 18.8 stainless steel or silicon bronze or better materials.

g. Each elevated supplemental stop bar light shall be connected to a frangible coupling and a designated transformer in the nearby transformer box, suitable for mounting on the concrete base block.

h. The lighting structure including a frangible coupling, supporting pole and a base plate shall withstand the exposure to aircraft jet blast.

i. The major lighting parts shall be made of a forged aluminum alloy, properly finished to resist corrosion.

j. The transformer box shall be made of cast iron or steel plate, properly finished to corrosion-proof, and shall have sufficient room for housing the isolating transformer, connecting devices, remote unit, etc.

2.11.5.3 SENSOR

a. The sensor shall be consisted of microwave transmitter, receiver, and swivel bracket, all suitable for outdoor use.

b. Microwave frequency shall be 9.4 - 10.7 GHz, and shall conform to the local regulation with the usable range of at least 120 m.

c. The sensor shall be made stable against vibration, noise, wind, rain, fog, snow, dust and extreme temperature change.

d. Both transmitter and receiver shall have each of their own light-weight housing units, suitable for mounting on the ground, and shall allow adjustment of the beam in both vertical and horizontal angle.

e. These transmitter and receiver units shall use the 6.6-ampere series circuit through the remote unit as well as the 6.6A / 6.6A insulation transformers. The system function shall keep normality even when the series circuit current fluctuates.

f. Control and monitor signals shall be transmitted and received through the above series circuit to/from the Main and Secondary AFL Substations.

2.11.5.4 REMOTE UNIT

a. Remote unit shall be completely waterproofed, and shall be designed to ensure a continuous service for the specified usable period in the defined ambient temperatures under the setting condition inside the transformer box.

b. Remote unit shall be completely sealed at its lead cable joint in black vulcanized rubber with polychloroprene sheathing or in anticorrosive metal enclosure to ensure water-tightness.

c. Remote unit shall be suitable for use in series circuit connection with a current of 2.8 - 6.6 amperes, and shall be capable of supplying required electric power to the sensors. It shall send and/or receive signals through the 6.6 A/6.6 A insulation transformer.

d. One primary lead cable and one secondary lead cable shall be attached to the remote unit, and both primary and secondary cables shall be of a 600 V type in not less than 2 x 2.5 mmϕ, supplied with a factory molded plug and a receptacle.

2.11.6 INSTALLATION

2.11.6.1 STOP BAR LIGHTS

a. Surface Type

1) The surface type of the stop bar lights shall be a shallow base mounting type, inset in the recess of the pavement with the upper frames of the base unit box to be leveled at such a height that the taxiway pavement is constructed to the finished level.

2) The shallow base type surface light shall be connected to the transformer box with cables protected by both flexible stainless steel pipe and galvanized steel pipe of 50 mmϕ.

3) A jig or fixture is required to hold the base unit box in position while the concrete anchor is placed. The elevation of the base unit box with respect to the runway surface and the azimuth with respect to the center line are two (2) parameters that shall be met.

4) Suitable isolating transformer as specified in the Specification shall be installed for each light in the transformer box.

5) Remote unit as specified in the Specification shall be connected between the secondary cable of the isolating transformer and the lead cable for the lights.

b. Elevated Type

1) The elevated type stop bar lights shall be composed of a lamp assembly unit, supporting pole and base plate, suitable for mounting on the concrete base block with an aluminum conduit laid in the in-situ concrete base block.

2) The elevated type lights shall be of light-weight anticorrosive construction by means of a frangible coupling and the supporting pole fastened on the base plate. The aluminum conduit laid in the concrete base block shall be connected to the flexible steel pipe of 50 mmϕ, and then connected to the galvanized steel pipe of 50 mmϕ under the taxiway and shoulder pavement area up to the transformer boxes of the elevated type stop bar lights. The transformer box for the elevated type lights shall be located at both sides of the taxiway, and shall be subjected to common use with the surface type stop bar lights, all as shown in the Drawing.

3) Suitable isolating transformers as specified in Subsection shall be installed for each light in the transformer box.

4) Remote unit as specified in the Specification shall be installed in the transformer box and connected between secondary cable of the isolating transformer and the lead cable for the lights

3/3

2.11.6.2 TAXIWAY CENTER LINE LIGHTS BEYOND THE TAXI-HOLDING POSITION

a. Taxiway center line lights beyond the holding position lights shall be installed in the same manner as specified in the Specification.

b. For the taxiway center line lights installed beyond the controllable stop bar lights, the corresponding subsection in the Specification above shall apply.

2.11.6.3 SENSOR

a.. Sensor shall be located 15 m beyond the taxi-holding position and 10 m from the taxiway edge, and shall be located at right angle and symmetrically to the taxiway center line.

b. Height of the sensor to be equipped for the stop bar light shall be as low as possible, but shall be designed not to receive the repercussions from the taxiway pavement nor from other fixtures.

c. Sensor shall be fixed to the transformer box by means of a frangible coupling.

d Sensor shall be connected to the isolating transformer via remote unit.

e. The corresponding subsection of 2.11.6 shall also apply for sensor installation.

2.11.7 SYSTEM OF POWER SUPPLY

a. The stop bar system including sensors shall receive power supplied through Constant Current Regulator Room (CCR Room) of each of the Main and Secondary Substations by means of the 6.6-ampere interleaved four (4) loop circuits; two (2) out of four (4) from the Main Substation and the remaining two (2) from the Secondary Substation.

b. For the series loop circuits, the cables shall be used as specified in the Specification and shall be installed in accordance with the Specification.

2.11.8 BRILLIANCY CONTROL

a. The stop bar lights shall be controlled in more than four (4) stages of light brilliancy.

b. Each electric current value of the stages shall be approved by the Employer.

2.12 RUNWAY GUARD LIGHTS

2.12.1 SCOPE

This work shall include all the goods and services that are required for engineering, supply and installation of the runway guard lights.

2.12.2 LIGHTING SYSTEM

a. Runway guard lights shall be provided at each runway and taxiway intersection associated with the runway.

b. Runway guard lights shall be located at each side of the taxiway 90 m distant from the runway center line.

2.12.3 CHARACTERISTICS

a. Runway guard lights shall consist of two (2) pairs of yellow lights.

b. Runway guard lights shall be unidirectional and shall be so aligned as to be visible to the pilot of an airplane taxiing to the holding position.

c. The effective intensity in yellow light and the beam spread of lights shall be in accordance with the standards of ICAO, Annex 14, Volume 1, Appendix 2, Figure 2.21.

d. The lights in each unit shall be illuminated alternately.

e. The light shall be illuminated at 60 cycles a minute, and the light suspension and illumination periods shall be equal, and opposite in each lighting.

2.12.4 LIGHT FITTINGS

a. Light shall be of an omnidirectional elevated light type, fitted with two (2) tungsten halogen lamps of 6.6 amperes, with a rating not exceeding 100 watts and a minimum life of 1000 hours for continuous use at 100% intensity.

b. Each light shall be composed of a light-weight anticorrosive lamp assembly unit, supporting pole, a frangible coupling and base plate, completely waterproofed, and an aluminum conduit laid in the concrete base block.

c. Each light shall be fitted with a factory molded 2-pole plug for connection to the receptacle of its own insulating transformer via remote unit housed together in the nearby transformer box.

d. All bolts, studs, nuts, lock washers, and other similar fasteners used in the light shall be fabricated from 18-8 stainless steel or silicon bronze or better. The major parts of the light including base plate, supporting pole and lamp assembly unit, etc shall be made of aluminum alloy.

2.12.5 INSTALLATION

a. Runway guard lights shall be placed on both sides of a taxiway 9.0 m from the taxiway edge and at right angle to the taxiway center line on the taxi-holding position.

375

b. Each elevated light shall be mounted, by means of a frangible coupling and supporting pole, on the base plate fastened to the in-situ concrete base block, either horizontally or vertically, connected to an aluminum conduit laid in the concrete base block.

c. The base plate of the elevated light shall be leveled at such a height that the taxiway shoulder pavement is constructed to the finished level.

d. Suitable isolating transformers specified in the Specification shall be installed in the transformer box.

e. Remote unit specified in the Specification shall be connected between secondary cable of the isolating transformer and the lead cable of the runway guard light.

f. The transformer box to be provided with a base plate shall be fabricated from steel plate and properly finished to corrosion-proof, and shall have sufficient space for housing it in isolating transformer, connecting devices, and remote unit.

2.12.6 SYSTEM OF POWER SUPPLY

a. Runway guard lights shall receive power supply from the Constant Current Regulator Room (CCR Room) through the Main or Secondary AFL Substation by means of a 6.6-ampere loop circuits in common use with the closely located series circuits of the stop bars lights.

b. For the series loop circuits, such cables shall be used as specified in the Specification and shall be installed in accordance with the Specification.

2.12.7 ON & OFF CONTROL

a. Runway guard lights shall be controlled ON and OFF from the remote control panel at the control tower.

b. The value of the electric current shall be fixed at 6.6 amperes.

2.13 TAXIWAY INTERSECTION LIGHTS

2.13.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the taxiway intersection lights.

2.13.2 LIGHTING SYSTEM

a. The taxiway intersection lights shall be provided at a taxiway intersection, where it is desirable to define a specific airplane holding limit and there is no need for such a "stop-and-go" signal as provided by the stop bar light.

b. The taxiway intersection lights shall be located at a point 60 m from the nearest edge of the intersecting taxiway.

2.13.3 CHARACTERISTICS

a. The taxiway intersection lights shall be the fixed unidirectional lights showing to illuminate the direction of approach to the intersection.

b. The performance of the taxiway intersection lights shall be in accordance with the standards of ICAO, Annex-14, Volume 1, Appendix 2, Figure 2.14.

c. Aviation yellow colored filters shall be dichroic type, and shall conform to satisfy the standards of ICAO, Volume 1, Appendix 1, Figure 1.1. even when the electric current or the light intensity drops to 5% of the 100% rated current. The filter shall have the permeability of more than 40%.

2.13.4 LIGHT FITTINGS

a. Light shall be of an unidirectional surface type, equipped with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 100 watts and a minimum lamp life of 500 hours for continuous use at 100% intensity.

b. Each surface light shall be fitted with a factory molded 2-pole plug for connection to the receptacle of its own corresponding insulating transformer housed in the nearby transformer box.

c. Each light shall be in less than 12.7 mm vertical projection above the surrounding surface in consistence with the required photometric characteristics.

d. All the metal parts including their contact surfaces with other metals shall resist corrosion.

e. All bolts, studs, nuts, lock washers, and other similar fasteners used in the light shall be fabricated from 18-8 stainless steel or silicon bronze or better materials.

f. All edges above the pavement shall be rounded to not less than 1.5 mm radius, and the cover of the lights that meets with the base unit box hall provide good heat transfer and water-tight sealing, sufficiently resistant against all stress of torsion and horizontal shearing in any direction imposed by impact, rollover and static load of present-day aircraft without damage to light, to aircraft and to vehicle tires.

g. Each light shall be suitable for a shallow base type.

h. The major parts of the light shall be made of forged aluminum alloy, properly finished to resist corrosion.

2.13.5 INSTALLATION

a. The taxiway intersection lights shall be consisted of three (3) lights, and shall be disposed symmetrically about and around 90°to the taxiway center line, with individual lights to be spaced 1.5 m apart.

b. The light shall be installed in the shallow base type at such a height that the taxiway pavement is constructed to the finished level.

c. The light shall be installed in the recess of the taxiway pavement which fits the base unit box with the cover. This base box shall be connected by means of the flexible stainless steel pipe of 50 mm, and then connected to the galvanized steel pipe of 50 mm buried in the taxiway and shoulder pavement area.

d. Each base plate shall be connected to an adjacent base box, and the outermost base plate shall also be connected to the transformer box which is placed 1 m away from the shoulder pavement edge through the galvanized steel pipe and the flexible stainless steel pipe.

e. A jig or fixture is required to hold the base box in position while the concrete anchor is placed. The elevation of the base with respect to the runway surface and the azimuth with respect to the center line are two parameters that shall be met.

f. The transformer box shall be fabricated from steel plate or cast iron, properly finished to corrosion-proof, and shall have sufficient room for housing the isolating transformer, connecting devices, and remote unit which may be installed in the near future.

g. The 100 W type isolating transformer as specified in the corresponding subsection for each light shall be installed in the transformer box.

h. Primary lead cable of the isolating transformer shall be connected to the series circuit cable with a plug and a receptacle, and secondary lead cable shall be connected to the lead cable of the light fittings with receptacle.

2.13.6 SYSTEM OF POWER SUPPLY

a. The taxiway intersection lights shall received their power supplied through the nearest series circuit of the taxiway center line lights.

b. For the series loop circuits, the cables shall be used as specified in the Specification, and shall be installed in accordance with the Specification.

2.13.7 BRILLIANCY CONTROL

The taxiway intersection lights shall be controlled in company with taxiway center line lights.

2.14 SIGNS

2.14.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the signs.

2.14.2 LIGHTING SYSTEM

a. The signs shall be provided to convey a mandatory instruction, information on a specific location or destination on a movement area or to provide other information to meet the requirement of enacted guidance and control system in accordance with ICAO, Annex 14, Volume 1, Section 8.9.

b. The signs shall have an elevated type light fittings.

c. The sign shall be divided into two (2) categories as "mandatory instruction signs" and "information signs".

d. A mandatory instruction sign shall be provided to identify a location beyond which an aircraft taxing or vehicle shall not proceed unless authorized by the aerodrome control tower as shown in the Drawings.

e. An information sign shall be provided where there is an operational need to identify, by a sign, a specific location or routing (direction or destination) information as shown in the Drawings.

f. Mandatory instruction signs shall include runway designation signs, runway category II holding position signs, taxi-holding position signs, road-holding position signs and NO ENTRY signs.

g. A pattern "A" taxi-holding position marking specified in ICAO, Annex-14, Volume 1, 5.2.9 shall be supplemented at a taxiway/runway intersection with a runway designation sign.

h. A pattern "B" taxi-holding position marking specified in ICAO, Annex-14, Volume 1, 5.2.9 shall be supplemented with a runway category II holding position sign.

i. A runway designation sign at a taxiway/runway intersection shall be supplemented with a location sign in the outboard (farthest from the taxiway) as appropriate.

i. A "NO ENTRY" sign is not required to be provided in this work, but should be furnished in the event that entry into an area is prohibited.

j. Information signs shall include direction signs, location signs, destination signs, runway exit signs and runway vacated signs.

k. A runway exit sign shall be provided where there is an operational need to identify a runway exit.

l. The runway vacated sign shall not be included in this work.

m. A destination sign shall be provided to indicate the direction to a specific destination on the aerodrome, such as cargo area, general aviation, etc.

n. A combined location and direction sign shall be provided when it is intended to indicate routing information prior to an intersection.

o. A direction sign shall be provided where there is an operational need to identify the designation and direction of taxiway at an intersection.

p. A location sign shall be provided in conjunction with a runway designation sign.

q. A location sign shall be provided in conjunction with a direction sign, except it may be omitted where aeronautical study indicates that it is not needed.

r. A location sign shall be provided to identify the taxiway exiting an apron or the taxiway beyond an intersection where a taxiway ends at an intersection such as a direction sign shall be provided to identify this.

2.14.3 CHARACTERISTICS

a. Signs shall be frangible and those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and the engine pods of jet aircraft. The installed height of the signs shall not exceed the dimensions indicated below:

Items	Mandatory instruction sign	Information sign	
		Runway exit sign	Other sign
Character height (min.)	400 mm	400 mm	300 mm
Face height (min.)	800 mm	800 mm	600 mm
Installed height (max.)	1100 mm	1100 mm	900 mm
Perpendicular distance from defined taxiway pavement edge to near side of sign	—	11~21 m	
Perpendicular distance from defined runway pavement edge to near side of sign	—	8~15 m	

b. Signs shall be rectangular, as shown in ICAO, Annex-14, Volume 1 Figures 5.20 and 5.21 with the longer side horizontal.

c. The inscriptions on a sign shall be in accordance with the standards of ICAO, Annex-14, Volume 1, Appendix 4.

d. The signs shall be illuminated in accordance with the standards of ICAO, Annex-14, Volume 1, Appendix 4.

e. A mandatory instruction sign shall consist of an inscription in white on a red background.

f. The inscription on a runway designation sign shall consist of the runway designations of the intersecting runway properly oriented with respect to the viewing position of the sign, except that runway designation sign installed in the vicinity of a runway extremity may show the runway designation of the concerned runway extremity only.

400

g. The inscription on NO ENTRY sign shall be in accordance with ICAO, Annex-14, Volume 1, Figure 5-20 'Mandatory instruction signs'.

h. The inscription on a CAT II or joint holding position sign shall consist of the runway designator to be followed by CAT II sign as appropriate.

i. The inscription on taxi-holding position sign established in accordance with ICAO, ANNEX-14, Volume 1, and the Specification shall consist of the taxiway designation and number.

j. Where appropriate, the following inscriptions/symbol shall be used:

Inscription/symbol	Use
17 CAT II (Example)	To indicate a category II taxi-holding position at the threshold of runway 17
NO ENTRY (symbol)	To indicate that entry to an area is prohibited
Runway designation of a runway extremity OR Runway designation of both extremities of a runway	To indicate a taxi holding-position at a runway extremity To indicate a taxi-holding position located at other taxiway/runway intersections
B 2 (Example)	To indicate a taxi-holding position located at other than a taxiway/runway or taxiway/taxiway intersections

k. An information sign other than a location sign shall consist of an inscription in black on a yellow background.

l. A location sign shall consist of an inscription in yellow on a black background, and, where it is a stand-alone, sign shall have a yellow border.

m. The inscription on a runway exit sign shall consist of the designator of the exit taxiway and an arrow indicating the direction to follow.

n. The inscription on a destination sign shall comprise an alpha, alphanumerical or numerical message identifying the destination plus an arrow indicating the direction to proceed as shown in ICAO, Annex-14, Volume 1, Figure 5.21.

o. The inscription on a direction sign shall comprise an alpha, or alphanumerical message identifying the taxiway(s) plus an arrow or arrows appropriately oriented as shown in ICAO, Annex-14, Volume 1, Figure 5.21.

p. The inscription on a location sign shall comprise the designation of the taxiway, runway or other pavement the aircraft is on or is entering, and shall not contain arrows.

q. Where it is necessary to identify each of a series of taxi-holding positions on the same taxiway, the location sign shall consist of the taxiway designation and a number.

r. Where a location sign and direction signs are used in combination:

1) all direction signs related to left turns shall be placed on the left side of the location sign and all direction signs related to right turns shall be placed on the right side of the location sign, except that where the junction consists of one intersecting taxiway, the location sign may alternatively be placed on the left hand side;

2) the direction sign shall be placed such that the direction of the arrows departs increasingly from the vertical with increasingly deviation of the corresponding taxiway;

3) an appropriate direction sign shall be placed next to the location sign where the direction of the location taxiway change significantly beyond the intersection; and

4) adjacent direction sign shall be delineated by a vertical black line as shown in ICAO, Annex-14, Volume 1, Figure 5.21.

5) A taxiway shall be identified by a designator comprising a letter, letters, or combination of a letter or letters followed by a number.

s. When designating taxiways, the use of the letters I, 0 or X and the use of words such as inner and outer shall be avoided wherever possible to avoid confusion with the numerals 1, 0 and closed marking.

t. The use of numbers alone on the maneuvering area shall be reserved for the designation of runways.

2.14.4 LIGHT FITTINGS

a. The sign fittings shall be constructed with light-weight, corrosion resistant materials and shall be designed for vertical installation on a concrete base pad with stay, by using a frangible coupling, and to allow horizontal adjustment at least ±2%.

b. The overall installation height of the fittings shall not exceed the height specified in ICAO, Annex-14, and as described in the Specification.

c. All materials to be used for signs shall be durable and corrosion resistance texture and finish. They shall be stable with normal exposure to natural UV (Ultra Violet rays) and IR (Infra Red rays) radiation.

d. Internal structural members shall be so arranged that there is no visible interruption to the sign message at the operational distance from the sign where the sign message is normally perceived by pilot.

e. Covers that are required to be opened or removed for field maintenance purpose, e.g. lamp changing, shall be secured by fastenings that may be operated with gloved hands. These fastenings shall be captive. Any gaskets shall be positively located either on the body of the fitting or on any removable cover.

f. The sign encasement shall be so designed that if water in the sign it can drain out effectively.

g. The sign shall be fitted with one (1) or more tungsten halogen lamp(s) of 6.6 amperes, with a rating not exceeding 100 wattage per inscription character and a minimum lamp life of 500 hours for continuous use at 100% intensity.

h. All signs shall have provisions for earthing.

i. Each sign fittings shall be fitted with a factory molded 2-pole plug (s) and fitted to the insulating transformer(s).

j. Frangible coupling and sign fittings shall not be broken by aircraft engine blast.

2.14.5 INSTALLATION

a. The sign shall be mounted on a concrete pedestal, so that the top sign is level.

b. The mounting concrete pedestal shall be erected so as to be capable of supporting the sign horizontally balanced within a tolerance ±2%.

c. The sign fittings shall be installed by means of frangible coupling which is to be fitted on the top of the mounting concrete pedestal.

d. The signs shall be placed outside the runway and/or taxiway pavement at the distance as described in the Specification.

e. The transformer box shall be fabricated from steel plate or cast iron, properly finished to corrosion-proof, and shall have sufficient room for housing the isolating transformer, connecting devices, etc. The transformer boxes shall be installed integrated with mounting concrete pedestal.

f. Each light capacity (wattage) required for the isolating transformers shall be as specified in the Specifications and shall be installed in the transformer box.

g. Primary lead cable of the isolating transformer shall be connected to the series circuit cable with a plug and a receptacle, and secondary lead cable shall be connected to the lead cable of the sign with receptacle.

2.14.6 SYSTEM OF POWER SUPPLY

a. The signs shall receive power supply from the Constant Current Regulator Room (CCR Room) through each of the Main or Secondary Substation by means of the 6.6 amperes loop circuits.

b. For the series loop circuits, the cables shall be used as specified in the Specification, and shall be installed in accordance with the Specification.

2.14.7 BRILLIANCY CONTROL

a. The signs shall be controlled in more than six (6) stages of light brilliancy.

b. Each electric current value of the stages shall be approved by the Employer.

403

2.15 WIND DIRECTION INDICATOR LIGHT

2.15.1 SCOPE

This wok shall include all the goods and services that are required for engineering, supply and installation of the Wind Direction Indicator Light.

2.15.2 LIGHTING SYSTEM

Wind Direction Indicator Light shall be located so as to be visible from aircraft in flight or on the movement area and in such a way as to be free from the effects of air disturbances caused by nearby objects.

2.15.3 CHARACTERISTICS

a. Wind Direction Indicator Lights shall be visible and understandable from the height of at least 300 m, having regard to both day and night background.

b. Wind Direction Indicator Light shall be so constructed as to make a clear indication of the direction of the surface wind and a general indication of the wind speed.

2.15.4 LIGHT FITTINGS

a. Wind Direction Indicator Light shall be in the form of a truncated cone made of fabric, having a length of not less than 3.6 m and a diameter, at the large end, not less than 0.9 m

b. The colors of the cone shall be so selected as to make the wind direction indicator clearly visible and understandable.

c. A combination of two colors is required to give adequate conspicuity against changing backgrounds day and night.

d. Colors shall be orange and white, arranged in five alternate bands, and the first and last bands shall be orange.

e. The lights shall be provided for illuminating the wind cone, and an obstruction light shall be mounted on the top of the mast.

f. The mast shall be collapsible for easy maintenance, and shall be light-weight anti-corrosive construction, having a cage holding a nylon cone fully open at the throat. Cone shall be provided with certain brass grommet drain holes.

g. The mast shall be suitable for fixing itself to the ground base plate.

2.15.5 INSTALLATION

a. Wind Direction Indicator

1) Wind Direction Indicator Light shall be located nearby both sides of the touchdown zones to infer local wind stream, but shall never be an obstruction to aircraft.

2) Wind Direction Indicator Light shall be marked by a circular band 15 m in internal diameter and 1.2 m wide outside. The band shall be centered about

the mast and shall be painted white in color. Both internal circle and external circle of the band 3 m wide shall be paved with asphalt at least 3 cm in thickness to give adequate conspicuity.

3) A local switch housed in the weatherproof box shall be provided, and fixed in the lower position of the mast or installed on the base plate of the mast.

b. Obstruction lights

1) Obstruction lights shall be provided on top of the wind direction indicator masts.

2) The obstruction light shall be omnidirectional or low intensity type showing aviation red with a light distribution intensity of not less than 10 cd over a beam width of not less than 10% of the main light beam.

3) The obstruction lights shall comprise one (1) AC. 220 V incandescent lamps and power consumption of not more than 100 W, sheet steel housing, and red heat-resistant glass globes or high quality transparent heat-resistant globes with red filters.

2.15.5 SYSTEM OF POWER SUPPLY

a. Wind directional indicator with lights shall be fed by AC 220 V single phase, via switch panel of Main or Secondary AFL Substations.

b. The 600/1000 V class cross-linked polyethylene insulated PVC sheathed power cables (XLPE/PVC) shall be used between the substations and Wind Direction Indicator Light through a local switch.

c. Specifications for cable installation are indicated in this document, and the drawings for cable installation layout and the applicable cables to be used are indicated in the Drawing.

405

2.16 APRON FLOODLIGHTS

2.16.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the apron floodlights.

2.16.2 LIGHTING SYSTEM

a. The Apron Flood Lights shall be provided to give sufficient illumination for all apron service areas intended to be used at night with minimum of glare to pilot of aircraft in flight and on the ground, aerodrome and apron controllers, and personnel on the apron.

b. The arrangement and aiming of floodlights shall be such that each aircraft stand receives light from two directions to minimize shadows.

c. The apron flood lights shall be installed at the passenger apron including remote apron, cargo apron and maintenance apron.

d. The apron flood lights shall be mounted to the pole with raising and lowering gear, and shall comprise a mixture of high pressure sodium vapor lamps and metal halide lamps with an obstacle light mounted on top.

e. The ON & OFF CONTROL of lights shall be possible from the remote control panels, substations, and switch boxes.

f. The remote control panels shall be provided at the General Control Center (G.C.C) in the international passenger terminal building for the passenger apron, in the cargo terminal building for the cargo apron, and in the maintenance building for the maintenance apron.

2.16.3 CHARACTERISTICS

a. The spectral distribution of apron floodlights shall be such that the colors used for aircraft marking with regard to routine servicing, and for surface and obstacle marking can be correctly identified.

b. The average illumination shall be at least the following:

1) Aircraft Stands in the Passenger Terminal Area:

① Horizontal illumination	: 30 lux with a uniformity ratio (average to minimum) of not more than 4 to 1; and
② Vertical illumination	: 30 lux at a height of 2 m above the apron in relevant directions.

2) Aircraft Stands in Other Apron Areas:

Horizontal illumination	: 25 lux with a uniformity ratio (average to minimum) of not more than 4 to 1.

3) Other Apron Areas:

Horizontal illumination : 10 lux with a uniformity ratio (average to minimum) of not more than 4 to 1.

2.16.4 LIGHT FITTINGS

a. The high pressure sodium vapor lamps have a rated life of not less than 12000 hours operation and shall take not more than 5 minutes from switching on to achieve full brightness. In the event of loss of supply for a period of 30 seconds or less, the lamp shall restrict 1 minute of supply resumption and rapidly regain full light output.

b. The metal halide lamps shall have a rated life of not less than 9000 hours operation and shall take not more than 5 minutes from switching on to achieve full brightness. In the event of loss of supply for a period of 30 seconds or less, the lamp shall restrict 1 minute of supply resumption and rapidly regain full light output.

c. The housing can be used both high pressure sodium vapor lamp and metal halide lamp commonly.

The light fittings shall have following optical beam characteristics:

Beam range		Luminous intensity of the beam	
Horizontal	Vertical	Minimum intensity	Maximum intensity
80°	40° (35~75°)	more than 100 cd/1000 lm	more than 1000 cd/1000 lm

e. An axis of the vertical plane shall be about 70° when project surface up to 40° from the horizontal plane.

f. The intensity of the direction shall be less than 150 cd/1000 lm at 100° up from the axis.

g. The intensity of the direction shall be less than 10000 cd at 15° up from the axis.

h. The housing shall be made of steel or sheet aluminum with a front face made of heat-resistant glass, and the reflector made of electrolytically polished aluminum sheet or equal materials.

i. All materials to be used for the flood lights shall be durable and corrosion resistant texture and finish. They shall be stable with normal exposure to natural UV (Ultra Violet rays) and IR (Infra Red rays) radiation.

j. All fittings shall be completely weatherproof and specifically designed to withstand the high temperatures caused by the light sources.

k. All fittings shall be suitable for mounting, and shall have the maximum beam adjustment capability in both the vertical and horizontal settings to facilitate final adjustment on the site.

407

1. Fittings shall be opened for field maintenance purpose, e.g. lamp changing, and shall be secured by fastenings that may be operated with gloved hands. These fastenings shall be captive. Any gaskets shall be positively located either on the body of the fitting or on any opened cover.

m. All fittings shall have terminals provisions for electric source and earthling.

2.16.5 OBSTRUCTION LIGHTS

a. Obstruction lights shall be provided on all apron floodlight poles.

b. The obstruction light shall be omnidirectional, or low intensity type showing aviation red with a light distribution intensity of not less than 10 cd over a beam width between -1o and +6° and between -10° and +10° and shall require not less than 10% of the main beam.

c. The obstruction lights shall comprise two (2) AC. 220 V incandescent lamps and power consumption not more than 100 W, sheet steel housing, and red heat-resistant glass globe, or high quality transparent heat-resistant globe with red filter.

2.16.6 BALLAST

Ballast shall be a reactor type with a power factor of not less than 85%.

2.16.7 INSTALLATION

a. Poles shall be fixed to be set on the concrete bases.

b. Mounting concrete base of the pole shall be erected underground made of concrete of adequate size to support the weight of pole and light fittings, ballast, etc.

c. The poles for apron floodlights shall be steel pipe of 25 m high, but for the remote apron, they shall be 20 m high to avoid obstacle concerning transitional surface, and suitable for mounting on the base plate.

d. Each pole shall be provided with the raising and bearing gear for the safety and efficient maintenance purpose.

e. Raising and bearing gear speed shall be at least 1 m/minute.

f. The number of wire ropes to be used for raising and bearing the flood lights unit shall be at least double, and in case of either one of the double ropes being cut, the remaining one shall be good enough to keep the weight.

g. Raising and bearing gear, wire ropes and guide shall be housed in the pole.

h. Raising and bearing part shall be stopped automatically at the upper position and low position, and furthermore, shall be required a perfect fixing mechanism at the upper position.

i. The motor for the raising and bearing gear shall be potable type, and shall be provided with 5 sets.

j. A fence shall be provided to protect the pole from the collision damages of Ground Service Equipment (GSE), etc.

408

k. The waterproof type switch panel box shall be installed closer to the poles. The switch box shall have MCCBs and receptacle for raising and bearing motor.

l. A lightning rod shall be provided for each of the apron flood lighting poles. The lightning rod shall be longer enough to cover the total height of the lighting facilities and bonded to the top of the pole. Copper ground plate(s) shall be installed close to the pole base, and connected and bonded to the base part of the pole with more than 38 mm^2 bare copper wire. Grounding resistance shall be required not exceeding 10 ohm.

2.16.8 SYSTEM OF POWER SUPPLY

a. The floodlights shall be fed by the 380 V / 220 V three phase 4-wires low tension circuits via switch panel from the respective substations.

b. The 600/1000 V class cross-linked polyethylene insulated polyvinyl chloride sheathed power cables (XLPE/PVC) shall be used between the substations and switch panels, and between the switch panels and each light fittings of poles via ballast.

c. Cable installation specifications are indicated in this document, and the cable sizes shall be in accordance with the Drawings or applicable IEC cable specifications.

d. Cable ducts works, manhole and hand hole works outside the building shall be included in this work under the contract.

2.16.9 ON & OFF CONTROL

a. The floodlights shall be controlled from the remote control panels.

b. The "On & Off" control shall be possible to each individual aircraft parking stand, and shall further be divided into two (2) circuits to reduce the illumination load when the flood lights are not required for specified illumination during no parking and no maintenance work of aircraft, etc.

c. The "On & Off" control of the obstruction lights shall be performed simultaneously all at once.

2.17 VISUAL DOCKING GUIDANCE LIGHTS

2.17.1 SCOPE

This work shall include all the goods and services that are required for engineering, supply and installation of the visual docking guidance lights.

2.17.2 OPERATIONAL REQUIREMENT

Following requirements as specified in ICAO, Aerodrome Design Manual Part 4, Appendix 1. shall be applied:

a. The system shall provide positive visual lead-in guidance, and when in use, shall be visible to the pilot throughout the aircraft docking maneuver.

b. The visual guidance shall be provided for the pilot to easily recognize and interpret it without ambiguity.

c. The system shall ensure a continuity between the visual parking guidance and the visual docking guidance systems.

d. The display of the system shall be readily conspicuous to a pilot approaching the system regardless of other distractions in the area.

e. Mounting of the system's unit above apron level shall not be critical in relation to the pilot's viewing angle as the aircraft closes on the stand.

f. The system shall provide a left/right guidance utilizing the self-evident signals which can inform the pilot of the position of the aircraft in relation to the longitudinal guidance line.

g. The guidance to be provided by the system shall be such that the pilot can acquire and maintain the longitudinal and stopping guidance without over-controlling.

h. The system shall be capable of accommodating variations in pilot's eye height including the effects of aircraft's loading weight.

i. The system shall have the left/right guidance aligned for use by the pilot occupying the left-hand seat.

j. The information regarding the rate of longitudinal closing shall be associated with, or incorporated in, the system.

k. The system shall be able to deploy permanently an unmistakable stop signal for each type of airplanes without a need for selective operation by ground personnel, and shall make available the correct stopping point to both seats of the pilots without making them turn their heads during docking operation.

l. The guidance shall provide as minimum effect as possible from external factors such as pavement condition, weather, sunlight, lighting conditions, etc.

m. The accuracy of the system shall be adequate for the types of loading bridges with which it is to be used.

n. The serviceability and unserviceability information of the visual guidance system shall not only be available, but also in the latter case, the point where the pilot should stop the aircraft shall be indicated on the visual guidance.

o. A human safety monitoring system shall be provided to the pilot with an indication of the need for an emergency stop.

2.17.3 SYSTEM CONFIGURATION

The systems shall consist of the following five (5) components:

① Sensor
② Control unit
③ Display
④ Operator panel
⑤ Remote control panel

2.17.4 GENERAL REQUIREMENT

a. The system shall provide both azimuth and stopping guidance.

b. The azimuth guidance unit and the stopping position indicator shall be adequate for use in all weather, visibility, background lighting and pavement conditions for which the system is intended both by day and night, but shall not dazzle the pilot.

c. Care is required in both the design and on-site installation of the system to ensure that reflection of sunlight, or other light in the vicinity, dose not degrade the clarity and conspicuity of the visual cues provided by the system.

d. Fail-safe mode shall be provided to each device in the event of an internal or external system failure. If the communication link breaks down the indicator shall indicate STOP.

e. Self checking function shall be requested to all devices, with reports to the central processing facility.

f. The azimuth guidance unit and the stopping position indicator shall be of design such that:

1) a clear indication of malfunction of either azimuth or stopping position, or both is available to the pilot: and

2) they can be turned off.

3) The azimuth guidance shall provide unambiguous left/right guidance which enables the pilot to acquire and maintain the lead-in line without over-controlling.

4) When azimuth guidance is indicated by color change, green color shall be used to identify the center line and red for deviations from the center line.

5) The stopping position guidance provided to the display for a particular aircraft type shall account for the anticipated range of variations in pilot eye height and/or viewing angle.

411

6) The stopping position guidance shall provide the stopping position for aircraft, and shall provide closing rate information to enable the pilot to gradually decelerate the aircraft to full stop at the intended stopping position.

7) The stopping position guidance shall provide the closing rate over a distance of at least 12 m.

8) When stopping guidance is indicated by color change, green color shall be used to show that the aircraft can proceed and red to show that stop point has been reached except that for short distance prior to the stop point, a third color may be used to warn that stopping point is close.

2.17.5 CHARACTERISTICS

a. Sensor

1) Aircraft detecting sensor shall be used for scanning laser radar and refresh data more than 2 times a second.

2) Laser shall be conformed to Radiological Class I, IEC 825.

3) The sensor shall be light weight, weatherproof and suitable for mounting it to the building wall or with steel pole.

4) The sensor shall be capable of identifying the aircraft type, at least 100 m before the sensor position as well as detecting the aircraft to give it the azimuth guidance.

5) The sensor shall detect the precise position of the aircraft at least 12 m from the stopping position, and shall inform closing and stopping information, etc.

6) The sensor unit shall be connected to the control and display units by means of the power and/or control cables.

b. Control unit

1) The control unit shall be located in conjunction with indicator or operators panel.

2) The control unit shall have microcomputer, and receive signals from the sensor and process it onto the azimuth and stopping position guidance units.

c. Control unit

1) Control unit shall be connected to the sensor, display, operator's panel and remote control panel.

2) When the control unit received the selected aircraft type command from the remote control panel or operator's panel, it shall send a signal to the display to indicate the selected type on the display. After having received the sensing signal about the aircraft type from the laser sensor and if the incoming aircraft does not match the type selected, the unit shall send a signal to the display, and display shall visualize the STOP sign for the pilot.

3) The control unit shall receive a signal to have searched the aircraft from the sensor after comparison with a correct location and shall send the signal to the display to give the azimuth and stopping position guidance information.

4) The control unit shall transmit to the remote control panel the information regarding occupied / unoccupied, emergency stop, and aircraft having gone past the correct stop position, etc. as well as system error status signals.

d. Display

1) Display unit shall be connected with the control unit and receive signal indications to show the azimuth and stopping position guidance etc. to display them to the pilot and ground operators.

2) The display shall show:

① type of the aircraft (indicating system activated)
② azimuth guidance(analog)
③ closing rate to the stopping position (both analog or digital)
④ STOP (when aircraft arrives at correct stop position or emergency stop command is received)
⑤ OK (when the aircraft stops at a correct stop position)
⑥ TOO FAR (if the aircraft has gone past 30 cm from the correct stop position)
⑦ Spot number (when the spot not used)
⑧ ERROR (when an error occurs in the system)

3) All indications shall be by high intensity LEDs or back illuminated LCD, and shall be able to change intensity to avoid dazzle.

e. Operator's panel

1) Operator's panel shall be connected to the control unit and provided terminals for optional emergency stop push-button.

2) Operator's panel shall be provided with the following functions:

① Door selecting touch key
② Dedicated test touch key
③ Off key
④ Dedicated parking key for manual parking
⑤ 20-aircraft types keys
⑥ Up(↑), down(↓), enter (ENTER), aircraft (AIRCRAFT) keys, for additional type aircraft other than most common 20-aircraft types.
⑦ LCD screen to indicate selected status
⑧ Emergency stop button
⑨ Chockon button (when the vehicle needs to be chocked to a halt)

413

f. Remote control panel

Characteristics of the remote control panel are specified in other chapters of this specification.

g. The azimuth guidance unit and the stopping position indicator shall be located in such a way that there is a continuity of guidance between the aircraft stand markings, taxiway center line lights, and the visual docking guidance system.

h. The accuracy of the system shall be within 130 cm in both center line and stopping positions for the type of loading bridge and for the fixed aircraft servicing installations.

i. The system shall be usable by all types of aircraft for which the aircraft stand is intended without a selective operation.

j. If selective operation is required for a particular type of air craft, then the system both for a pilot and a system operator shall be available as a means of ensuring that the system has been set properly.

k. Aircraft identification device shall be so designed that, if the incoming aircraft does not match the selected type, the system shall automatically display a STOP sign for both pilot and system operator to stop, while the system's remote control panel receives the alarm signal and indicates that the STOP symbol is flashing and the audio sound is giving alarm.

l. The system shall conform to Electro Magnetic Compatibility (EMC) specification of IEC, or equivalent.

2.17.6 INSTALLATION

a. Sensor and display shall be fixed under normal condition to the building wall with anchor bolt, or fixed to a steel pole with suitable metal fittings such as U bolt, the work of which will be provided by the building contractor for front apron spots construction.

b. Steel poles shall be for common use with both Visual Docking Guidance Sign (VDGS) and Aircraft Stand Identification Sign (ASIS) but shall not be included in this works.

c. Steel poles shall be fixed with anchor bolts to fasten it on the building wall.

d. The control unit and operator's panel shall be installed at closer location of the loading bridge controller seat for front apron spots.

e. Remote control panel shall be installed at the General Control Center (GCC.) as specified in other chapter of this Specifications.

2.17.7 SYSTEM OF POWER SUPPLY

a. Display and control unit shall be fed by AC 220 V single phase circuit via switch panel of the respective substations.

b. The 600/1000 V class cross-linked polyethylene insulated ploy vinyl chloride sheathed power cables (XLPE/PVC) shall be used between the substations and control and display units.

c. Cable installation specifications are indicated in this document, and the installation layout and cable sizes shall be in accordance with the Drawing s and respective legends.

d. Cable ducts works, manhole and handhole works outside the building shall be included in this work under the contract.

e. Conduit pipe works in the terminal building and in the loading bridge shall not be included in this work. However, such work as all the wiring and cabling works shall be included in this work under the contract.

415

2.18 AIRCRAFT STAND IDENTIFICATION SIGNS (ASIS)

2.18.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the Aircraft Stand Identification Signs (ASIS)

2.18.2 LIGHTING SYSTEM

Aircraft Stand Identification Signs (ASIS) shall be consist of display panel which indicates spot number as well as latitude and longitude of the aircraft stand/spot location.

2.18.3 CHARACTERISTICS

Aircraft Stand Identification Signs (ASIS) shall consist of an inscription in black on a yellow background, and spot number shall be clearly visible from the cockpit of an aircraft prior to entering the aircraft spot.

2.18.4 LIGHT FITTINGS

a. The housing of the system shall be made of steel or sheet aluminum and be completely weatherproofed.

b. Spot number, latitude and longitude of the stopping location shall be indicated by the reflective lamps, high intensity LEDs etc. and shall be visible from cockpit of an aircraft prior to entering the aircraft spot at the time of low visibility condition in day and night.

c. Aircraft Stand Identification Signs (ASIS) shall be able to change its intensity to avoid dazzle to the pilot, ATC staff and maintenance persons.

d. Aircraft Stand Identification Signs (ASIS) shall be a light weight construction suitable for fixing it to the building wall and/or on steel pole.

2.18.5 INSTALLATION

a. Aircraft Stand Identification Signs (ASIS) shall be installed associated with VDGS or independently fixed to the building wall with anchor bolt, the work of which shall be provided by the building works as front apron spots work, and/or as steel pole work using suitable metal fittings for remote apron.

b. Steel poles shall be for common use with both VDGS and ASIS installations the same as those specified in the Specification.

c. Local switch housed in the weather proof box shall be provided rigidly fixed to the lower position of the pole.

2.18.6 SYSTEM OF POWER SUPPLY

a. Aircraft Stand Identification Signs (ASIS) shall be fed by the AC 220 V single phase circuit via switch panel of the respective substations.

b. The 600/1000 V class cross-linked polyethylene insulated polyvinyl chloride sheathed power cables (XLPE/PVC) shall be used between the substations and Aircraft Stand Identification Signs (ASIS) via local switch.

c. Cable installation specifications are indicated in this document, and the installation layout as well as the cable sizes to be applicable are also indicated in the Drawings.

d. Cable ducts work, manhole/handhole work outside the building shall be included this contract.

e. Conduit pipe works in the terminal building, cargo building and maintenance building shall not be included in this contract, but those for all wiring and cabling works shall be included in this work under the contract.

f. Remote control panels shall be installed respectively at the General Control Center (GCC.), cargo building and maintenance building in accordance with the specifications as shown in other chapters.

417

2.19 ROAD-HOLDING POSITION LIGHTS

2.19.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the road-holding position lights.

2.19.2 LIGHTING SYSTEM

Road-holding position lights shall be provided at each road-holding position serving a runway with road-holding position sign.

2.19.3 CHARACTERISTICS

a. The road holding position lights shall comprise a controllable red (STOP) and a green (GO) traffic lights.

b. The road-holding position light beam shall be unidirectional and aligned so as to be visible to the driver of a vehicle approaching the holding position.

c. The road-holding position light shall be fitted with two (2) tungsten halogen lamps of 6.6 amperes, with a rating not exceeding 100 watt and a minimum lump life of 1000 hours for continuous use at 100% intensity.

d. The intensity of the light beam shall be adequate for the conditions of visibility and ambient light in which the use of the holding position is intended, but shall not dazzle the driver.

e. A road-holding position sign shall consist of an inscription in white on a red background.

f. The inscription on a road-holding position sign shall be in Chinese language, and shall be in conformity with the Chinese traffic regulations inclusive of the following:

1) a requirement to stop; and
2) where appropriate:
   ① requirement to obtain ATC clearance; and
   ② location designator.

g. A road holding position sign shall be illuminated internally or externally by the 6.6-ampere tungsten halogen lamps with a rating not exceeding 100 watt and a minimum lump life of 1000 hours for continuous use at 100% intensity.

h. Both road-holding position light and road-holding position sign shall be controlled by the air traffic controllers.

2.19.4 LIGHT FITTINGS

a. The housing of both road-holding position light and road-holding position sign shall be made of a steel or sheet aluminum and be completely weatherproofed.

b. Both road-holding position light and road-holding position sign shall be light weight construction and suitable for fixing it on the concrete base block.

c. Signal colors of the road-holding position light shall meet the ICAO, ANNEX-14, VOLUME 1, Appendix 1, Figure 1.1 and painting color of the load-holding position sign shall meet the same in Figure 1.2.

2.19.5 INSTALLATION

a. Both road-holding position light and road-holding position sign shall be installed on the concrete base block with transformer boxes.

b. Road-Holding position lights shall be located adjacent to the holding position marking and 1.5 m±0.5 m from right edge of the road.

c. Road-holding position sign shall be located adjacent to the road-holding position light and 1.5 m±0.5 m front right edge of the road, but shall never block off the road-holding position lights signal to the drivers.

d. Suitable isolating transformers as specified in the Specification for both road-holding position light and road-holding position sign shall be installed in the transformer box.

e. Remote unit as specified in the Specification shall be connected between secondary cable of the isolating transformer and the lead cable of the road-holding position light.

f. The transformer box shall be provided with a base plate, made of a cast iron or steel plate with anticorrosive finish, and shall also have sufficient room for housing the isolating transformer, connecting devices, etc.

2.19.6 SYSTEM OF POWER SUPPLY

a. Road-holding position sign with light shall be fed from the series circuits for signs.

b. Road-holding position lights shall be controlled under same manner as those of other stop bars.

c. Road-holding position sign shall have the same fixed light as those of other signs.

d. Specifications for cable installation shall be as indicated in this document, and those for the installation layout as indicated in the Drawing.

419

CHAPTER 3

CONTROL AND MONITORING SYSTEM FOR AIRFIELD LIGHTS

3.1 SCOPE

This work shall include all the goods and services that are required for engineering, supply and installation of the remote control and monitoring system for the airfield lighting facilities (herein after called "AFL") of Shanghai/Pudong International Airport (herein after called "the Airport"), unless specified otherwise in this Chapter and in the tender documents.

3.2 SYSTEM REQUIREMENTS

a. The control and monitoring system to be provided under the contract shall be of a logical control system and shall comprise a system for control and monitoring of the following facilities and equipment:

1) Approach Lights
2) Capacitor Discharge Lights
3) Precision Approach Path Indicator (Papi)
4) Runway Edge Lights
5) Runway Threshold And Wing Bar Lights
6) Runway End Lights
7) Runway Center Line Lights
8) Runway Touchdown Zone Lights
9) Taxiway Center Line Lights
10) Taxiway Edge Lights
11) Stop Bar System
12) Taxiway Intersection Lights
13) Signs
14) Wind Direction Indicators With Lights
15) Road-holding Position Light

b. Airfield lighting facilities shall be controlled and monitored;

1) from the remote control panels (touchscreen) located at the VFR room of the control tower (hereinafter called "the VFR Room"),

2) from local control panel (console and touchscreen) of the main airfield lighting substation (hereinafter called "ithe Main AFL Substation"), and

3) from local control panel (touchscreen) of the Secondary airfield lighting substation (hereinafter called "the Secondary AFL Substation").

c. Interfaces required for the above control and monitoring system shall be provided respectively at the remote control panels of the VFR Room, and at the local control console, local control panels in the Control Room of the Main AFL Substation, as well as at the local control panel in the Control Room of the Secondary AFL Substation. These interfaces shall interact, by means of signal cables (optical fiber cable or metal cable), with the Central Processing Facilities to be equipped at the Computer Room (CPU Room) of the Main AFL Substation for transfer of signals relating to the control and monitoring system.

d. The system shall have the following reaction times:

- Time from an input at the control desk to acknowledgment or rejection: in less than 0.5 second

- Time from input of a command at the control desk to output of the control signals of the controllers in a substation: in less than 1.0 second

- Time from the input of a command at the control desk to the ON or OFF status signal from the system: in less than 2.5 seconds

3.3. VFR ROOM OF THE CONTROL TOWER

3.3.1 SYSTEM CONFIGURATION

The following sets of lighting control and monitoring equipment shall be installed at the VFR room of the aerodrome control tower;

1) Remote control panel with touch control part and status display part (CRT) for Approach and Runway Lights — 2 sets

2) Remote control panel with touch control part and status display part (CRT) for Stop Bar System and Taxiway Lights — 2 sets

3) Communication Interface with microcomputer — 2 sets

3.3.2 REMOTE CONTROL PANEL WITH DISPLAY FOR AFL

a. Remote control panels (touchscreen type) with display for both AFL and Stopbar lights ("STB") shall be installed one set at the Airfield Controller desk and another set at Supervising Controller desk with their types and numbers/set as specified in the Specification.

b. Logical controlling conditions

Following logical control inputs for "brightness" and "on/off" controlling conditions shall be provided at the AFL touchscreen panel:

1) Back ground brightness condition:
"DAY" "WILIGHT" "NIGHT"

2) Ceiling condition:
"iLESS THAN 300 m" "MORE THAN 300 m"

3) Runway visual range condition:
"LESS THAN 350 m" "350 m TO 550 m"
"550 m TO 1,500 m"
"MORE THAN 1,500 m"

4) Active runway condition:
"17" "35"

c. Direct control function

Following direct control function preset as per group of circuits shall be provided at the AFL control panel:

1) Direct control operation

The lighting control panel shall have such function that can switch the operating conditions from logical control position to direct control position of the system (hereinafter called direct control) to control the system conditions individually through m anual operation in accordance with the pre-determined groups of circuits.

2) Up-down operation

A set of up-down touch symbols shall be provided on the control panel to enable the lighting brightness levels to be changed at the request of the pilot.

3) Reset operation

All operation shall be nullified by the activation of a touch surface "RESET" symbol, and shall be back to a logical control condition.

4) Touch panel type remote control operation

The remote control panel shall be of touchscreen panel type, with its layout to be as simple and precise as possible and shall be suitable for installation at each controller's position.

d. Following lighting operation status and function for the AFL shall be provided at the control part of the remote control panel of the VFR Room.

1) Touch Panel:

The lighting operation status shall be indicated on the touchscreen panel so that the lighting group can be displayed when an "on / off" signal and brightness step are received from the central processing facilities. Color coding shall be used to ease the interpretation.

2) Display Panel:

All lighting systems and their operation status shall be shown on the display panel and shall be depicted by symbols which as far as possible have the same location as the system itself on the airfield. These symbols shall display the actual operating status using illuminated color coding.

e. Illumination dimmer (Intensity Adjuster) shall be provided for the AFL and Stop Bar System ("STB")display .

f. An alarm device shall be provided on both control panels, and shall be automatically operative when the runway usability under each category condition goes below the pre-set level. The alarm shall be audible with acoustic sound and also visible with a blinking prompt on the monitor. Control of an acoustic sound shall be manual, but a blinking prompt can not be stopped manually but stay on the screen until such a critical status is recovered.

425

g. The control panel for stop bar light control shall be provided with graphic panel (a schematic diagram of the aerodrome) with symbols of stop bars. These symbols shall be illuminated red in color, and be furnished with a "switch off" symbol necessary for an individual stop bar control. When the stop bar lights are extinguished ("switched off"), the symbol color of the panel will turn to green, so that the aircraft can proceed beyond the taxi-holding position onto the runway.

h. When a malfunction of the stop bar light occurs, the stop bar symbol shall show red blinking. At the same time a buzzer shall be sounded. A sound volume control and reset (sound stop) device shall be provided.

i. When the aircraft proceed across the stop bar without a clearance obtained from the tower controller, an acoustic sound and a visible alarm on the screen shall start in the same manner as describe above.

j. The graphic panel described in Item g. above shall be limited, in the panel layout, to relevant portions of the movement area of the aerodrome in order to reduce clatter and to save space.

k. The display of stop bar lights with the graphic panel (a schematic diagram of aerodrome) shall be provided with those symbols required for each of the stop bar lights, runway guard lights and taxiway center line lights, which shall be all located beyond the taxi-holding positions.

l. These stop bar light symbols as described above shall be able to indicate the actual operating status of the corresponding stop bar lights, in which stop bar lights shall automatically be illuminated under Category II operation.

m. The time required for response shall be within one (1) second.

3.4 CONTROL ROOM OF THE MAIN AFL SUBSTATION

3.4.1 SYSTEM CONFIGURATION

The following equipment shall be installed at the Control Room in the Main AFL Substation.;

1)	Local control console with graphic panel (Mosaic Type) for AFL.	1 set
2)	Local control panel with touch control part and status display part for AFL and STB	1 set
3)	Data processing unit with display and printer	1 set
4)	Direct speech telephone system:	1 set

3.4.2 LOCAL CONTROL CONSOLE

a. Local control console shall consist of an operation section and a graphic panel section.

42b

b. Operation section of the local control console shall be of a self-supported construction made of steel plate, with doors or detachable covers to be provided on its front and back sides, to allow necessary maintenance and/or inspection. Furthermore, the operation section shall be of such a construction as to permit the internal maintenance and/or inspection in case of control panels being difficult to be removed. The outside appearance of the operation section shall match that of the neighboring console.

c. The thickness of the steel plate to be used for the operation section shall be more than 2.3 mm, and for the door, more than 3.2 mm to protect the console from distortion.

d. The operating section (self-illuminated button type) shall have the following functions:

1) Logical controlling conditions:
Logical control inputs for "brightness" and "on/off" controlling conditions shall be provided with the same identical inputs as those of the AFL touchscreen panel in Item above.

2) Direct control function:
Direct control function shall be provided with the same identical function as those of the AFL control panel in Item above.

3) A reset switch function:
All the lights in the airfield shall be back to the logical control condition from direct controlling conditions with this reset switch as specified in Item above.

4) Changeover switch:
This shall change the control function over to either remote control panel of VFR Room or to local control consoles (Local control panel of the Main AFL Substation and Local control panel of the Secondary AFL Substations).

5) Normal/Standby changeover input unit for CCR:
This shall be provided at the operation console to change each CCR from normal to standby and vise versa.

6) Stable light intensity stage conditions:
When the normal CCR position is changed over to the standby, or vice versa, the light intensity stage conditions shall remain constant and shall not be changed. Furthermore, automatic changeover control mechanism shall automatically change standby CCR.

7) An alarm device for the operation console section;
this shall be equivalent in mechanism to those specified in Item above.

e. The graphic panel section shall have the following functions;

1) The graphic panel of the local control console shall be of a self- standing figurative display mosaic type (graphic mosaic panel).

2) The graphic panel section shall have an illuminated graphic layout display of configured approach, runway, taxiway and apron in the aerodrome shall

be provided in the graphic panel section. The quantity of luminous points shall be sufficient to provide conspicuity and easy interpretation.

3) LED of different colors corresponding to the color of the lights in situ with the "on" and "off" of each lights and shall ensure that the operational status is shown on the graphic panel.

4) The size of the graphic panels shall be not less than 3 x 1.5m (w x h). The graphic panel shall be set on an elevated structure.

3.4.3 LOCAL CONTROL PANEL

a. Local control panel shall be consisted of the following operation part and monitor part:

1) The operation part (touchscreen type) shall have the same function as operation section of the Local Control Console.

2) The monitor part (CRT) shall have the same functions as graphic panel section of the Local Control Console.

b. By changing the screens, the local control panel shall have same functions as specified in Items above of the local control console.

3.4.4 DATA PROCESSING UNIT WITH DISPLAY AND PRINTER

a. The data processing unit to be installed in the Control Room of the Main AFL Substation shall consist of three (3) sections; a processing control section., an operation section and a recording section to compile monthly reports, annual reports, and required statistics, etc.

b. The processing control section shall be able to input the lighting control data for storage and to make the result available with a program software for editing and printing the monthly and annual reports with a list for a prescribed period. The period to be prescribed shall be not more than one (1) year, and a table of contents by which reports can be edited shall be as shown below:

i) Setting time for logical control condition
ii) CCR operating time for each tap
iii) Lights' operating time
iv) Fault records.

c. Guidance message software shall be provided for reports editing work which shall be sufficiently supportive and instructive in editing and saving a report in the form of a computer output file.

d. The result of the report editing work shall be printed out by a printer which is connected to the microcomputer.

e. The printer shall be able to print out all the records in the forms of reports which may be preset in the software as shown in the following items;

1) The operational records of the lighting as described in Item above, and

2) Electric current values of lighting which can be recorded at each circuit. In the case of a light's failure, the electric current value at the time of failure shall also be printed out.

3.4.5 DIRECT SPEECH TELEPHONE SYSTEM

Direct speech telephone system shall be constructed to render the verbal communication services, which shall consist of :

1) 2 sets of telephones between the VFR Room of the Tower (1 set) and the Control Room of the Main AFL Substation (1 set)

2) 2 sets of telephones between the Control Room of the Main AFL Substation (1 set) and the Control Room of the Secondary AFL Substation (1 set)

3) 1 set of telephone at the Control Room of the Main AFL Substation to have a direct speech telephone linkage with the Main Airfield (35 kV) Power Substation

4) The work to be included in the contract and to be installed inside the buildings shall be the supply and installation of the above number of telephones, a telephone relay box and the cable works among these direct speech telephone networks.

3.5 COMPUTER ROOM OF THE MAIN AFL SUBSTATION

3.5.1 SYSTEM REQUIREMENTS

The central processing facilities to be engineered, supplied and installed under the contract shall be the computational and control unit of a computer and shall have the device that interprets and executes instructions for data management and information sharing with sophisticated network administration over the computer system of the central processing facilities, all of which are necessary and indispensable services to be required in this work under the contract for the control and monitoring of the airfield lighting and the power distribution systems of the project..

3.5.2 SYSTEM CONFIGURATION AND CHARACTERISTICS

The central processing facilities shall be installed in the computer room (CPU Room) of the Main AFL Substation, which are consisted of a programmable logical controller section and an interface section.

The central processing facilities shall perform such required tasks as lighting and power monitoring and control, their logical control under category II operation and stop bar control, etc. and exercise, among others, the following controls:

a. The high performance dual processor mainboard based control system shall meet the following technical requirements:

1) Industrial control
2) Conformity with industrial standards for high electromagnetic environment to withstand temperatures up to :
3) High resistance to shock and vibration.
4) Basic components can be combined in a redundant system.
5) Modular design with wide range of individually combinable modules.

6) Extremely short instruction processing times of 0.2 ms / 1K binary statements, or better.
7) Program storage on non volatile memory.
8) Robust, fully enclosed modules
9) Modules may be plugged in and unplugged while under power.
10) Capable of easy expansion.
11) Conformity with international standards and ISO.

b. The central processing facilities shall exercise, among others, the following logical controls:

i) In an inputting exercise under the logical control condition;
the brightness and ON/OFF signals which are allocated as the pre-determined control conditions for each lighting group shall be output.

ii) In an inputting exercise under the direct control condition;
the signals as specified in Item above to be the control conditions for each lighting group shall be output.

iii) When the input as noted in the preceding paragraph i) above is exercised, the control circuit shall be able to display the logical input condition, and shall output signals to each control panel.

iv) When the input as pre-programmed for each lighting circuit is exercised individually from the control panel, the control circuit shall be able to output the control condition signals and respond to display the corresponding signals.

v) The control circuit section shall be able to output signals necessary for recording the lighting operations as specified in Item above.

A provision shall be made for the future to facilitate a modification in the software upon a change made on the specifications of the computer system

3.5.3 PROGRAMMABLE LOGICAL CONTROLLER FUNCTION

The Programmable logical controller section of the central processing facilities shall be consisted of controllers for communication, memory, monitor, etc. which relates to, for example, transferring data to and from the central processing facilities to which it is connected, and is dedicated to data transmission; sending, receiving, deciphering and checking transmissions for errors.

a. The logical controller shall be the programmable machine in its own right, and being an integral component of the central processing facilities, shall provide with the following functions:

① Received command from the remote control panels, local control panels, local control console for AFL and for stop bar shall send their command signals to each high speed modem.

② Received status signals from each high speed modem shall be send to each panel and console after their analyses, and processing the signal data to display their information.

③ Alarm signals shall be sent when each lighting system function goes under the standard as specified in ICAO Annex 14, Volume 2, 8.3.3, 8.3.4, 9.4.21, 9.4.22, and 9.4.23.

b. PLC shall be capable of using at least 32 bites high speed modems.

c. The logical controllers shall be of the following construction:

① An industrial type of computer equipped with a logical input/output controller for programming

② Redundant central processing system with an automatic switching device in the event of system's failure.

③ High performance operating system (OS) with high-speed disk drive controllers for MO/CD-ROM/floppy disks.

④ A set of software necessary for the above tasks.

d. As a protective measure, in case of voltage losses the central processing facilities or power failure shall be buffered by an uninterrupted power supply system(UPS).

3.5.4 STORAGE SECTION OF THE CENTRAL PROCESSING FACILITIES

The storage section of the central processing facilities shall have the following function:

a. Recording function for storage of the lighting controlling status

b. The unit shall have a function to store the lighting control status for a certain period of time.

c. Following contents shall be recorded, in addition to the date, time and name of the unit:

i) Changes to be made in the logical control condition and in the direct control condition.

ii) Electric current values of circuit loads to be recorded at a regular time or at the desired time when the operating state or condition is changed to the approach lights, PAPI, runway lights, runway threshold/end lights, touchdown zone lights, and runway center line lights.

d. A storage part of the central processing facilities shall be able to store a digitized electric current value of the CCR per second for a period of one (1) day. The data thus obtained shall be saved in a MO disk or other memory media as may be required.

e. The output value of electric current of the CCRs shall be recorded in the following manner:

i) The output to be available from CCRs as a transition of the CCRs' electric current for a day shall be recorded in the system.

431

ii) The above CCR's electric current output but available as transition of its operating state or condition for a day shall be recorded in the preset category items such as "the date", "time" and "name of CCRs", and shall be printed out in the event of any change or failure made.

f. The system unit shall be capable of outputting the particular state of CCRs recorded as above-mentioned as well as the events of failure to the printer of the control room.

g. storage part shall have a function to monitor and record an insulation resistance of each CCR circuit.

i) The monitor-storage section unit shall be capable of outputting the insulation resistance of each CCR circuit to the local control console, panel and printer respectively.

ii) In addition to the monitoring of the insulation resistance, the monitor-storage section unit shall be capable of recording the insulation resistance when it becomes below the presetting level of resistance value.

iii) The above presetting value levels shall be changeable by the operation section computer.

h. Fault recording function

When a fault occurs in the airfield lighting system, such items as the time, name of the unit at fault and description of the fault shall be recorded in the storage section unit.

3.5.5 INTERFACE SECTION OF THE CENTRAL PROCESSING FACILITIES

Interface section of the central processing facilities of the Computer Room shall be provided with a proper interface mechanism such as a converter which is required for exchanging the data one another with other system components.

a. Two (2) identical communication interfaces shall be provided, with each computer serving as a back-up to the other.

b. One interface of the above two shall serve as Main, and the other computer as Hot-Standby computer.

c. The microcomputers shall be able to check continuously the data logged in with as least error as possible and, in case of a malfunction of the Main, the Hot-Standby shall take over the main.

d. The switchover of functions between the computers shall be accomplished within a few milliseconds, and shall be free from jam and from loss or interjection of data.

e. Such switchover shall be accomplished without being noticed, and shall not influence whatsoever the operating function and condition of the system and shall ensure the integrity and security of the current data .

3.5.6 PAPI MONITOR FUNCTION (Tilt Switch)

The PAPI shall have setting angle detecting mechanism and shall be monitored through a communication interface which has a function of interface, processing, control, monitoring, and recording in the same manner as mentioned in the AFL substations.

3.5.7 RESPONSE TIME

The communication interface shall be able to indicate on all the panels the actual status of each light within one (1) second from the time of control.

3.6 BURNT-OUT LAMP DETECTION SYSTEM

3.6.1 SCOPE

This work shall include all the goods and services that are required for the engineering, supply and installation of the lamp failure detection system.

3.6.2 SYSTEM REQUIREMENT

a. The system shall be used for detecting fail lamps for the following airfield lighting:

Runway center line lights
Runway touchdown zone lights
Runway threshold lights
Runway end lights
PAPI
Rapid exit taxiway center line lights from the runway to the stop bar
Taxiway center line lights beyond the taxi-holding position
Runway guard lights
Stop bar lights
Road-holding position lights

b. The system shall be used for controlling "on" and "off" of the following lights:

Stop bar lights
Runway guard lights
Taxiway center line lights beyond the taxi-holding position.
Runway threshold lights
Road-holding position lights

c. The system shall be used for controlling the blinking of lamps for the runway guard lights.

d. The system shall be used as interfaces for the aircraft to detect the ground signal lights by the aircraft sensing device.

e. The system shall conform to the Electromagnetic Compatibility (ENC) as specified in IEC.

f. The response time shall be not more than 1 second from the reception of the command to its reply indication. If it can no be possible to respond logically, the indication shall be controlled mechanically, but when the actual operating status

433

differs from the indication, the system shall correct its indication and report it with alarm.

g. Fail-safe mode shall be provided for each device, in the event of an internal or external system failure. If the communication linkage breaks off, the remote unit shall be switched over to the redefined fail safe state.

h. Self-checking function shall be requested for all devices to perform, the result of which shall be reported to the central processing facilities.

3.6.3 SYSTEM CONFIGURATION

This system shall consist of the following components:

a. Programmable logical controllers (including PLC part of central processing facilities in the computer room of the Main AFL Substation)

b. High speed modem to be equipped at each CCR.

c. Remote unit shall be equipped and connected to each light or sensor (secondary side of each isolating transformer), and shall also be connected to the secondary side of each isolating transformer in series circuit connection (primary side).

d. Communication Line

i) Series circuit power cable shall be commonly used as communication means.

ii) Dual fiber optical cables for the control and monitoring of AFL shall be commonly used between Main AFL Substation and Secondary AFL Substation as a means of communication

iii) Metal signal cable shall be used between high speed modem and programmable logical controllers as a means of communication.

3.6.4 CHARACTERISTICS

a. Remote unit

i) The dimension of the remote units shall be within 150 x 200 x 100 (w x h x d), and suitably housed in the transformer box together with isolating transformer.

ii) Remote unit shall have 500 mm±10% primary and secondary lead cables, with plug and receptacle suitable for connection with the isolating transformer and lighting fixture.

iii) Remote unit shall be accommodated in a water-tight and anti-corrosion container, and, furthermore, shall be anti-impact and anti-vibration under harsh condition during installation and maintenance works.

iv) Remote unit shall be provided with the following functions:

① Continuous monitoring of lamps to be ensured and when the lamp fails, its signal shall be sent with an identifiable code.

② Special features should be given to the secondary of the transformer which shorts itself in case of burnt out lamp.

③ Controlling the "on" and "off" of lamps, or "blinking" in the event that the command from the PLC via high speed modem and cables is received.

④ A sensor for a maneuvering aircraft shall transmit the signal of the presence of aircraft with the progression signal sent to the PLC.

⑤ The power consumption shall be less than 10VA.

⑥ Remote unit shall be set with identical address, which shall be interchangeable through the lead cable by address setting device.

⑦ Address setting shall not require any specific knowledge.

⑧ Electric current working range shall be at least 2.8 - 6.6 A, and shall be used at least up to 300 W.

b. High Speed Modem

i) High speed modem shall be connected to both PLC and secondary circuit of the CCRs.

ii) High speed modem shall be provided with the following functions:

① True bi-directional communication in series circuit connection.

② Communication speed between high speed modem and any remote unit shall at least be 9600 Baud.

③ High speed modem can be connected at least 150 remote units per each high speed modem.

④ High accuracy of communications shall be ensured by the Cyclic Redundancy Check, and error checking on communications signal between high speed modem and remote units.

⑤ Fault lamp location shall be identified by the number, and other status signals.

⑥ Received command from PLC shall be send to the remote units.

⑦ Received status signals from remote units shall be sent to the PLC.

i) Suitable outline dimensions shall be required to accommodate it in the CCRs.

435

ii) Necessary power shall be provided from each CCR or independent 380 V/220 V circuits.

c. The programmable logical controller (PLC) for burnt-out lamp detection
PLC shall be integrated with the burnt-out lamp detection system and shall be provided with the following function.

① Received command from the remote control panels, local control panels, local control console for AFL and for stop bar shall send their command signals to each high speed modem.

② Received status signals from each high speed modem shall be send to each panel and console after their analyses, and processing the signal data to display their information.

③ Alarm signals shall be sent when each lighting system function goes under the standard as specified in ICAO Annex 14, Volume 2, 8.3.3, 8.3.4, 9.4.21, 9.4.22, and 9.4.23.

3.6.5 INSTALLATION

a. Programmable logical controllers (PLC) shall be the integral component of the central processing facilities and shall be installed in the computer room at the Main AFL Substation..

b. High speed modems shall be installed at secondary circuits of the nominated CCRs.

c. Remote unit shall be connected between the isolating transformer and lighting fixture, and shall be installed inside the housing of the transformer box together with the isolating transformer which shall be connected to all lighting positions as well as sensor positions of the nominated Stop Bar circuits.

3.7 MAINTENANCE ROOM OF THE MAIN AFL SUBSTATION

The personal computer shall be installed with a printer in the maintenance room at the Main AFL Substation to monitor the operational behavior of each lighting for maintenance.

3.8 CONTROL ROOM OF THE SECONDARY AFL SUBSTATION

Local control panel combined with touch control part (touchscreen) as well as status display part (CRT) for AFL and Stop Bar System shall be provided in the control room with a suitable desk.

3.9 FIBER OPTICAL COMMUNICATION LINE

The data communication via central processing facilities among the Tower, Main and Secondary AFL Substations shall rely on dual fiber optical cables which offer a higher transmission safety and are not affected by electromagnetic interference.

All connections and joints shall be executed in a workmanlike way so as to minimize the losses in the signal.

3.10 SYSTEM RELIABILITY AND REDUNDANCY

The equipment to be used for the system shall consist of highly reliable components and parts duly assembled in a highly reliable procedure.

a. Communication interface to be installed at the computer room shall be of a duplicated system so that the integrity and security of lighting operation data can be ensured by switch-over of a faulty system to the other system. The system shall be immune from any external influences.

b. The lighting control monitoring system shall have a self-diagnostic function to monitor its control condition at all times so that the highly reliable lighting control can be ensured.

c. Uninterrupted power supply unit shall be provided for an uninterrupted operation of the communication interface which shall be installed at the computer room to enable itself to endure for at least 10 minutes in the event of power failure.

3.11 MAINTENANCE OF THE SYSTEM

a. The system components shall be of modular type as far as possible to facilitate the maintenance and replacement works to do.

b. All units shall be of such a construction that can permit easy inspection and maintenance work in the field.

c. All the parts of receptacles and units shall have their names posted on them and shall be readily identifiable with the individual names together with their assembled state illustrated.

d. A provision shall be made to the lighting control system to prevent a specific circuit from closing by error while the circuit is being opened for field inspection of a control unit or any other units.

e. A troubleshooting flow chart shall be provided to facilitate the recovery work in the event of a system 's failure.

437

CHAPTER 4

EQUIPMENT AND MATERIALS

4.1 SCOPE

This chapter specifies equipment and materials to be supplied and incorporated in the Work, whose characteristics shall be common to all airfield lighting and its associated power distribution systems.

4.2 ISOLATING TRANSFORMER

4.2.1 The types and characteristics of the isolating transformer to be supplied shall be as shown in the table below:

Capacity Characteristics	45/60 watts	45/60 watts	100 watts	200 watts	300-500 watts	Remarks
Rated voltage (V)	3000	5000				
Frequency	50/60 Hz					
Primary voltage regulation	Max. 80					Open circuit
Efficiency (%)	Min. 80	Min. 80	Min. 80	Mi. 80	Min. 90	100% load
Primary power factor (%)	Min. 95					100% load
Secondary current (A)	6.6 - 7.1					Short circuit
Secondary current (A)	6.53 - 6.67					100% load
Primary current (A)	6.6					100% load

4.2.2 All isolating transformers shall be suitable for use on series circuits with a current of 6.6 amperes.

4.2.3 All isolating transformer shall be completely waterproof, and shall withstand continuous long-term use under the designated ambient conditions and shall be suitable for setting in the transformer box.

4.2.4 Each transformer shall be completely sealed together with the lead cable joints, in black vulcanized rubber with polychloroprene sheathing of 7 mm or more in thickness to ensure water-tightness.

4.2.5 Two primary lead cables, one secondary lead cable and one earth terminal connected to one end of the secondary winding coil shall be attached to the isolating transformer.

4.2.6 The primary lead cables shall be 600 mm$\pm$30 mm in length, 5,000 V, single cored 6 mm^2 PN cables, the one with a receptacle and the other with plug. The secondary lead cable shall be of 600 V two cored 4 mm^2 cross-linked elastomer insulation cross-linked elastomer sheathed, 1,200 mm$\pm$50 mm in length, and provided with a receptacle. All plugs and receptacles of lead cables shall be factory molded.

4.3 FRANGIBLE COUPLING

a. Elevated type lights installed in the maneuvering and approach areas shall be mounted on frangible devices or couplings. The impact load required to cause failure at the break

point shall not exceed 5 kg, and a static load required to cause failure shall not exceed 230 kg applied horizontally 30 cm above the break point of the mounting device. The desirable maximum height of light unit and frangible coupling is 36 cm above ground.

b. Units exceeding the height limitation shall require higher breaking characteristics for the frangible coupling, but the frangibility shall be such that, should a unit be hit by aircraft, the impact would result in minimum damage to the aircraft.

c. In addition, all elevated lights installed on runways shall be capable of withstanding a jet engine exhaust velocity of 300 knots.

d. Frangible coupling shall be made of aluminum-alloy casting, and shall be of the following table:

Table 1 Frangible Couplings - Characteristics

Type	For Use with	Static load characteristics			Impact load
		Loading point	Minimum break load	Maximum break load	Characteristics
A	Signs	30 cm	675 kg	-	-
B	PAPI	30 cm	More than 135 kg	Less than 230 kg	-
C	Runway / taxiway edge light, Approach light Stop bars	30 cm	More than 135 kg	Less than 230 kg	5 kg

Note: Approach lights installed higher than 36 cm shall apply to the type C.
The aircraft sensor units, the capacitor discharge lights and control units shall apply to the type C.

4.4 CABLES

4.4.1 GENERAL

The sizes of the cable conductors in the Specifications and the Drawings are given in mm or mm^2 and number of cores. The following information shall be marked repeatedly on suitable part of the cables:

- Manufacturer's name and/or trademark
- Year of manufacture
- Size of stranded conductor cross section(for series cable only)
- Voltage rating(for series cable only)

Cable length per cable drum shall be less than 1,000 meters. Where cable end projected from a drum, they shall be adequately protected to prevent damage during handling and transportation, and a thick PVC wrapping shall be placed over the cable to prevent the ingress of dirt, dust and grit, etc.

Each drum shall bear a distinguishing number which is branded with hot-ironed or neatly chiseled on the outside of one flange. A painted marking shall not be accepted.

Particulars of the cables, i.e. type of cable, rated voltage, length, conductor size, number of cores, gross and net weights, as well as position of cable end, manufacturer's name

442

and year and month of manufacture shall be clearly shown on the drum in the direction of rolling shall be indicated by an arrow.

4.4.2 SERIES CIRCUIT CABLE

Series circuit cable to be used in this works shall be 6 mm^2 single core, ethylene-polypropylene rubber insulated, copper sealed, polychloroprene sheathed cable or better cables than those in the following specifications:

Table 2 Cable Specifications

Voltage rating		6 kV	5 kV
No. of conductor		1	1
Conductor	Nominal area	6 mm^2	6 mm^2
	No. & diameter of wires	7/1.04	7/1.07
Insulation thickness		0.12 mm	0.08 mm
Sealed tape thickness		1.4 mm	1.2 mm
Sheath thickness		1.48 mm	11.1 mm
Overall diameter of cable (Approx.)		15.0 mm	15.4 mm
AC withstand voltage (Testing voltage)		11.0 kV mm (5 min.)	(17.0 kV) (10 min.)
Insulation resistance for 1000 m (20 °C) (Min.)		36.7 Kilo.ohm	(900) Kilo.ohm
Conductor resistance per 1000 m (20 °C) (Max.)		3.08 ohm	2.81 ohm

a. The cable conductor shall be tin or lead-alloy coated annealed stranded copper wires.

b. The average thickness of the insulation, sealed and sheathed, shall not be less than 90 % of the value given in the above table.

c. The minimum thickness of the insulation, sealed and sheathed at any point, shall be not less than 80% of the above specified value.

d. All cables of above-listed 5 kV shall comply with specifications of AFF L-824 Type C.

e. The figures in brackets are for reference only and shall be subjected to proposals of particulars by the respective tenderers together with their own test data duly attached.

4.4.3 ISOLATING TRANSFORMER SECONDARY LEAD CABAL, AND EXTENSION CABLE

Secondary lead cable of isolating transformer and extension cable to be used between isolating transformer and lighting fixture shall be 4 mm^2, two-cores, ethylene-polypropylene rubber insulated, polychloroprene sheathed cable or better materials than those in the following specifications:

43

Table 3

Voltage rating		450 V/750 V
No. of conductor		2
Conductors	Nominal area	4 mm^2
	No. of wires	50
Insulation thickness		1.0 mm
Thickness of sheath		1.8 mm
Overall diameter of cable (approx.)		12.8 mm
Weight of cable per 1000 m (approx.)		24.7 kg
AC withstand voltage (for 1 minute)		2.5 kV
Conductor resistance per 1000 m (20 °C) (Max.)		1.08 ohm

*1: Synthetic rubber or silicone rubber
*2: Piolychloroprene

4.4.4 PARALLEL CIRCUIT CABLE (in accordance with IEC 227)

All power cables of parallel circuits to be used up to 450/750V in this work shall be cross-linked polyethylene insulated polyvinyl-chloride sheathed cables of the following specifications:

a. The cable conductor shall be tin or lead-alloy coated annealed stranded copper wires.

b. The average thickness of the insulation, sealed and sheathed, shall be not less than 90% of the value given in the following table.

c. The minimum thickness of the insulation, sealed and sheath at any point, shall be not less than 80% of the specified value.

d. Number of cables, sizes and number of conductors are indicated on the contract drawings.

4.4.5 METAL CONTROL CABLE

Control cables associated with the airfield lighting system in this works shall be manufactured and tested in accordance with the relevant IEC specifications for cables or equivalent standards.

4.4.6 FIBER OPTIC CABLE

Fiber optic cable shall be loose tube type, jelly filled, optical single mode duct cable and shall be manufactured and delivered to the site in accordance with the following specifications:

a. Fiber characteristics

① The fiber shall comply with specific Table-1 described hereafter.

② The fiber shall be uniformly coated and firmly attached to the fiber cladding. The fibre coating shall be mechanically strippable and have the nominal outer diameter of 0.25 mm.

③ Fibres for the cable shall be proof-tested with at least 0.8% proof-strain with a minimum duration of one second.

④ The fibres shall be identified according to the colour sequence in Table-2.

⑤ One or more fibres shall be protected by loose packaging within a tube in accordance with Table-3. The filling compound shall be filled within the protective tube. The filling compound shall be soft thixotropic gels that provided the fibre(s) buffer and free movement.

b. Optical cable core make-ups

① One or more secondary protected tubes shall be tightly stranded in one or two reverse directions around a central strength member.

② The central strength member may be sheathed with polyethylene when necessary for accommodating a layer of the desired number of tubes.

③ Additional filler, binder and/or strength members may be incorporated with cable core if necessary for manufacturing reasons.

c. Cable core filling compound

① The cable core filling compound shall be distributed into interstices of the optical cable core for water blocking.

② The cable core filling compound shall be non-toxic, free from bad smell and should not affect the skin,

③ The cable core filling compound shall minimize the slip between the strength member and the sheath and shall comply with the minimum dropping point of 65° in accordance with IEC 811-5-1 Clause 4, Methods A.

d. Core wrapping

① The cable core shall be wrapped with one or more layers of suitable tape(s). The wrapping shall be lapped or applied longitudinally.

② Suitable binder(s) shall be incorporated if necessary for manufacturing reasons.

e. Manufacturer's identification

A tape shall be incorporated into the core wrapping which shall show the following details marked throughout the whole length of cable:

- Manufacturer's name
- Year of manufacture

Alternatively, above details shall be printed on the outer wrapping or the sheath.

f. Sheath

① Laminated aluminum tape
The cable core shall be wrapped with one-side polymer aluminum tape longitudinally with polymer outside. The nominal thickness of aluminum tape and polymer shall be 0.15 mm and 0.05 mm respectively.

② Sheath
The cable core shall be sheathed with black polyethylene.
The minimum radial thickness shall be in accordance with the table 4 above.

③ Length mark
The length mark with a regular interval of 1 m shall be printed on the cable outer jacket. The accuracy of the marking interval shall be held within the limit of ±1 %. Re-marking of the marking shall be of another colour.

g. Marking and sealing

The cable end at which the colour scheme sequence follows a clockwise direction shall be marked. The other end shall be marked green. Suitable self-adhesive tape may be used for those purposes. The ends shall be properly sealed with metallic caps to prevent ingress of moisture.

h. Drumming

The factory length shall be wound on non-returnable wooden or steel drum. After the cable has been tested and sealed, the drum shall be lagged with stout, closely fitting wooden battens.

i. Properties

① Tensile performance
The maximum pulling strength shall be at least 2000 N according to the method of IEC 794-E1 at least 5 meter length. The variation in attenuation shall be less than 0.1 dB at 1310 nm and 1555 nm for maximum pulling strength. And the maximum fibre strain at maximum allowed pulling strength shall be less than 33 % of the proof test strain. There shall be no residual strain in the cable after releasing the pulling strength.

② Crush
The attenuation of any fibre measured at the wavelength of 1310 nm and 1550 nm shall not increase more than 0.1 db at the load 2000 N/100 nm with flat plate for minute according to the test of IEC 794-I-E3.

③ Cable bend
The cable bend test shall be in accordance with IEC 794-1-E11 and the following procedure.

The diameter of the test mandrel shall be twenty-fold the cable diameter and the number of cycles shall be 5.
The variation in attenuation during the test shall not exceed 0.10 db at 1310 nm and 1550 nm. No permanent change in attenuation after test shall be observed.

446

④ Temperature
Cable shall be subjected to a temperature test of one cycle in the temperature range of -20°C to 70°C. The attenuation shall not vary within measuring error in the temperature range of -10°C to ±60°C and shall not vary more than 0.05 db/km at 1310 nm and 1550 nm.

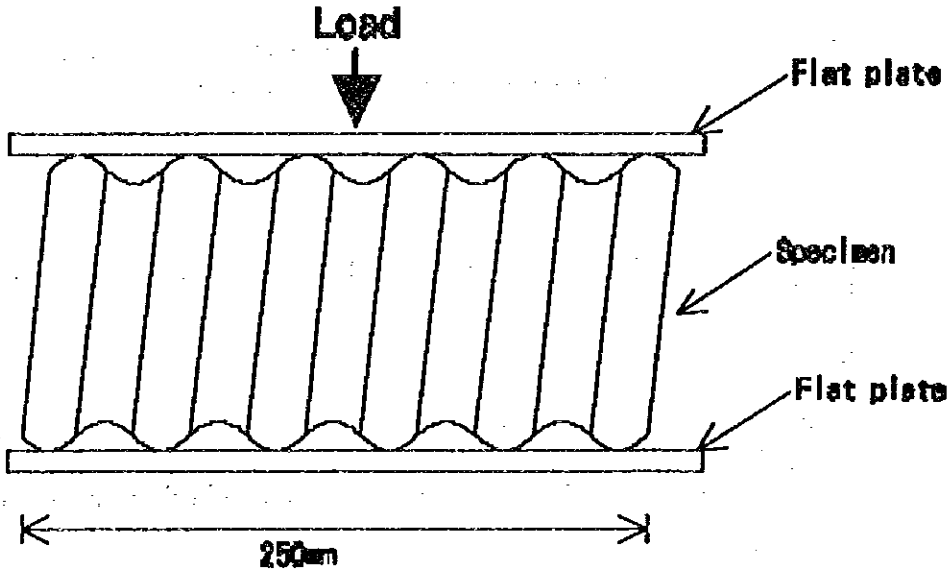
j. Cable construction
The cross-section and dimensions of cable shall be in accordance with Fig. 1 and table 4 respectively.

k. Installation information

① Minimum bending radius :
(during installation) : Twenty-fold the cable diameter
(when setting) : Ten-fold the cable diameter

② Allowable tensile strength: 2000 N

③ Allowable lateral force : 2000 N/100 nm.



4.5 PLUGS AND RECEPTACLES

Plug and receptacle for the 5 kV/6 kV 6 mm² single-core cable shall be designed for 25 amperes current, and 450 V two-cores cable for 20 amperes.

The plug and receptacle shall be water-tight and shall withstand continuous use under the designed ambient conditions.

The connected plug and receptacle shall resist a pulling force equal to a static weight of 5 kg without becoming disconnected. All plugs and receptacles shall be identical and of uniform manufacture.

447

4.6 CABLE PROTECTORS

Corrugated rigid synthetic resin pipe shall be used as cable ducts where cables are laid in on paved area. Galvanized steel pipes shall be used as cable ducts to across the paved area, e.g. runway, taxiway and apron shoulders, maintenance road and GSE road, etc.

The ducts shall be buried at a depth of more than 700 mm from the pavement or ground surface to the top surface of the ducts.

The ducts shall not allow common use between high tension cables and low tension cables, and between power cables and communication cables.

Furthermore, same airfield lighting system introducing the interleaved two circuits shall not allow common use with the same ducts, e.g. ducts for approach lights, runway lights, and runway center line lights, etc.to be separated

Total cable cross section area shall not exceed 60 % of the duct area.

A manhole or hand hole shall be provided on both sides of the crossing paved area, straight section at intervals of not more than 300 m and at every duct corner. Also, manhole or hand hole shall be provided at a divided construction position between inside and outdoor work scopes.

Contractor shall submit to the Engineer for approval shop drawings with structural calculations of the manholes and hand-holes before construction.

4.6.1 Corrugated rigid synthetic resin pipe

a. Scope

This specification shall cover corrugated rigid synthetic resin pipe for underground electric cable conduits.

b. Construction and Property

i) The pipes shall be principally made of polyethylene materials (JIS K 6748 "Polyethylene molding materials" or equivalent), and shall be formed by extrusion, and shall have the dimensions specified in the following table.

Table 4

Nominal diameter (mm)	Outer diameter (mm)	Inner diameter (mm)	Average thickness (mm)
100	130.0±4.0	100.0±4.0	over 1.6
80	102.0±3.0	80.0±3.0	over 1.5
50	64.5±2.5	50.0±2.5	over 1.2

(1) The pipes shall be corrugated to get flexibility.

(2) For improving weather ability of the product, a proper amount of carbon black and a stabilizer shall be added and dispersed uniformly

448

in the product, and the product shall have uniform quality after it is formed.

(3) The color of the pipes shall be black.

(4) The pipeís projected cross section shall be practically ground, and its wall thickness shall be uniform.

ii) Property

The properties of the pipes shall be in accordance with the following table, when they are tested to the test methods as described in c) ii) - iv) hereof.

Table 5

Item	Property	Applicable test item
Tensile strength	19.6 N/mm^2 (2.0 kgf/mm^2) or above	c)-ii)
Compressive strength	The relative deflection of the outer diameter shall not exceed 3.5 % and no crack or breakage shall appear at any part after being tested.	c)-iii)
Bending strength	Deformation ration of 20 % or less	c)-iv)

c. Test

i) Construction Test

A test piece of 500 m long shall be taken out from finished product, and the construction and dimension of each part of the test piece shall be measured.

A 0.05 mm unit caliper (specified JIS B 7507 "Caliper" or equivalent) shall be used for measurement of the diameter and thickness of the test specimen.

(1) Diameter

The diameter shall be measured at 4 points which are positioned equal angle from center of a pipe and which are located on the same plane perpendicular to the pipe axis. The gained values shall be averaged.

(2) Thickness

The thickness shall be measured at 4 points which are positioned equal angle from center of a pipe and which are located on the same plane perpendicular to the pipe axis. The gained values shall be averaged.

ii) Tensile strength test
The tensile strength shall be obtained from the same material, which is used in pipe (the test shall be performed in accordance with JIS 6760 4.3 or equivalent specification of manufactureris country). The test speed shall be 50 mm/min.

iii) Comprehensive strength test
The procedures for compressive strength test shall be in the following steps:

(1) A test specimen 250 mm long shall be taken out from a finished product.
(2) A testing equipment shall be prepared.
(3) After keeping the test specimen and testing equipment at temperature of 20 ±20°C for two hours, the test shall be carried out at the same temperature condition.
(4) Hold the test piece between to pieces of flat steel plates, and then subject the test piece to the compressive load stated below with a speed of 20 mm per minute in the direction of the right angle to the pipe axis.

Compressive load: P = 21.3 x R N (2.17 x R kgf)
where,
R: Average radius of the pipe (D + d) : 4 (mm)
D: outer diameter of the pipe (mm)
d: inner diameter of the pipe (mm)

The relative deflection of the outer diameter shall be calculated by the following formula:

Relative deflection of the diameter =
[{ (outer diameter before compression) -
(outer diameter after compression) } ÷
(outer diameter before compression)] x 100

iv) Bending test

A specimen with adequate length shall be taken out from a finished product. Then the specimen shall undergo 180° bending around a cylinder having 20 times as large as outer diameter of the specimen. Next, the specimen shall be bent in the same way toward reverse direction of aforementioned test and straightened.

The cycle of the test shall be repeated 3 times, at room temperature and after this repeated cycle of the test, the amount of deformation of outer diameter of the specimen shall be measured.

Calculation of deformation ratios of the specimen shall be done in accordance with c), iii), (4) above.

d. Packed pipe length

The standard packed pipe length shall be as follows:

Table 6

Nominal diameter (mm)	Standard coiled pipe length (mm)
100	100
80	100
50	200

1-50

4.6.2 Steel pipe

Steel pipe used in this Work for cable ducts shall be galvanized carbon steel pipe.

Properties and test methods shall be applicable to JIS G 3452 or ISO, BS, DIN or authorized standards of the manufacturer's country.

Size and number of ducts are indicated on the contract drawings.

4.6.3 Flexible steel pipe

Flexible steel pipe shall be used between base box / transformer box and cable ducts. Inner diameter of the flexible stainless steel pipe shall be the same size of the jointed cable duct inner diameter.

Length of the flexible steel pipe shall be good enough to keep the safety bending.

Properties and test methods shall be applicable to authorized standards of the manufacturer's country or manufacturer's standards, and shall be submitted to the Engineer together with specifications, drawings and samples for his approval.

4.7 Constant Current Regulators (CCR)

Constant Current Regulators (CCR) shall be manufactured in accordance with the following IEC specification, IEC-1822 (its enactment work is currently under way) or equal standards, and additional performance requirements as specified hereinafter.

4.7.1 Number and capacity

Number and each capacity of Constant Current Regulator to be installed in the Main and Secondary AFL Substations are specified on the respective Contract Drawings,

4.7.2 General

Constant Current Regulator shall be controlled by a microprocessor, and consist of a power module and a control module. A maximum of two power modules shall cover load from 2.5 KVA to 30 KVA.

Constant Current Regulator shall have the following features:

- High operational reliability
- Small space requirement
- Withdrawable-unit design
- Use of micro-controller for monitoring functions
- Serial communication
- Extensive status and malfunction information on regulators and series circuits
- Reliable and fast data transfer between the control computer and regulators
- Integral earth-leakage monitor functions
- Simple adjustment of lamp failure functionality by micro-controller support
- Space-saving front connectors for serial and parallel connection and diagnostics

451

- Parameterization of Constant Current Regulator function via diagnostic computer
- Alphanumeric multi-function display on front panel
- Brightness control steps three plus option one step (less than 1.5 A) or five plus option one step (less than 1.5 A)

4.7.3 Requirements

a. Rating

All Constant Current Regulators shall have standard power ratings as specified below:

i) Capacity : 4.0 KW, 7.5 KW, 20 KW and 30 KW.
ii) Output current : 6.6 amperes
iii) Input voltage : 208 volts
iv) Frequency : 50 Hz±5%

b. Environmental requirements

i) Temperature range : from -10 to +55 °C
Not in operation : from -20 to +70 °C
ii) Relative humidity : from 10 % to 95 %
iii) Altitude range : from 0 m to 1,000 m.

c. Performance requirement

i) Regulation

(1) Positive loading

The Constant Current Regulator shall maintain the output current within the limits of the following table, while powering any load between no load (short circuit) and full load.

Constant Current Regulators shall provide regulation over the full range of environmental conditions specified in the Specification and the input voltage range of 95 % to 110 %.

Table 7

Style	Brightness Step	Nominal Output (RMS Amps)	Allowable Range (RMS Amps)
1	3	6.6.	6.42 - 6.70
	2	5.50	5.33 - 5.67
	1	4.80	4.66 - 4.94
	0	1.50	1.50 - 1.20
2	5	6.60	6.42 - 6.70
	4	5.20	5.04 - 5.36
	3	4.10	3.95 - 4.22
	2	3.40	3.30 - 3.50
	1	2.80	2.72 - 2.88
	0	1.50	1.50 - 1.20

(2) Reactive loading

The Constant Current Regulator shall maintain the current within the limits of the above table for all brightness steps when the load is connected via isolating transformers, and the secondaries of 30 % of these transformers shall become open-circuited. The load before opening the isolating transformers may be of any value between 50 % and 100 % of nominal load.

(3) Efficiency

The efficiency of the Constant Current Regulator, operating at rated input voltage into a full load having a unity power factor, shall not be less than 90 %.

(4) Power factor

The regulated power factor of the Constant Current Regulator, operating at rated input voltage into a full load having a unity power factor, shall not be less than 90 %.

(5) Input voltage

Input voltage shall be single phase, 50 Hz AC. The Constant Current Regulator shall operate at 380 V when the input voltage is anywhere between 95 and 110 % of nominal input. The Constant Current Regulators may be provided with several different voltage taps from which the correct tap may be selected for the supply voltage.

The Constant Current Regulator shall be designed to withstand momentary increase of voltage up to 120 % of nominal input voltage without being shut off or damaged by such over-voltage. The duration of such over-voltage execution shall not be longer than 50 milliseconds and shall not occur more than once per minute.

(6) Load matching

The Constant Current Regulators, rated 10 KW and above, shall match the connected loads of 50 % to 100 % of the rated load.

The following requirements shall be met:

- On resistive loads in the range of 75 % to 100 % of the nominal load, at rated voltage and output current at 100 %, the efficiency and power factor shall not be less than the specified values.

- If the requirements cannot be met, output load taps shall be provided to allow a more precise adjustment.

(7) Temperature rise

The temperature rise of the power transformer windings shall be in accordance with ANSI C 57.12.00 (for liquid-cooled Constant Current Regulators) or ANSI C 57.12.91 (for air-cooled Constant Current Regulators) or equivalent.

453

(8) Operation

The control system shall stabilize the output current at any selected intensity within 500 ms, and shall hold the output current stable within ±0.1 ampere. The control system shall provide both local and remote control. The control system shall provide information on brightness step intensity and remote / local control for external monitoring.

The control system shall be integral to the Constant Current Regulator and shall not be supplied from a source located outside Constant Current Regulator package. There shall not be any interruption of output current to the airfield lighting circuit when switching from one brightness step to another.

(9) Remote control / Monitoring System

Constant Current Regulators shall have the following functions for remote control and monitoring system:

Remote Control:

- Automatic and manual brightness selection
- Automatic and manual ON/OFF selection

Monitoring:

- Selected control position
- Active runway number
- CCR On/OFF status
- CCR selected step status
- Operational standard category level failure warning
- Supply power condition commercial/standby.

(10) Output current surge limitation

The Constant Current Regulator shall be designed with a controlled "soft-start" feature so that switching the CCRs on and off, changing brightness, steps or shorting the load, shall not produce output current surges that will damage series incandescent lamps.

(11) Circuit isolating

The power input circuit shall be electrically isolated from the output circuit. With the open circuit protection disabled, the peak output voltage of an open-circuited Constant Current Regulator shall not exceed two times the rated output wattage divided by the rated current.

Constant Current Regulator shall be provided with the following protection devices:

- Open circuit protection
- Over-current protection
- Output lightning protection.

(12) Constant Current Regulator shall have following functions and characteristics:

- Primary switch
- Over-load protection
- High voltage protection
- Earth fault indicator
- Lamp fault indicator
- Load indicator

In the event of input power loss, the Constant Current Regulators shall resume operation on the selected brightness setting within one second after the restoration of input power.

(13) CCR Cabinet

① The CCR cabinet shall be constructed of steel plate and frame, accessible both from the front and the back for installation and maintenance.

② Constant Current Regulator shall be fixed suitable on the horizontally balanced base of steel channel securely anchor-bolted to the floor.

③ The low voltage equipment shall be separated from the high voltage equipment.

④ Constant Current Regulator shall be automatically switched off when the cabinet door opens, or shall be labeled [DANGER HIGH VOLTAGE, SWITCH OFF BEFORE OPENING THIS DOOR]. This instruction shall be produced in the Chinese language.

⑤ The inside and outside of the CCR cabinet shall be given at least one prime coat and one finish coat of any oil-proof and weatherproof paint.

4.7.4 Type test

The type tests shall ensure that the Constant Current Regulator is able to comply with this specification. The test shall be certified by an authorized test organizations. The certification report shall mention of the compliance to an applicable standard equivalent to this Specification.

All the following tests shall be run for at least one set of changeover switch.

The contractor shall submit for approval of the Engineer a type test certificate(s) issued by an independent testing organization(s) or civil aviation authority of the country of origin for each of the following items:

- Environmental tests
  - Low temperature
  - High temperature and altitude
  - Humidity
- Ambient temperature tests
- Visual inspection

- Safety
- Operation
- Performance
- Mechanical operation
- EMC
- Basic impulse insulation level test
- Transient test
- Protective test
- Dielectric test
- Output current surge
- Leakage test

4.7.5 Number and capacity

Number of each capacity of the Constant Current Regulator installed in the Main and Secondary AFL Substations shall be as indicated on the drawings

4.8 Changeover switch

4.8.1 Requirements

The changeover switch shall be provided for changing two switching positions, normal use CCR and standby use CCR.

Changeover shall be effected for both power and control functions within 1 second, while keeping the same brightness step.

The changeover switch shall be controlled remotely by electrical manipulation, but when inoperative by electricity, it shall be possible to operate it mechanically by manual manipulation

4.8.2 Construct ion

The changeover switch shall have the following major components:

- Metal frame and steel plate of not less than 1.6 mm thick, rigidly constructed
- Contactor for main circuits, controllable both electrically and manually
- Auxiliary relays
- Switch for circuit selection
- Switch for selection of remote / local
- Indicating lamp
- Operating coil
- Operating Voltage: AC 208 V
- Type: Latched type

4.8.3 Type test

The type tests shall ensure that the changeover switch is able to comply with this specification. The test shall be certified by an authorized test organizations or civil aviation authority of the country of origin. The certification report shall mention of compliance to an applicable standard equivalent to this Specification.

All the following tests shall be run for at least one set of changeover switch.

The Contractor shall submit for approval of the Engineer a type test certificate(s) issued by an independent testing organization(s) for each of the following items:

- Environmental tests
  - Low temperature
  - High temperature and altitude
  - Humidity
- Ambient temperature tests
- Visual inspection
- Safety
- Operation
- Performance
- Mechanical operation
- EHC
- Basic impulse insulation level test
- Protective test
- Dielectric test
- Leakage test

4.8.4 Number of changeover switch

Number of changeover switch to be installed in the Main and Secondary AFL Substations shall be as indicated on the Drawing.

4.9 Maintenance Equipment for Airfield Lighting Units

4.9.1 Requirements

The maintenance equipment shall be provided for such preventive maintenance work as inspection, measurement, cleaning, repair, replacement and testing of all the visual aids to be installed at the Airport.

These m aintenance equipment shall be compatible with the requirements as recommended in ICAO Annex 14, Section 9.4 "Maintenance" and Airport Service Manual, Part 9 on "the system of preventive maintenance" to be employed during any period of the precision approach runway category II or III operations.

4.9.2 Types and Kinds of Maintenance Equipment

The types and kinds of maintenance equipment for airfield lighting units to be supplied shall include, but not limited to the following:

Type	Kind	Quantity
I. Cleaning Equipment	Light Cleaning Equipment	1
	Parts Cleaning Equipment Hot Water Type	1
	Cleaning Equipment Supersonic Wave Type	1
	Cleaning Equipment Dry Type	1
II. Inspection Equipment	Air Leakage Testing Equipment Dry Type	1
	Air Leakage Testing Equipment Simple Type	1
	Air Leakage testing Equipment Semi-automatic Type	1
	Light Distribution Intensity Measuring Equipment for PAPI and for Other Lights	1
	Halogen Lamp Testing Equipment	1
III. Common Equipment	Warm Wind Drying Equipment	1
	Air Compressor	1
IV. Special Vehicles	Light Cleaning Car	1
	Light Distribution Intensity Measuring Car	1
	Light Cart	1
	Lighting Power Supply Cart	1
	Maintenance Car	3

I. Cleaning Equipment

1. Light Cleaning Equipment

Light Cleaning Equipment shall be provided in the Maintenance Room of the Main AFL Substation building to remove such alien materials as dirt and aircraft tire rubber adhered to the light glass of the surface lights inset in the runway and taxiways by means of the high-pressure water, and shall comprise:

1) Main Lighting unit cleaning equipment
2) High-pressure water generating equipment (pump)
3) Lighting unit holding jig
4) Resin filter
5) Cleaning nozzle, and
6) Water filter

The system shall have the light unit selector switch suitable to adjust the positions of nozzles to effect the required cleaning for the right units, and consist of the following components. Water pressure shall be re-settable depending on the properties of the dirt adhered, first to clean it with high-pressure water nozzle and to eliminate water drop with air blower nozzle.

1) Power source : 3-phase, AC 220 V, 40 kW
2) Capacity : 700 kgf/sq.cm (adjustable)
3) Cleaning nozzle : 4 pcs.
4) Nozzle : Cleaning 2 pcs.
: Rinsing 2 pcs.
: Drying 1 pc.

2. Hot Water Type Parts Cleaning Equipment

This is the Hot Water Type Equipment to be provided in the Maintenance Room of the Main AFL Substation to clean the component parts of the visual aids using hot water.

458

1) Main parts cleaning equipment
3-phase, AC 220 V, 9 kW

Capacity	:	200 sq.cm/min.
Timer adjustable within	:	30 minutes

2) Water tank : 150 liters
Rinsing water tank : 55 liters
3) Cleaning basket : Max. 100 kgs.
4) Basket carrier
5) Lower position cleaning nozzle
6) Detergent : 18 liters

The system shall have the basket and basket conveying device to carry in and out the light unit with the door to open and close after the unit is in the right place in the main equipment. Timer set in the main equipment shall allow the required time of cleaning with the warm water and the detergent. The system shall be equipped with an alarm sensor and an emergency stop switch button to prevent the operator from risk of opening the door.

The light unit shall be cleaning and rinsed properly with cleaning nozzles blasting warm water-detergent mix to the horizontal and bottom sections of light, and blow off water drop with air gun nozzle.

3. Supersonic Wave Type Cleaning Equipment

This is the Supersonic Wave Type Equipment to be provided in the Mainantenace Room of the Main AFL Substation to clean the lighting units of the visual aids using supersonic wave.

1) Main supersonic wave type cleaning equipment (water vessel)
Single phase, AC 220 V, 550 VA

Capacity	:	Max. 300 W
Oscillating frequency	:	39 kHz

2) Water vessel lid

3) Timer adjustable within	:	90 minutes
Normal cleaning time	:	3 - 15 minutes
Cleaning water vessel	:	13 liters (up to the designated water level)

4) Basket
5) Detergent

4. Dry Type Cleaning Equipment

This is the Dry Type Equipment to be provided in the Maintenance Room of the Main AFL Substation to remove dirt and tire rubber from the lighting units through blasting of minute abrasive plastic particles eliminating the use of water (dry).

1) Main cabinet	:	3-phase, 220 V, 0.6 kW
Blasting capacity	:	2 - 4 kgf/sq.cm
air consumption	:	750 liters/min.

2) Dust collector
with cyclone device for separating the collected abrasive particle and dirt particle.
3) Synthetic resin particles (20 kgs)

459

II. Inspection Equipment

1. Dry Type Air Leakage Testing Equipment

This is the Dry Type equipment to be provided in the Maintenance Room of the Main AFL Substation to inspect and test the air leakage of the lighting units in the master chamber through pressurized air of 1.5 kgf/sq.cm. The system shall be activated with an on/off foot switch and the computer to detect the variations of the air pressure for comparison with the controlled values already stored in the computer; green color to be displayed for excellent performance and red color for defective performance with an alarm sound.

1) Main equipment : AC 220 V, 200 W
   Air pressure : 5 - 6 kgf/sq.cm
   Air capacity : 6 liters/min
2) Foot switch
3) Dry type leakage valve
4) Plug
   2-pin flat type (for grounding and 3-m extension cable)

2. Simple Type Air Leakage Testing Equipment

This is the Simple Type Equipment to be provided in the Maintenance Room of the Main AFL Substation to inspect and test the air leakage of the lighting units.

The simple type air leakage testing equipment shall be capable of detecting the irregularities of the lighting units which have been found to be defective at the above Dry Type Air Leakage Testing Equipment. The equipment shall have such device to fill the pressurized air of 1.5 kgf/sq.cm from the opening of the light unit using the air leakage checking plug outfit, and then submerge it in the water for duration of one (1) minute for confirmation of air leakage. The lighting unit shall be cleaned of wet water on its surface before the detecting work finishes or in case of defective units, repaired or reassembled or parts replacements.

1) Main double sinks : AC 220 V
2) Electric warm water heater : 1.5 kW
   Setting temperature : 30 - 75 °C
   Water capacity : 20 liters
3) Water dripper
4) Dry type air leakage checking plug outfit
5) Air gun

3. Semi-automatic Type Air Leakage Testing Equipment

This is the Semi-automatic Type equipment to be provided in the maintenance Room of the Main AFL Substation to inspect and test the air leakage of the lighting units which shall be subjected to the pressurized air and submerged in the water for detecting the bubbles coming up from the leakage.

1) Main equipment : AC 220 V, 50 W
2) Attachments for : Surface-type lighting units, 3 types
   Elevated-type lighting units, 3 types
3) Cabinet box

46

4. Light Distribution Intensity Measuring Equipment for PAPI and for Other Lights

This is the Equipment to be provided in the maintenance Room of the Main AFL Substation to measure and test the light distribution intensity of PAPI and other lighting units.

The system shall be equipped with:

1) Light distribution intensity measuring console
   Power : AC 220 V, 2.7 kW
   Dimensions (approx.) : 1,100 deep x 1,800 wide x 1,450 high
2) Pattern measuring device
3) Light distribution disk (for recording purpose)
4) Lighting source (minute CCR)
   Max. load : 600 W
   Current stabilizing time : 5 seconds
   Allowable current : 6.6 A ± 0.1A
5) Camera (CCD)
6) White screen
   Dimensions : 1,100 x 5,429 x 2,300
   Weight : 200 kg
7) Lights' setting table (3 m)
   Dimensions : 440 x 440 x 750
   Weight : 150 kg
   Jigs for the above
8) Adopter box
9) Accessories : 2-HD disk
   Toner cartridge
   Drum cartridge
   Bar-code label
   Bar-code printer ribbon

The light intensity shall be measured by CCD camera at the 1° vertical and horizontal mesh, and shall be compared with the reference light pattern already stored in the personal computer for further processing the data for average intensity and evenness of each lights. The individual lights shall be numbered with bar codes, all the date of which shall be stored in the computer disks for printing as daily reports, classified by type and kind of lighting equipment

5. Dry Type Halogen Lamp Testing Equipment

This is the Dry Type Equipment to be provided in the Maintenance Room of the Main AFL Substation to inspect the filaments of the Halogen lamps of the lighting units.

III. Common Equipment

1. Warm Wind Drying Equipment

This is the Equipment to be provided in the Maintenance Room of the Main AFL Substation to dry wit the wind the water soaked lighting units.

2. Air Compressor

This is the Air Compressor to be provided in the Maintenance Room of the Main AFL Substation to generate compressed air and to feed the necessary air to he respective testing equipment.

IV. Special Vehicles

1. Light Cleaning Car

Light Cleaning Car shall be able to remove at airfield site such alien materials as dust and aircraft tire rubber adhered on the light glass of the surface lights which are inset in the runway and taxiways by means of high-pressure water with the automatic selector device equipped for adjusting the position of and rotating the cleaning nozzles, and shall comprise:

1)	Automobile body	:	4-ton carriage Flash type rear door Power-steering, automatic gear shift type Water-cooled 4-cycle diesel engine
2)	Cleaning device with position-adjustment mechanism		
3)	High pressure water generating device		
	Pressure	:	Max. 700 kgf/sq.cm
	Capacity	:	20 liters/min
4)	Engine-generator	:	55 kV
5)	Compressor	:	2.2 kW
6)	Water tank	:	1,000 liters
7)	Rotating light and searchlight		
8)	Racks for lights		
9)	Pump unit		
10)	Nozzle with spare		
	Cleaning nozzle	:	4 pcs
	Air nozzle	:	4 pcs
11)	Water filter		

3. Light Distribution Intensity Measuring Car

Light distribution intensity measuring car shall be provided in the maintenance yard of the Main AFL Substation, and shall be of a construction as stated below, equipped with the function which can continuously measure the light intensity of the surface lights while running on inserts light of the runway and taxiways.

The car shall also be provided with the recording function in the measuring system to store the measured data in the computer disks for later analyzing them using a separate small personal computer for long-term storage:

1)	Automobile body	:	Power-steeling, automatic gear shift type Water-cooled 4-cycle diesel engine
2)	Light measuring device (at 30 km/hr speed)		
	Light position detecting sensor		
	Light intensity detection sensor		
3)	Power unit (engine-generator)		
	Input	:	DC 12 V (car battery)
	Output	:	AC 100 V (for light measurement)
4)	Rotating light		

462

3. Light Cart

This is the Cart to be provided in the maintenance yard of the maintenance Room of the Main AFL Substation to supply and project necessary lights for maintenance of the lighting units.

4. Lighting Power Supply Cart

This is the Cart to be provided in the maintenance yard of the Maintenance Room of the Main AFL substation to supply necessary source of power during maintenance of the lighting units.

5. Maintenance Car

This is the Car to be provided in the maintenance yard of the maintenance Room of the Main AFL Substation to be used for transportation of all the materials and equipment required for maintenance of the lighting units. The maintenance Car shall be equipped with the coupling for towing rod to connect other service carts.

6. Special Requirement for Vehicles

All vehicles which shall maneuver in the airfield shall be equipped with obstruction flashing lights (blue light) as well as a telecommunication unit to maintain at all times the necessary contact with the ground control personnel and the tower.