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SCIENCE AND TECHNOLOGY COMMISSION OF
SHANGHAI MUNICIPAL PEOPLE'S GOVERNMENT,
PEOPLE'S REPUBLIC OF CHINA

DETAILED DESIGN OF SHANGHAI PUDONG INTERNATIONAL AIRPORT FINAL REPORT

VOLUME III
TENDER DOCUMENT

PART IV-2
SPECIFICATION
FOR
AIRFIELD LIGHTING SYSTEM

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NIKKEN SEKKEI LTD.

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SHANHAI MUNICIPAL PEOPLE'S GOVERNMENT

SHANGHAI PUDONG INTERNATIONAL AIRPORT PROJECT
FINAL REPORT

TENDER DOCUMENT
PART IV-2
SPECIFICATION
FOR
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CHAPTER 1

GENERAL PROVISION

1.1 GENERAL

a. The specifications provided hereunder and entitled "Technical Specifications for Airfield Lighting System and its Associated Power Distribution System (hereinafter called the "Specifications") shall be an integral part of the Contract Document for the Construction Project of Shanghai / Pudong International Airport (hereinafter called the "Contract" or "Airport Project"), the Peopleís Republic of China.

b. The Specification shall apply to the works of Airfield Lighting System and its associated Power Distribution System of the Airport Project (hereinafter called the "Work"), and shall be read in conjunction with the General and Particular Conditions of Contract and the General Specifications of the Contract Document for the Airport Project.

c. Any matter not provided in the Specifications hereof shall be determined by the Engineer through detailed clarification to be made on the bases of the Contractor's proposed system and practices during tender stage of the Airport Project.

d. The matters written in the Contract drawings (hereinafter called the "Drawings") shall take precedence over the Specifications.

e. The Airport Project will be financed out of the proceeds of the loan(s) of Overseas Economic Cooperation Fund (hereinafter called "the OECF" or "the Fund"), Japan.

f. The Work shall be engineered, designed, manufactured, supplied, deliveried, installed, tested and commissioned by the Contractor in accordance with the Specifications and the relevant Clauses of the Contract Document.

g. The Specification for the Work shall cover following items of works;

I. Airfield Lighting System
Approach Lights
Capacitor Discharge Lights
Precision Approach Path Indicator (PAPI)
Runway Edge Lights
Runway Threshold And Wing Bar Lights
Runway End Lights
Runway Center Line Lights
Runway Touchdown Zone Lights
Taxiway Center Line Lights
Taxiway Edge Lights
Stop Bar System
Runway Guard Lights
Taxiway Intersection Lights
Signs
Wind Direction Indicators With Lights
Apron Floodlights (FLO)
Visual Docking Guidance Signs (VDGS)
Aircraft Stand Identification Signs (ASIS)
Road-Holding Position Lights

II. Control And Monitoring System for

Airfield Lighting
Burnt-Out Lamp Detecting System

III. Equipment and Materials:

Isolating Transformer
Frangible Coupling
Cables
Plug And Receptacles
Cable Protectors
Resin Filler (Cast Resin, Asphalt Glue)

IV. Electrical Power Distribution System

10 kV Metal Enclosed Switchgear
Control And Monitoring System for
Apron Floodlights (FLO),
Visual Docking Guidance Signs (VDGS)
Aircraft Stand Identification Signs (ASIS).

V. Control and Monitoring System for

Power Distribution System

VI. Building Works

VI-1 Building Works for Main AFL Sub-Station

(Total Floor Area : 1,1969.92 m^2)

Architectural Works
Air Conditioning and Ventilation Works
Plumbing Works
Electrical Works
Landscaping Works including Road Pavement in Site

VI-2 Building Works for Secondary AFL Sub-station
(Total Floor Area : 678.6 m^2)

Architectural Works
Air Conditioning and Ventilation Works
Plumbing Works
Electrical Works
Landscaping Works including Road Pavement in Site

VI-3 Building Works for Garage
(Total Floor Area :126.36 m^2)

Architectural Works
Electrical Works

The Contract shall also include supply of the spare parts for equipment and apparatus to be supplied under the Contract. Training Employer's stuff at manufacturer's factory and on the job training at site are included in the Contract.

The scope of works and the major materials for the Project are shown in Drawings in VOLUME of the Tender Document.

The Contractor shall, except as otherwise provided for in the Contract, provide all labors, materials, plants, equipment, temporary facilities, civil works and other necessary incidentals required for the completion for the works.

1.2 STANDARDS AND REGULATIONS

a. Characteristics of the Work shall, except when clearly indicated otherwise in the Conditions of Contract and Specifications, conform to the relevant ICAO Standards and Recommended Practices, Annex 14 Aerodrome, Aerodrome Design Manuals, Airport Services Manuals and other related national or international regulations and agreements in respect of the airport development and/or construction.

b. Unless specified otherwise in the Specifications, the design, materials, manufacture, and testing of all works under the Work of the Contract shall comply with the following standards and regulations;

ISO : (International Organization for Standardization) Standards

ICAO : Annex 14 Aerodromes, Volume 1 Aerodrome Design and Operations, Second Edition, July 1995

ICAO : Aerodrome Design Manual, Part 4. Visual Aids, Third Edition, 1993

: Aerodrome Design Manual, Part 5. Electrical Systems, First Edition, 1983

IEC : (International Electrotechnical Commission) Publication on Standard and Recommendation

CIE : (Commission Internationale de l'Eclairage = International Commission on Illumination) Regulations

Standards of the People's Republic of China:

A. National Standards of the People's Republic of China

- Fire Code for Architectural Design (GBJ 16-87)
- Standard for Architectural Water Supply and Drainage Design (GBJ 15-88)
- Standards for Industrial and Civil Power Supply Networks Design
- Code for electrical Design of Civil Buildings (Standards for Civil Architectural Electricity Design) (JGJ T16-92)
- Standards for Automatic Fire Alarm Equipment (GBJ 116-88)
- Construction Standards for Security & Protection Installation of Civil Aviation Transportation Airport, CAAC (MH/T 7003-95)

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- Technical Standard for Flight Area of Civil Aviation Transportation Airport, CAAC No. 155-76 (MHJ 1-85, August 1985)

B. Standards of Shanghai City

- Guidelines for Foundation Design (DBJ 08-11-89)
- Requirements for Architectural Aseismic Design

Standards equivalent in Japan

- JIS : Japanese Industrial Standards
- JEC : Standards of Japanese Electromechanical Committee
- JEM : Japan Electrical Manufacturers' Association, Standards
- JCAB : Japan Civil Aviation Bureau;
  : Standard Specification of Airport Lighting,
- Technical Standards for Electrical Facilities
  (Public Utilities Department, Agency of Natural Resources and Energy of Japan)

Standards equivalent in the United States of America

- FAA : U.S. Federal Aviation Administration, Advisory Circulars
- NEMA : U.S. National Electrical Manufacturersí Association, Standards

c. All designs and the calculations for manufacturing and tests to be executed shall be in accordance with the latest standards and regulations of such internationally accepted organizations as enumerated above and also those presently in force in China.

d. All materials, parts, devices and equipment to be incorporated in, used for and provided to the Work shall conform in the first place to the appropriate standards authorized in the country of origin/manufacture and other standards which are equivalent to those of the organizations as enumerated above. Moreover, all airport systems in this Work shall be able to conform to the performance requirements of ICAO, and where no standard specifications are found in the ICAO publications, FAA and/or other equivalent specifications shall apply.

e. JEC, JEM, JCAB and other equivalent standards applicable in Japan shall be acceptable as the technical specifications for design and the calculations, and methods of installation for the Works.

f. Symbols and standard device-function numbers used in the diagrams shall be those specified in IEC, JEM of Japan and legends captioned everywhere in the contract drawings.

g. Should any standards or recommendations in the regulations and agreements mentioned above be revised after the issue of the Specifications, the Contractor shall be responsible to submit to the Engineer in writing for any modifications to his shop drawings, etc. in accordance with the revised version of the Specifications. No variation to the Work shall be made unless so approved by the Engineer in writing.

h. Equipment and materials forming part of this Contract shall comply with the relevant local statutory regulations, by-laws and orders currently in force in China.

i. However, adequate modification shall be made for the point of interface between foreign and locally available equipment and materials in accordance with the acceptable standards and regulations available for aviation industries.

1.3 CONTRACT TEMRINAL POINTS

The Contract terminal points to be covered under this contract shall be as follows:

1) Each threshold of the runway shall be provided with one AFL substation adjacent thereto, a nd each AFL substation shall receive power supply through a double circuit line (10 kV). The contract terminal point shall be defined as the power receiving point of the AFL substation, the 10 kV power cable to the power receiving point shall not be included in this Contract.

2) AFL substation shall supply low voltage power to the Radio Navigation Aids. The contract terminal point shall be on the secondary side of a MCCB (Molded Case Circuit Breaker) for the low voltage distribution board located in the AFL substation. Also, the installation of a power supply cable as well as the design for power supply to the Radio Navigational Aids shall not be included in this Contract.

3) The design boundary of water supply, rainwater drainage and sewage ejectors for AFL substations shall be 2 m point from the structure 's outer wall.

4) The telephone system for AFL substations shall be consist of 10 pairs, and the terminal of telephone terminal boards located in both AFL substations shall be defined as the contract terminal point.

5) When an Aerodrome Beacon Aircraft Stand Identification Signs and Visual Docking Guidance System is installed utilizing such structures as terminal building, anchor bolt required or the attachment work and piping work inside the structures for the power supply and monitoring control shall be provided under the building structure package (other contract as referred as "Building Design portion"), while the cabling work for monitoring control and power supply shall be included in the scope of this Contract.

7) Power supply for Apron Floodlights and monitoring control equipment shall be included in this Contract, while indoor piping required for the work concerned shall be excluded from this Contract. Instead, it shall belong to the scope of Building Design portion. Hence a 2-m point from the outer surface of a building wall shall be defined as the contract terminal.

8) A substation (at one particular location) for the apron floodlighting of the apron in the terminal area and detached apron (apron detached from the terminal building) shall be included in the scope of this contract. The substation of apron floodlighting shall receive power supply through a double circuit line cables. The contract terminal point shall be defined at the power receiving point of the AFL substation. The service cable line to the power receiving point shall not be included in this contract.

9) In-door piping work for monitoring control cable wirings to be provided for the Remote Control Desk for Airfield Lightings, Remote Control Desk for Stop Bars and Road Holding Position Signs shall not be included in this contract.

Instead, it shall be included in the scope of the Building Design portion. Thus the contract terminal point shall be 2 m from the outer surface of a building wall.

1.4 CIRCUMSTANTIAL CONDITIONS

All equipment and materials to be provided under this Specifications shall be installed on the Site and shall be capable of working continuously under the following circumstantial conditions.

1)	Ambient temperature	Inside room	: - 10℃ - +40 ℃
		Outside	: - 10℃ - +45 ℃
2)	Relative humidity	Inside room	: Max. 95%
		Outside	: Max. 100%
3)	Maximum wind speed (10 m height above ground)		: 45 rpm/sec.
4)	Design Seismic Coefficient		: 0.08

1.5 TRANSPORTATION

a. The Contractor shall make all arrangements and pay all the necessary costs in respect of the transportation of he Plant and tools from the place of manufacture to the Site including landing and handling of cargoes at the Chinese port, inland transportation therefrom to the Site and unloading at the Site including warehouse rent and other charges.

b. The Contractor shall observe any regulations which limit loads on roads and bridges over which the Plant may be conveyed.

c. The handling and storage of any Plant during the transportation shall be at the risk of the Contractor and without responsibility to the Employer.

d. The Contractor shall provide adequate packaging, to the satisfaction of the Engineer, for the protection of the Plant against damages during the transportation and handling.

1.6 DESIGN AND MANUFACTURE

a. In complying with the requirements of the Specifications, with respect to both arrangements and details, the design shall conform to the best and most up-to-date engineering.

b. The essential design concept shall be of simplicity and reliability in order to give long continuous service with high economy, and low maintenance and operation costs.

c. The design, dimensions and materials of all parts shall be such that they will not suffer damage or instable performance, as a result of stresses under the most severe service conditions.

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d. The materials used in the equipment shall be of the highest quality, compatible to each other, and selected particularly to meet the specified performances required of them. Where necessary in such parts as mechanisms of the equipment, they shall be constructed of stainless steel, brass or gunmetal to prevent sticking due to rust or corrosion.

e. The materials and equipment to be supplied under subcontracts shall be of the highest q uality available, compatible with other equipment, and be interchangeable.

f. All equipment shall operate without undue vibration and with the least possible amount of noise, and shall not cause a nuisance.

g. All equipment shall be so designed and manufactured as to ensure safety for all personnel involved.

h. All e quipment shall be designed to minimize the risk of fire and any damage which may be caused in the event of fire.

i. The equipment shall also be designed to prevent ingress of all vermin, accidental contact with live parts and to minimize the ingress of dust and dirt. The use of materials which may be liable to be attacked by such insects as termites shall be avoided.

j. Cubicles for electrical power distribution equipment shall be properly made not to allow rodents entering into the cubicles.

k. The design voltage shall be of the commercial power normally supplied in China.

l. The Contractor shall submit with his tender documents structural calculations and drawings of proposed structures, lamp wattage of every light.

1.7 PROGRESS REPORTS AND MEETINGS

a. At monthly intervals after approval of the programme chart referred to Conditions of Contract, the Contractor, before the fifteenth (15th) day of each next calendar month, shall submit six (6) copies of detailed monthly progress reports to the Engineer in an approved form, indicating the stage reached in the design, ordering of materials, manufacture, delivery and erection of all components of the equipment in comparison with the approved programme including inventory status report of the equipment and materials. These reports shall be forwarded promptly so that on receipt by the Engineer the information contained therein will not be more than fifteen (15) days out of date.

b. During the progress of the work the Contractor shall provide six (6) sets of photographs of an approved type at the instruction of the Engineer. These photographs will be required to supplement the Progress Reports. Six (6) prints of photographs so ordered shall be handed over the Engineer without delay.

c. If during the execution of Contract, the Engineer considers the status position of any section of the work to be unsatisfactory, he will be at livery to call such meetings, either at the Engineer's Head Office or at the Site, as he deems to be necessary. If required by the Engineer, a responsible representative from the Contractor shall attend such meeting.

d. Access to the Contractor's and Sub Contractor's works shall be granted to the Engineer at all reasonable times for the purpose of ascertaining the progress.

1.8 PACKING

a. Each item shall be packed properly or protected for shipment from the place of manufacture to the Site.

b. Each crate or package shall contain a packing list in a waterproof envelope and a copy in triplicate shall be forwarded to the Employer and the Engineer respectively. All items of materials shall be clearly marked for each identification against the packing list.

c. All cases, packages, etc., shall be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear and identification mark relating them to the appropriate shipping documents.

d. The Engineer shall reserve the right to inspect and approve the Plant and the packing before the items are dispatched. The Contractor shall be entirely responsible for ensuring that packing is suitable for transit and such inspection will not relieve the Contractor from responsibility of any loss or damage due to faulty packing.

d. All packing materials shall be removed from the Site at the earliest opportunity and disposed to the satisfaction of the Employer.

1.9 DELIVERRY

a. The Contractor shall deliver all Plant including Contractor's Equipment provided under the Contract to the Site in adequate time for its preparation and erection according to the Approved Program.

b. The Contractor shall be responsible for the reception at the Site of all deliveries for the purpose of the Contract.

c. Upon shipment of each package or item with the Engineer's authorization in writing, copies of the shipping documents comprising through or combined transport Bill of Lading, Detailed Invoice, Packing List, Insurance Policy and Inspection Certificate shall be received by the Employer, at least tow weeks before arrival of cargoes and by the Engineer.

d. The Contractor shall, at his responsibility, inspect the cargoes at the Site upon arrival of the cargoes and shall report in writing the particulars, quantities, conditions damages, if any, of the cargoes to the Employer and to the Engineer within one (1) week after arrival.

1.10 TOOLS AND APPLIANCES

a. Tools and appliances necessary for normal maintenance shall be supplied, unless otherwise stated in the Contract,

- 1 set of normal type of tools and appliances which can be available in the household market, and
- 2 sets of special types of tools and appliances which can be available from the contractor and/or manufacturer for use with the equipment and materials to be supplied and incorporated in the Work,

a list of which shall be presented, duly priced therein, at the time of tender.

b. Each tool or appliance shall be clearly marked with its size and/or purpose where necessary.

c. The smaller items of the tools and appliances shall be suitably arranged in fitted boxes made of mild steel, wood, or synthetic resins, the number of boxes being determined in relation to the layout of the equipment in question. Each box shall be fitted with a lock and three keys, and the nameplate shall be painted white and clearly marked in black letters with the name of the equipment for which the tools and appliances therein are intended.

d. The tools and appliances supplied in the Work shall be new and shall not be used for erection and installation purposes.

e. The tools and appliances with appropriate boxes shall be handed over to the Engineer at the time of issuing of the taking-over certificate of the Works.

f. All tools and appliances necessary for construction, erection, installation and testing shall be arranged by the Contractor, in addition to the aforesaid tools and appliances to be supplied for normal maintenance of the installed equipment.

1.11 MEASURING EQUIPMENT

a. Measuring equipment shall be supplied, under this Contract, which are deemed to be necessary for normal maintenance, but not limited to those specified in the following relevant sections, a list of which shall be presented, duly priced therein, at the time of tender.

b. Measuring equipment supplied under this Contract shall not be used for erection purposes.

c. Measuring equipment shall be provided with all the necessary accessories for measuring duly attached with an adequate supply of spares.

d. Measuring equipment shall have sufficient measuring range and accuracy required by the respective system for which it is intended.

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e. Measuring equipment, except of the stationary type, shall be easy to transport. If the weight of the measuring equipment is such that it cannot conveniently be carried, suitable hand steerable rubber-tired wheels shall be supplied.

f. All measuring equipment to be used on AC shall be suitable for 50 Hz, 220 V / 380 V, three (3)-phase four (4)-wire circuits and be capable of ensuring satisfactory operation within voltage variations of 10%.

g. All measuring equipment necessary for installation and testing shall be arranged by the Contractor in addition to the aforesaid measuring equipment to be supplied for normal maintenance.

1.12 SPARE PARTS

a. Spare parts which the Employer agree to retain in stock and which are required to be replaced for two years of normal operation of the equipment shall be supplied under this Contract, a list of which shall be presented, duly priced with the name(s) and address(es) of the supplier(s) specified therein, at the time of tender.

b. The Contractor shall guarantee the supply of spare parts of the same type or substitutes of equal or better quality for at least 10 consecutive years after the taking-over of the Works.

c. All spares supplied shall be treated and packed for long-term storage under the climatic conditions prevailing at the Site. Each spare shall be clearly marked or labeled on the outside of its packing. with its description and purpose and, when more than one spare is packed in a single case or other container, a general description of the contents shall be shown on the outside of such case or containers and detailed list enclosed therein. The containers and other packages thus suitably marked shall be properly numbered for easy identification, with a summary lists attached.

d. All such cases, containers, cable drums or other packages shall be subjected to opening for such examination as the Engineer may reasonably require, and all such opening and subsequent re-packing shall be at the expense of the Contractor.

1.13 GENERAL TECHNICAL REQUIREMENTS

1.13.1 UNIT OF MEASUREMENT

Metric System shall be used for design and manufacturing of the equipment, unless otherwise specified in the Tender/Contact Document.

1) Length in mm
2) Weight in metric ton / kg
3) Temperature in degree centigrade.

1.13.2 SCREW THREAD

All bolts, nuts and screws shall conform to the Metric Thread of ISO (International Organization for Standardization).

1.13.3 CLEANING AND PAINTING

a. All bright metal parts shall be covered before shipment with an approved protective compound and protected adequately during shipment to the Site. After erection these parts shall be cleaned with a correct solvent and polished bright where required.

b. All metal work, which is normally painted after manufacture, except where finish painted, galvanized or polished in the factory, shall be well brushed down and given one coat of red lead paint before shipment.

c. All parts, which will ultimately be buried under the ground and in concrete, shall be cleaned and protected by their approved method before leaving the factory. Before being built in, they shall be thoroughly descaled and cleaned of all rust and adherent matter by the use of strong wire brushes.

d. Before erection at the Site, all exposed steelworks, including bare pipe surfaces and hand railing, shall be well wire-brushed down and cleaned after which all parts shall be given one coat of primer, one undercoat and one finishing coat of a quality paint in colours approved by the Engineer.

e. Exterior surface of metal-enclosed switchgear and controlgear (Metal-enclosed type, Cubicle-type) cabinets, switch box, transformer box, etc. shall be given one prime coat, one undercoat before assembling and two finish coats at factory.

f. Before applying prime coat, the oil or grease shall be removed with benzene or other solvent, and the scale, rust and other foreign substances on the surface shall be thoroughly cleaned by sandblast or bonderized.

g. Prime coat shall be of an anticorrosive paint. The dry film thickness of the coating shall be not less than 0.02 mm, and its coating weight shall be not less than 0.14 kg/sq.m.

h. The coating weight of oil putty shall be decided in accordance with the surface condition of the prime coat.

i. The coating weight of filling shall be not less than 0.15 kg/sq.m. for each coat.

The dry paper-sanding shall be applied after putty work.

j. The dry film thickness of the undercoat shall be not less than 0.02 mm and its coating weight shall be not less than 0.14 kg/sq.m.

k. The coating weight of finish coat shall be not less than 0.12 kg/sq.m for each coat and the dry film thickness of the finish coat shall be not less than 0.035 mm.

l. Interior surface of metal-enclosed switchgear and controlgear (Metal-enclosed type, Cubicle-type) cabinet switch box, transformer box, etc. shall be given one prime coat before assembling and two finish coats at factory.

m. Before prime coating, the oil or grease shall be removed with benzene or other solvent, and the scale, rust and other foreign substance on the surface shall be thoroughly cleaned by sandblast or bonderized.

n. Prime coat shall be of an anticorrosive paint.

o. The dry film coating thickness shall be not less than 0.02 mm, and the coating weight shall be not less than 0.14 kg/sq. m.

p. The coating weight of finish coat shall be not less than 0.12 kg/sq. m for each coat, and the dry film thickness of finish coat shall be not less than 0.025 mm.

1.13.4 LOCKS

a. Three keys shall be supplied for each lock which is called for under the Specifications. Locks and keys for all equipment under a particular group to be designated by the Engineer shall be interchangeable.

b. All locks for outdoor equipment shall be weatherproof.

c. All locks and padlocks shall be brass and, where fitted to access doors, shall be chromium plated.

d. A rack or cabinet of the approved design which are required in the Work shall be supplied for accommodating the padlocks and/or keys for their safe storage when the Work is finished. The padlocks and keys shall be engraved with a suitable identifying code or inscription, and this shall be repeated on the corresponding racks or cabinets on engraved labels attached thereon.

1.13.5 ENVIRONMENTAL CONDITIONS AND THEIR MEASURES

a. In choosing materials and their finishes, due regard shall be given to the environmental conditions of the Site, in which the facilities, equipment and tools are provided for installation, and under which equipment is to work and is to be maintained. It is preferred that materials to be incorporated in the Work shall be those that can withstand the environmental climatic conditions of Pudong, Shanghai Area wherever possible.

b. Iron and steel shall, in general, be painted or galvanized as appropriate. Indoor parts may alternatively have chromium or copper-nickel plated or other approved protective finish. Small iron and steel parts (other than rustless/stainless steel) of all instruments and electrical equipment, the cores of electromagnets and the metal parts of relays and mechanisms shall be treated in an approved manner to prevent rusting. Cores, etc. which are built up of laminations or anti-rust treated, shall have all exposed parts thoroughly cleaned and heavily enameled, lacquered, or compounded.

c. When it is necessary to use dissimilar metal in contact, these should, if possible, be so selected that the potential difference between them in the electro-chemical series is not greater than 0.5 volts. If this is not possible, the contact surfaces of one or both of the metals shall be electroplated or otherwise finished in such a manner that the potential difference is reduced to within the required limits or, if practicable, the two metals shall be insulated from each other by an approved insulating material or a coating of approved varnish compound.

d. The use of iron and steel shall be avoided in instruments and electrical relays wherever possible. Steel screws, when used, are to be zinc, cadmium, or chromium plated or, when plating is not possible owing to tolerance limitations, shall be of corrosion resisting steel. All wood screws shall be of dully nickel

plated brass or of other approved finish. Pivots and other parts for which nonferrous materials is unsuitable shall be of an approved rust-less steel where possible.

e. Fabrics, cork, paper and similar materials, which are not subsequently to be protected by impregnation, shall be adequately treated with an approved fungicide. Sleeves and fabrics treated with linseed oil or linseed oil varnishes shall not be used.

f. The use of wood in equipment shall be avoided so far as possible. When used, woodwork shall be of thoroughly seasoned teak or other approved wood which is resistant to fungus decay and shall be free from shakes and warp, sap and wane, knots, faults and other blemishes. All woodwork shall be suitably treated to protect it against the ingress of moisture and from the growth of fungus and termite attack, unless it is naturally resistant to those causes of deterioration. All joints in woodwork shall be dovetailed or tongued and pinned as far as possible. Metal fittings where used shall be of nonferrous material.

g. Adhesives shall be specially selected to ensure the use of types which are impervious to moisture, resistant to mold growth and not subject to the ravages by insects. Synthetic resin cement only shall be used for joining wood. Casein cement shall not be used.

1.13.6 GALVANIZED WORK

a. All materials to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, drilling, screw tapping and the removal of burrs shall be completed before the galvanizing process commences.

b. All galvanizing shall be done by the hot dip process with spelter, not less than 98% of pure zinc. No alternative process shall be used without the approval of the Engineer. No components shall be galvanized which are likely to come into subsequent contact with oil. Bolts shall be completely galvanized including the threads, but the threads shall be left uncoated in the case of nuts.

c. The zinc coating shall be uniform, clean, smooth and as free from spangle as possible. In the case of component parts, the zinc coating shall weigh not less than 550 gr. per sq. m of area covered.

d. Galvanized wire shall comply with the authorized standard of the country of origin/manufacture. The Engineer may select for test as many components to be weighed after pickling and before and after galvanizing as he may think fit.

e. All galvanized parts shall be protected from injury to their zinc coating due to differential aeration and abrasion during the periods of transit, storage and erection. Damaged areas of the coating shall be touched up with an approved zinc-dust paint or other approved flake metallic compound.

1.13.7 CHROMIUM PLATING

The chromium plating of those components of the equipment, where specified and where offered by the Contractor, shall comply with the requirements of the authorized standard of the country of origin/manufacture.

1.13.8 RATING PLATES AND LABELS

a. Each main and auxiliary items of equipment shall have permanently attached to it in a conspicuous position a nameplate and/or a rating plate made of an incorrigible material, upon which any identifying name, date of manufacture, type or serial number shall be engraved together with details of the conditions under which the items in question have been designed to operate as well as such diagram plates as may be required by the Engineer.

b. All cubicle doors shall be labeled in an approved manner to indicate the service provided.

c. Labels or appropriate identification marks shall also be provided to identify all items of equipment or parts, and where applicable current ratings of fuses and setting of relays, etc.

d. Warning labels with red lettering shall also be provided on covers over equipment carrying high tension voltage, as directed by the Engineer.

e. The inscriptions of all nameplates and labels shall be in Chinese language, and identification marks shall be in Chinese, and clearly designate the service or rating of the particular equipment. Such nameplates or labels shall be of non-hydroscopic material with engraved lettering of a contrasting colour or, alternatively, in the case of indoor switchgear etc. of transparent plastic material, with suitably coloured lettering engraved on the back.

f. Current transformers and potential transformers shall be provided with an identifying label giving type, ratio, class, burden and serial number.

g. All labels shall be attached to equipment by means of adhesive material or of machine screws and nuts, machine screws in drilled and tapped holes. Wherever practicable, identifying signs shall be provided by means of engraving or printing directly on the body of equipment.

1.13.9 ELECTRICAL POWER EQUIPMENT

a. The electrical panels shall be of self-contained cubicle type, floor standing, with a full front face door, and/or rear access, with cable entry from the bottom.

b. Each electrical and power equipment shall be separated from another unit by a completely grounded steel plate, and high tension and low tension circuits shall also be separated by a completely grounded steel plate. The housing for the various components shall be constructed of fabricated steel.

c. Adequate ventilation shall be provided to enable the equipment to operate continuously under the local ambient temperature designated hereinabove, and at the same time care should be taken into account of rodents intrusion with a supply of a suitable grille.

d. Precautions shall be taken to prevent overheating through hysteresis and eddy current loss.

e. All electric equipment shall be provided with a suitable grounding terminal.

f. All electrical instruments and meters to be mounted on electrical panels shall be accurate to tolerance range of ±1.5%, flush-mounting type with dustproof cover of 80 - 110 sq. mm. Wherever necessary, instruments shall be provided with easily accessible zero adjuster.

g. Wirings for all control panel and secondary control in the circuit breakers, control gear and the like shall be arranged in a neat and systematic manner with cables properly supported and clear of panels and other surface plates at all points to obtain free circulation of air.

Wiring shall be colour-coded as follows:

- Green : Grounding
- Yellow : All wiring other than grounding circuit

h. All small wiring ends shall be marked to discriminate the circuits, voltage, current, fault circuit, etc.

i. The mold case circuit breakers (MCCB) shall be of manually operated, trip free mechanism with electromagnetic or thermal-magnetic type tripping element.

j. Equipment shall be provided with lamps that indicate the stage of operation. A lamp test circuit shall be provided on the panel where many lamps are equipped. It is desired that light emitting diode (LED) should be adopted rather than filament lamp, if possible.

1.13.10 GROUNDING SYSTEMS

a. General

1) The lightning protection for underground cables is specified in this Chapter.

2) The light fittings, secondary cables and secondary wires of isolating transformer, electroducts, and exterior lighting poles shall be specified in the respective subsections of the Specifications for the airfield lighting system.

3) The grounding system shall be of the type that can safeguard the person, equipment, light unit, and light fitting, etc. of the Work.

4) The equipment, lights, poles, and masts shall be grounded mechanically and electrically to ensure the continuous grounding services, which shall be fully conductive.

5) The common grounding wires that are compatible to both grounding and lightning systems shall be used for light fittings and light units.

b. Common Grounding Wires

The lightning arrester wires shall be installed underground at upper location of the underground cables and power cables, and linked together to a common grounding wire circuit.

c. Grounding Wire

1) The grounding wire to be used in this Work shall be not smaller than IEC H16 wire (16mm^2), and shall be manufactured and tested in accordance with

the appropriate standards of IEC or JEC, or equivalent standards duly authorized in the country of manufacture.

2) The portion of flexible stainless pipe protecting cables shall be bypassed by 6.0 mm^2 (more than 5.5 mm^2) bare copper stranded wire.

d. Light Fittings

The 6.0 mm^2 (more than 5.5 mm^2) bare copper stranded wires shall be installed and shall be connected between the grounding terminals or grounding lead wires of the light fittings and the main common grounding wires.

e. Light Units

The PAPI, Taxiing Signs, Illuminated Wind Direction Indicator and Apron Floodlight shall be grounded by connecting more than 8 mm^2 750 V/450 Volt PVC insulated wire with the grounding terminal of each light unit which then connected to the main common grounding wires.

f. Exterior Lighting Pole

1) All exterior lighting poles shall be grounded in accordance with relevant Chinese Electrical Codes or JIS A 4201 (The Protection of Structures against Lightning).

2) Lightning rods shall be mounted on top of each pole of apron floodlighting, and shall be bonded thereto.

3) Two grounding plates shall be placed close to each pole and connected at its bottom part with PVC insulated wires.

g. Equipment

1) Common grounding wire shall be installed in cable pit. The wire shall be connected to copper grounding plate, or rods and shall also be connected with the grounding terminal of equipment.

2) The copper grounding plates and rods shall be installed underground to a depth of not less than 1.0 m. Grounding resistance of the system as a whole shall not exceed 2 ohms.

1.13.11 RESPONSE TIME FOR COMMUNICATION INTERFACE

The communication interface shall be able to indicate on all the panels the actual working status of each light in not less than three (3) seconds from the commencing time of control operation.

1.14 CONCRETE WORK

a. General

This work shall apply to the supply and installation of plain concrete and reinforced concrete for the mounting base, handhole, manhole, foundation, concrete base for cubicle and panel as well as concrete housing of fuel main tank, etc.

b. Concrete

Concrete used in this work shall be either of the following types:

	Type - I	Type - II
Aggregates Size	Maximum 25 mm	Maximum 25 mm
28-day Strength	210 kg/cm^2	180 kg/cm^2
Slump	15 cm	12 cm

c. Forms

Concrete forms shall be made of either wood or metal and be constructed such that no warping or deformation shall occur due to external force, moisture, vibration, or pressure of concrete.

d. Reinforcing Bars

Reinforcing steel bars for the foundation, manhole shall be steel bars conforming to "Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement", ASTM A615, latest edition, and JIS G 3112 (Steel bars for concrete reinforcement) or equivalent.

e. Installation

No concrete mixture shall be used beyond one hour after mix.

Concrete shall be cast continuously without interruption until completed and no additional casting shall be permitted except where so approved by the Engineer in writing.

Concrete forms shall not be removed for at least five (5) days after casting during which period it shall be cured under protection from direct sunlight, rain or wind.

f. Test Pieces

The Contractor shall perform in the presence of the Engineer a series of pressure bearing tests of 3 test pieces taken out of the concrete under construction.

1.15 EXCAVATION AND BACKFILL WORK

a. General

This work shall apply to the installation of mounting base, handhole, manhole, concrete base for cubicle, outdoor duct/conduit trench and foundation of structure.

b. Excavation

The depth and width of excavation shall be minimum for installation of the above facilities. The bottom plane of the excavation shall be flat.

c. Backfill

The excavated soil should be used as backfill material provided that it is free of stones and other objects that can cause damage to the duct/conduit. Refilling shall be made in horizontal layers not to exceed every 600 mm in depth along the facilities, and shall be compacted to be restored to the existing condition.

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The backfill for the trenches shall be in accordance with the code for Electrical Design for Civil Building, JGJ/T 16-92, Construction Standards, The People's Republic of China.

The duct/conduit in the trenches shall be carefully laid over 100 mm of sand cushion. On top of the cables another 100 mm of sand layer shall be added before refilling. To secure correct spacing, an adequate jig(s) shall be used for horizontal and vertical adjustment during cable laying.

1.16 INTERCHANGEABILITY OF THE EQUIPMENT PARTS

a. Simple Construction

The equipment to be supplied and incorporated in the works shall be of simple and durable construction with its number of component parts to be as minimum as possible for assembly, so that the cost of spare parts for inventory stores can be as low as possible while ensuring ease of replacement work during maintenance.

b. Interchangeability

The component parts of the lighting equipment such as surface lights shall be standardized of its component parts as much as possible so that their component parts can be interchangeable for assembly into same types of equipment one another to ensure easy control and saving of replacement spare parts for maintenance, preferably at a ratio of more than 50 % of common spare parts of the same type of lights.

1.17 SAFETY

1.17.1 GENERAL

The Contractor shall take safety measures to prevent accidents during construction in the work premises of the airport.

The Contractor shall prepare a safety work program based on the foreseeable causes of accidents to prevent his own work force and the personnel of the third parties from loss and injury of lives, and the works from damage as well as from fire.

1.17.2 ASSUMED CAUSES OF ACCIDENTS

The following causes of accidents which are assumed to be encountered during construction shall be highlighted in the preparation of the safety work program as fundamental bases to establish the measures to effectively cope with them:

(1) Premature work execution plan

(2) Loose insight into details of the work jobs

(3) Non-familiarity with newly introduced technologies and techniques

(4) Insufficient preparatory work or in sufficient preliminaries of work

(5) Unskilled management of the work

(6) Poor inspection of the site and low maintenance of constructional plant and equipment

(7) Lukewarm safety inspection and dull precautionary maintenance

(8) Lack of training on safety signs, signals and indication boards

(9) Other human error from carelessness.

1.17.3 ACCIDENT PREVENTION MEASURES

The Contractor shall incorporate the following fundamental safety plans in the measures established against above assumed causes of accidents to prevent the accidents during construction on the basis of the aforementioned safety work program, and submit them for approval of the Engineer:

(1) Safety, security and health plans

(2) Labour accident prevention plan

(3) Guidelines for work safety and its procedure

(4) Safety training plan

(5) Other proposal which the Contractor deems it effective in accident prevention and work safety measures

1.17.4 SAFETY CONSIDERATION FOR BOTH CONSTRUCTION AND OPERATION MANAGEMENT

The Contractor shall proceed with the Work in accordance with his own respective safety work plans, which should be useful for the Employer in preventing and minimizing the accidents during operation and management of the facilities after the Work has been taken over by the Employer.

1.18 CONTRACTOR'S ACCOMMODATION AND FACILITIES

(1) Living Accommodation - The Contractor shall make his own arrangements in regard to accommodation for his expatiate staff during the erection work.

(2) Office Accommodation - The Contractor shall provide such temporary buildings as may be necessary for office accommodation for his site staff during he erection of the Works and shall furnish an office for the Engineer and his local staff at separate place. The cost thereof shall be deemed to be included in the Contract Price.

(3) Electricity a nd Telephone, Water Supply, Lighting Facilities, Medical Arrangements - The Contractor shall make all necessary arrangement at his own expenses. The Employer will assist the Contractor to arrange for arrange for provision of the above items, if required.

1.19 STORAGE OF EQUPMENT AND MATERIALS

In general, the Contractor shall make his own arrangements for storage of the equipment and materials at the port of elsewhere and to bring forward the equipment and materials to he respective Sites and at the appropriate times. However, the Employer will endeavor to provide, if possible to do so, a reasonable amount of uncovered storage

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space at suitable sites, as set forth in the Conditions of Contract. The provision of covered storage facilities, office accommodation and the like at any of the sites shall be the Contractor's won responsibility. The storage and handling of the equipment at any of the sites shall be solely at the risk of the Contractor. The Contractor shall provide all necessary protection and watchmen to safeguard the Plant and materials in the areas allocated to him of which, the cost shall be deemed to be included in the Contract Price.

1.20 CONTRACT'S EMPLOYEES

The Contractor shall fulfill all his obligations in respect of accommodation, feeding and medical facilities for all personnel employed by his as necessary to ensure the satisfactory execution of the Contract. He also shall comply with the requirements of all relevant local Statutory Employment Regulations.

The Contractor shall be responsible for the behavior on the Site of all personnel employed by him.

1.21 TRAINING OF PERSONNEL

1.21.1 GENERAL

Training for operation and maintenance of the equipment and systems in the Work shall be provided to the Employer's personnel in two phases as specified below:

1) Factory training phase

2) On the job training phase

All training shall be rendered in Chinese/English languages to trainees having appropriate level of education in accordance with the following particulars of Training Program. The Contractor shall submit his own training program to the Engineer nineteen (90) days before any training is started:

1) FACTORY TRAINING

Unit: Working Days

	Subjects/Lessons	Factory Training			Total	Remarks
		Manuals	Operation	Maintenance		Location
1	AFL Control & Monitoring System	1.0	2.0	1.0	4.0	
	Power Control & Monitoring System					
	5 personnel					
2	FLO Power Control & Monitoring System	1.0	1.0	1.0	3.0	
	5 personnel					
3	AFL Fittings	1.0	-	1.0	2.0	
	5 personnel					
4	FLO Power Distribution System					
	UPS	1.0	1.0	1.0	3.0	
	E/G	1.0	1.0	1.0	3.0	
	Power Substations	1.0	2.0	2.0	5.0	
	Total	6.0	7.0	7.0	20.0	

Note:

1 Total number of trainees for Factory Training shall be not more than 5 staff of Shanghai/Pudong Airport Authority/CAAC.

2 Total days required for Factory Training shall be not more than 20 days (5 days /week) in all.

3 The cost of training shall include costs for a round ticket, hotel accommodations, local transportation and daily subsistence allowance.

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2) ON-THE-JOB TRAINING AT SITE

Unit: Working Days

	Subjects/Lessons	Site On-the-job Training			Remarks
		Manuals	Operation	Maintenance	
1	Airfield Lighting System				
	Subtotal	5	2	5	12
2	Airfield Lighting Control & Monitoring System				
	Subtotal	3.0	7.0	5.0	15.0
3	Maintenance Materials				
	Subtotal	2.0	2.0	1.0	5.0
4	Power Distribution System				
	Subtotal	4.0	4.0	4.0	12.0
5	FLO Control and Monitoring System				
	(Common with AFL Lessons)				
	Subtotal	1.0	2.0	1.0	4.0
	Grand Total	15.0	17.0	16.0	48.0

Note:

1. The some lessons out of the above total of 48 days shall be given in common and in parallel with other lessons depending on the work similarities. The total number of days for training shall be not more than 30 days (5 days/week) in all.

2. Total number of trainees for the Site On-the-Job Training shall be 5 personnel at maximum.

1.21.2 PROGRAM OF TRAINING

The Contractor shall update, if deemed necessary by the Engineer/Employer, the detailed program in this Work through consultation with the Engineer/Employer not later than thirty (30) calendar days before the date when the Contractor intends to start the training program.

1.21.3 TRAINEES

Before such consultation, the Employer through the Engineer shall nominate candidates for the trainees whose qualification shall be subject to examination by the Contractor. The Contractor shall reserve the right to reject any or all the candidates who are not well qualified and to request the Employer to nominate other candidates.

The Employer shall have the trainees selected by the required qualification so requested by the Contractor and shall make the trainees ready and available full time without replacement/change during w hole period of trainings in accordance with the agreed training program between the Employer and the Contractor.

1.21.4 TRANSPORTATION AND ACCOMMODATIONS

The Contractor shall provide the trainees with necessary costs for transportation and accommodations during the training period in accordance with the training requirement as specified in Section 1.13.1.

1.21.5 REPORTS AND CERTIFICATES

In the course and upon completion of the training the Contractor shall reserve the right to give examinations to the trainees on the respective professional fields, and shall report the results thereof to the Engineer/Employer. Upon completion of the training, the Contractor shall issue the Certificate of Training to certify such trainees as qualified personnel for the respective job assignments.

1.22 TEST AND INSPECTION

1.22.1 DOCUMENTS FOR TESTS AND INSPECTION

Before execution of test and inspection, the Contractor shall prepare and submit the following documents to the Engineer for his approval.

a. Complete description in writing about type/model tests called for by the civil aviation authority of the country of origin of the equipment.

b. Complete description in writing about procedure of tests at the factory.

c. Complete description in writing about procedure of tests at the Site.

d. Complete description in writing about procedure of commissioning tests at the Site.

Certified readings and data of all tests and inspections required to be carried out by the Contractor under this Contract shall be submitted to the Engineer in the form of test and/or inspection report(s), which shall be bound in book form and submitted in four (4) copies of complete set of all these tests and inspection data for submission at the time of the commissioning test.

1.22.2 TYPES OF TESTS

The types of tests to be conducted under this work shall comprise:

1. Type/Model Test
2. Factory Test
3. Tests at Site during Construction
4. Commissioning Test
5. Reliability Test
6. Adjustment
7. Other Test
8. Retest

Should any of the above tests of the equipment and materials be not approved by the Engineer/Employer within the stipulated number of days after the test is made and

witnessed by the Engineer (as defined in the General and Particular Conditions of Contract), the equipment that has been subjected to the witnessed test shall be deemed to have been approved by the Engineer, and the Contractor shall be able to proceed with the work using the equipment and material as an accepted equipment and material for incorporation in the work.

1.22.2.1 TYPE/MODEL TEST

The equipment to be supplied and incorporated in this work shall be subjected to the type/model test in accordance with the requirements of the civil aviation authority of the country of origin.

The Contractor shall submit, as an addendum to the tender documents, a copy of the certificate issued by the respective civil aviation authority of the country of origin in the form of Type/Model Test Approval Document, saying that the equipment in question has satisfactorily been approved in the type/model test, and accepted for use in the airports of the country of origin. Such type/model test shall include, but not limited to, the following items of tests for airfield lighting equipment:

I. Dimensional test
   1) Surface type lights
   2) Elevated type lights

II. Photometricity test

III. Chromaticity performance test

IV. Electrical characteristics
   1) Insulation characteristics test
   2) Withstand voltage test
   3) Over-current test

V. Environmental test
   1) Leakage test (for surface type light)
   2) High temperature test
   3) Low temperature test
   4) Thermal shock cycle test
   5) High temperature high humidity test
   6) Surface temperature test(elevated type light)
   7) Solar radiation test (elevated type light)
   8) Corrosion resistance test

VI. Test of the resistance to severe condition brought about aircraft
   1) Horizontal shearing test (elevated type light)
   2) Hydraulic impact test (elevated type light)
   3) Mechanical impact test (elevated type light)
   4) Static load test (elevated type light)
   5) Vibration test
   6) Snowplow test (elevated type light)

7) Jet blast resistance test (elevated type light)
8) Frangibility test (elevated type light)

VII. Accelerated life test.

The type/model test for other equipment and materials than the airfield lighting equipment such as for constant current regulator, isolating transformer, changeover switch, etc. shall be conducted and certified in the accordance with the IEC specifications regarding tests or relevant requirements of the civil aviation authority of the country of origin for necessary certification of the type or model test for use of the accepted equipment.

In the absence of such a type/model test of the civil aviation authority, the Contractor shall submit a copy of such other test certificate as that of FAA or of an independent organization in the same effect in lieu of the type/model test.

1.22.2.2 FACTORY TESTS

Factory tests shall be made by the Contractor at his factory on specific equipment and materials upon completion of their production to demonstrate sufficiently before their shipment that the equipment and materials comply with applicable specifications and any additional tests called for by the Engineer to ensure that the equipment and materials to be supplied and incorporated in this work meet the requirement in these specifications. The method of testing of equipment and materials not covered by any specifications or applicable standards shall be agreed with the Engineer.

The Engineer shall be given the opportunity of witnessing tests.

Should any need arise in the event that such a witnessing test be required by the Engineer/Employer and requested in writing by the Engineer/Employer to the Contractor and when the equipment is ready for inspection or test for the designated equipment and materials, the Contractor shall give such a test notice sufficiently in advance of the testing date to the Engineer together with the data of tests done by himself. The cost for witnessing factory test(s) so requested in writing by the Engineer/Employer shall be borne by the Employer.

The results of the factory tests shall be recorded for submission to the Engineer.

The test report shall contain the information as specified below:

(1) the performance of each equipment under test and whether it meets the system limits.

(2) a record of any engineering changes necessary to correct design deficiencies.

The Contractor shall prove the suitability of diagnostics and technical manuals provided by the Contractor as well as capability of off-line failure isolation and repair.

1.22.2.3 TESTS AT SITE DURING CONSTRUCTION

During the course of installation, the Engineer shall have full right for making tests and inspection of the work, as he may deem necessary.

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The Contractor may be requested by the Engineer for participation of the Employer's personnel in these tests for the purpose of on-the-job training at the construction site, in which case, the Contractor may have part of the tests to be assisted to be conducted by such personnel at a construction/installation site, but shall assume his final responsibilities for such test results.

1.22.2.4 COMMISSIONING TESTS

Commissioning tests of the system of the works shall be carried out after they have been installed and tested. No commissioning test shall be commenced without prior approval of the Engineer. As regards the schedule and procedure to be followed, the Contractor shall be required to make to the Engineer at least ten (10) working days prior to such test a notice of his readiness to start each site test.

Tests shall be designed to minimize interference with other facility and/or work operations. The Contractor shall conduct the commissioning tests under direction of the Engineer.

1.22.2.5 RELIABILITY TESTS

a. When the Contractor considers that the works are ready for commercial service, the Engineer shall be notified accordingly after the commissioning tests. When the Engineer agrees that the works are ready for commercial service, each system shall be required to put into operation under normal working conditions, either continuously or intermittently as may be convenient, to check the system's failure or interruption of any kind, for a period of not less than fifteen (15) days.

b. The systems shall be operated by the Contractor's staff during the reliability test period, but the Contractor will be allowed to make any minor adjustments which may be necessary, provided that such adjustments do not in any way interfere with, or prevent commercial use by the Employer.

1.22.2.6 ADJUSTMENTS

The Contractor shall make any and all adjustments to the protective device and/or equipment necessary for proper operation and coordination of the tests.

1.22.2.7 OTHER TEST

The Contractor shall carry out any test other than specified hereinbefore wherever so required by the Engineer. All tests shall be carried out in the presence of the Engineer and/or the personnel of the Employer and to the satisfaction of the Engineer.

The Contractor may use, for this purpose at the site and with permission of the Engineer, the measuring equipment which shall be supplied by him under the Contract, provided that such equipment be restored to its original condition at the time of commissioning tests.

1.22.2.8 RETEST

Should the systems or any portion thereof fail under tests to give the performance required, then any further test(s), which may be considered necessary by the Engineer shall be carried out in a similar manner, but the whole cost of the repeated test(s) shall be borne by the Contractor.

1.22.2.9 REJECTION

If any item fails to comply with the requirements specified in the Technical Specifications in any respect whatsoever at any stage of manufacture, test, erection, installation or on final completion, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit the item for further inspection and/or test. In the event of the defect of any item being of such a nature that the requirements in the Specifications can not be fulfilled by adjustment or modification, such item shall be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer.

1.23 FLIGHT CHECK

1.23.1 FLIGHT TESTS

Within thirty (30) calendar days after Reliability Test, the approach lights and PAPI shall be subject to Flight Tests by the Employer or his agent. These tests shall conform to those set out in FAA Handbook OA-P-82001 (FLIGHT INSPECTION MANUAL) and other documents concerned. Flight-tests shall be conducted during ILS flight test of Radio Navigation Aids.

Flight test will be completed within a flight time of thirty (30) hours and within a period of six (6) consecutive days for airfield lighting.

The Employer shall make arrangement of a plane and personnel necessary for the flight tests, and shall notify the Contractor the date of the commencement of the test within fifteen (15) days after the date of completion of Reliability Tests.

During flight tests to be carried out by the Employer or his agent, the Contractor shall make available at the Site his personnel for the purpose of assisting the Employer to carry out the various checks smoothly and satisfactorily.

The Contractor, at his own expense, shall be responsible for and make good such defects as found by the flight tests. In the even of flight re-testing to be conducted by the Employer or his agent as a result of any such defects, the Contractor shall make available at the Site his personnel who witnessed the initial flight check.

The cost of flight test shall be borne by the Employer. However, should the said flight time and period of flight tests be extended for any reason of the Contractor, the additional cost of any further flight test shall be borne by the Contractor. Within fifteen (15) days after satisfactory completion of flight tests, the Engineer shall issue to the Contractor the Provisional Acceptance Certificate.

For the items which do not require flight test, the Engineer will issue the Provisional Acceptance Certificate to the Contractor after satisfactory completion of Reliability Tests.

1.24 DOCUMENTATION

The Contractor shall provide the following documents during the course of the Contract. All documentation shall be in both Chinese and English languages.

1.24.1 DESIGN DOCUMENTS

a. Design Approval

The Contractor shall submit the design documents to the Engineer for approval within sixty (60) days after the award of the Contract. The Engineer shall be advised if any change in design is found necessary after the original approval is granted.

The Engineer may require re-approval if they involve changes in concept, approach, quantity, size or weight, power requirements, or performance thereof.

b. Pre-installation Approval

Not less than sixty (60) days prior to the shipment of the related equipment or structures, two (2) final draft copies of installation instructions, drawings, and instruction manuals shall be submitted to the Engineer for approval.

1.24.2 INSTRUCTION MANUALS

a. The Manuals shall be prepared in Chinese and English languages and shall include:

- Information on any special unpacking and assembling requirements, and
- on essential installation instruction such as foundation requirements, plumbing or electrical connections, power requirements and initial lubrication.
- Servicing and inspection instructions shall also be explained.

b. Operation manual.

Instruction shall be as applicable to the equipment, but not be limited to :

- preliminary adjustment
- control settings
- starting and stopping the equipment and
- operation, etc.

c. Maintenance manual

For both periodical and emergency maintenance such as:

- Cleaning and lubricating
- Trouble-shooting
- Preventive maintenance, if any

- Test equipment
- Parts list (including component and parts layout).

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SPECIAL PROVISION

CHAPTER 2

AIRFIELD LIGHTING SYSTEM

2.1 THE CAT. II. PRECISION APPROACH LIGHTING SYSTEM (PALS)

2.1.1 SCOPE

This work shall includes all the goods and the services that are required for engineering, supply and installation of the precision approach Category II lighting system for both Runway 17 and Runway 35 of Shanghai / Pudong International Airport.

2.1.2 LIGHTING SYSTEM

a. The CAT II precision approach lights shall consist of a row of lights on the extended center line of the runway, extending 900 m from the runway threshold, two side rows of lights, extending 270 m from the threshold, and two crossbar lights, one at 150 m and the other at 300 m from threshold, all as shown in the Drawing.

b. The lights forming center line (center line lights) shall be placed at longitudinal intervals of 30 m with the innermost lights located 30 m from the runway threshold.

c. The lights forming the side rows (side row lights) shall be placed on each side of the center line, at a longitudinal spacing equal to that of the center line lights and with the first light located 30 m from the threshold. The lateral spacing (or gauge) between the innermost lights of the side row shall be 18 m and shall be equal to that of touchdown zone lights.

d. The length of a side row barrette shall be 1.5 m and the spacing 1.5 m.

e. The crossbar lights provided at 150 m from the threshold shall fill in the gaps between the center line and side row lights.

f. The crossbar lights provided at 300 m from the threshold shall extend on both sides of the center line lights to a distance of 15 m from the center line

2.1.3 CHARACTERISTICS

a. The center line lights of the precision approach category II (& III) lighting system shall consist of barrettes showing variable white. The barrettes shall be 4 m in length and shall be uniformly spaced at intervals of 1 m.

b. The side row shall consist of barrettes showing red.

c. The lights forming the cross bar shall be the fixed light showing variable white. The lights shall be uniformly spaced at intervals of 1.75 m for the 150 m crossbars and 1.5 m for the 300 m cross bars.

d. The performance of the precision approach light shall be in accordance with ICAO, Annex 14, Appendix 2, Figure 2.1 for center line lights and crossbars, and Figure 2.2 for side row lights.

2.1.4 LIGHT FITTINGS

Two (2) types of lights shall be used for the precision approach lights, the elevated lights and the surface (inset) lights.

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The height of the elevated lights shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

Surface lights shall be so fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the lights themselves.

a. Elevated Lights

(1) Each elevated light shall be fitted with one (1) pre-focussed tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 200 watt and a minimum lamp life of 500 hours for continuous use at 100% intensity. The color filters shall be of the dichroic type.

(2) Each light shall be composed of a light-weight anticorrosive lamp housing consisting of an appropriate front glass and a reflector for the lamp, suitable for mounting at ground level on a base plate, and shall allow adjustment of the beam in the vertical plane between zero and 15 degrees from the horizontal plane.

(3) Each light shall be fitted with a factory molded 2-pole plug for plug-in to the receptacle of its own designated insulating transformer.

(4) Each elevated light shall be fixed on the base plate by means of a frangible coupling, and shall be connected through a mechanically protected cable for its whole run to the transformer box which is located in the vicinity of the light.

(5) Each light including frangible coupling, and light fittings shall not be broken by aircraft engine blast.

b. Surface Lights (Inset Light)

(1) Each surface light shall be unidirectional type, fitted with three (3) pre-focussed tungsten halogen lamps of 6.6 amperes, with a rating not exceeding 350 watt with a reflector and a minimum lamp life of 1000 hours for continuous use at 100% intensity. The color filters shall be of the diachronic type.

(2) Each surface light shall be composed of a cover, a base unit box and an optical assembly, with the base unit box to be interconnected by means of conduits protecting primary circuit cables, fitted with a factory molded 2-pole plug for plug-in to the receptacle of its own designated isolating transformer which is installed separately in the vicinity of the light.

(3) Each light shall be in less than 12.7 mm vertical projection above the surrounding surface, consistent with the required photometry characteristics.

(4) Major parts of the light shall be made from aluminum alloy, and all parts including their contact surfaces with other metals shall be fully corrosion proof.

(5) 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.

(6) All edges of the light fittings above the pavement shall be rounded in not less than 1.5 mm radius, and the surface of the light fitting together 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.

(7) Each surface light shall be suitable for a shallow base type.

2.1.5 INSTALLATION

a. In general, elevated lights are more prone to misalignment during service, while inset lights demand very accurate alignment during initial installation as subsequent correction is difficult to achieve, but the variations from the norm are unlikely to be more than one degree. Consequently, a tolerance of one degree should be added to each side of the angles in Annex 14, Volume I, Appendix 2, Figures 2.1 to 2.11 for the specification of the output characteristics of the fittings. Furthermore, when manufacturing light fittings, it is important that the specified tolerances be followed to ensure that all fittings so manufactured and so aligned to the specified tolerances meet the specification that the lighting patterns should not to give inconsistent visual segments.

The surface inset type light shall be installed on the shallow type base unit box at such a height that the overrun pavement is constructed to the finished level.

b. The base unit box of the surface lights shall be inset in the overrun pavement, suitable for shallow base type mounting in the concrete. The base unit box shall be connected to the transformer box by means of a combination of a flexible stainless steel pipe of 50 mmϕ and a galvanized steel pipe of 50 mmϕ buried in the shoulder pavement area.

c. Surface lights shall consist of one (1) center line light bar and one (1) pair of red row of approach lights.

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

e. The transformer box to be located in the vicinity of the light shall be made of cast iron or steel plate and finished to resist corrosion, having sufficient space for housing an isolating transformer, connecting devices, and remote unit (for future connection to burnt-out lamp detection unit).

f. The elevated light shall be fastened on the base plate by means of a deeply grooved frangible coupling, and then connected to the transformer box through a connecting duct pipe.

g. For vertical setting angles of the approach center line lights and crossbars lights, the following vertical coverage of the main beam shall be met.

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Distance from threshold	Vertical main beam coverage
Threshold to 315 m	0 - 11
316 m to 475 m	0.5 - 11.5
476 m to 640 m	1.5 - 12.5
641 m and beyond	2.5 - 13.5

h. Lights for crossbars beyond 22.5 m from the center line shall be aligned at toe-in value of 2 degree. All other lights shall be aligned parallel to the center line of the runway.

i. For approach side row lights, the vertical setting angle of the lights shall be such that the following vertical coverage of the main beam shall be met:

Distance from threshold	Vertical main beam coverage
Threshold to 115 m	0.5 - 10.5
16 m to 215 m	1.0 - 11.0
216 m and beyond	1.5 - 12.5

j. Side row lights shall be aligned at toe-in value of 2 degrees.

k. The transformer box shall be inset in the concrete foundation and laterally integrated for each row.

l. Suitable isolating transformers as specified in the corresponding subsection for respective light shall be fixed in the transformer box.

2.1.6 SYSTEM OF POWER SUPPLY

a. The approach lights shall receive power supply from Constant Current Regulator (CCR) through each of the Main (4-circuit) and Secondary AFL Substations (4-circuit) by means of the interleaved 6.6-ampere 4-loop circuits respectively.

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

2.1.7 BRILLIANCY CONTROL

a. The approach lighting system shall be controlled in more than six (6) stages of lighting brilliancy.

b. The value to be set at each electric current of the stages shall be approved by the Employer.

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2.2 SEQUENCE FLASHING LIGHTS (CAPACITOR DISCHARGE LIGHTS)

2.2.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the sequence discharge lights for both Runway 17 and Runway 35.

2.2.2 LIGHTING SYSTEM

a. The sequence flashing lights shall be consist of 29 high intensity, unidirectional, elevated type capacitor discharge lights placed on the extended runway center line, extending 900 m from the runway threshold. The lights forming the center line shall be placed at longitudinal intervals of 30 m with the innermost light to be located 60.5 m from the threshold.

b. The capacitor discharge light shall be offset 0.5 m at its lateral and parallel positions from the extended center line to avoid overlap with approach center line lights

2.2.3 CHARACTERISTICS

a. Each elevated type sequence flashing light (capacitor discharge light) shall flash twice a second in sequence, beginning with the outermost light and progressing toward the threshold to the innermost light of the system.

b. The electrical circuit of the capacitor discharge light shall be designed such that these lights can be operated independently from other lighting system.

c. Furthermore, capacitor discharge lights installed at the inner side of 300 m from the runway threshold, shall be extinguished automatically when the operational condition reaches Cat. II and Cat. III conditions.

d. Minimum effective intensity of the light shall be as shown below:

High Level : 8000 cd ±15 degrees both in vertical and horizontal;
Medium Level : 800 cd ±15 degrees both in vertical and horizontal;
Low Level : 150 cd ±15 degrees both in vertical and horizontal.

2.2.4 LIGHT FITTINGS AND CONTROL DEVICES

2.2.4.1 LIGHT FITTINGS

a. Each elevated type sequence flashing light (capacitor discharge light) shall be fitted with a xenon discharge lamp for a minimum lamp life of 500 hours at 2 Hz.

b. Each light shall be composed of light weight anticorrosive fittings, suitable for mounting at ground level on the base cover plate fastened to the base unit box buried underground in the concrete foundation, and adjustable of its beam in the vertical plane between zero and 15 degrees from the horizontal plane.

c. Each light shall be of light weight construction and shall be fixed on the base cover plate by means of a supporting pipe and a frangible coupling.

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d. The light fittings including the base cover plate, supporting pipe and the frangible coupling shall not be broken by aircraft engine blast.

e. The lamp of the light shall be so designed as to be replaced by removing the front ring or opening the back captive door, while the high voltage power supply is automatically switched off during re-lamping.

f. Each control cabinet shall be remotely controlled to select three (3) levels of brightness, and shall send back signals to the central processing facilities of the computer room in the Main AFL Substation to indicate any burnt-out lamp location on the respective monitoring panels of the Main and Secondary AFL Substations through their central control cabinets.

g. Each control cabinet shall be equipped with a control device unit consisting of a master printed circuit board to control sequential synchronization system of the capacitor discharge light by means of two (2) extra low-voltage wires which are linked in series circuit to all the individual control cabinets and operated independently of the other lights of the approach lighting system.

h. The base unit box shall be made of cast aluminum, properly finished to resist corrosion.

i. 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.

2.2.4.1 CONTROL DEVICES

a. Each control device unit of the elevated type sequence flashing lights shall be a light weight, water-tight and anticorrosive construction, housed in the base unit box with the base cover plate, and forming an electronic device shelter.

b. Each control device unit shall be equipped with a controllable capacitor discharge light connected by a wire of not less than 50 m.

c. Each control device unit shall be provided with a terminal board having its primary and secondary circuits for connection with both power and control cables.

d. Each control device unit shall be designed such that the high voltage power is automatically switched off and starts discharging automatically when the cabinet door is opened.

e. Central control cabinets which are equipped in the Main and Secondary AFL Substations shall receive ON and OFF as well as brilliancy command signals from the central processing facilities, and relay those signals to each control device unit, at the same time and simultaneously with the status signals to be sent from each of the control device units, then feeding them back again to the central processing facilities.

2.2.5 INSTALLATION

a. Each elevated type sequence flashing light (capacitor discharge light) shall be installed closer to the approach center line lights and shall be set in the same height as that of the approach lights.

b. Each light shall be mounted on the base plate, by means of the frangible coupling and supporting pole, fastened to the concrete foundation base with its base unit box buried.

c. Each control cabinet of the capacitor discharge lights shall be installed laterally about 40 m away and at right angle to each light.

d. Each control cabinet shall be installed in the same manner as specified in b. above.

e. Central control unit shall be installed at the CCR room of the Main and Secondary Substations.

2.2.6 SYSTEM OF POWER SUPPLY

a. Each control cabinet of the sequence flashing lights shall receive power supply from the Main or Secondary AFL Substation of the 380 V / 220 V 3-phase 4-wire power distribution system. The size of conductors and number of cables required for this system are indicated on the Drawings.

b. Each control cabinet shall be controllable of its input voltage from the 200 V to 250 V at 50 Hz.

c. Each control unit shall supply high voltage power and triggering signal to the light for sequential flashing as indicated in the Drawing.

2.2.7 BRILLIANCY CONTROL

The sequence flashing lights shall be controlled of its brilliancy at three (3) stages, high, medium and low.

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2.3 PRECISION APPROACH PATH INDICATOR (PAPI) SYSTEM

2.3.1 SCOPE

This work shall include all the goods and services that are required for engineering, supply and installation of the precision approach path indicator (PAPI) system for both runway 17 and runway 35.

2.3.2 SYSTEM CONFIGURATION

The precision approach path indicator PAPI system shall consist of a wing bar of 4 sharp transition multi-lamp units equally spaced, and shall be located on the left side of the runway.

2.3.3 OPERATIONAL REQUIREMENTS

The wing bar of a precision approach path indicator PAPI shall be constructed and arranged in such a manner that a pilot making an approach will:

a. when on or close to the approach slope, see the two units nearest the runway as red and two units farthest from the runway as white;

b. when above the approach slope, see the one unit nearest the runway as red and three units farthest from the runway as white; and when further above the approach slope, see all the units as white; and

c. when below the approach slope, see the three units nearest the runway as red and the unit farthest from the runway as white; and when further below the approach slope, see all the units as red.

2.3.4 CHARACTERISTICS

a. The system shall be suitable for both day and night operation.

b. The color transition from red to white in the vertical plane shall be so designed as to appear to an observer, at a distance of not less than 300 m, and to occur within a vertical angle of not more than 3° .

c. At full intensity, the red light shall have a Y coordinate not exceeding 0.320 according to ICAO, Annex 14, Volume 1, Appendix 2, Figure 1.1.

d. The light intensity distribution of the precision approach path indicator lighting units shall be as shown in ICAO, Annex-14, Volume 1, Appendix 2, Figure 2.20.

2.3.5 LIGHT FITTINGS

a. The precision approach path indicator light (PAPI) shall be an unidirectional elevated type, fitted with three (3) pre-focussed tungsten halogen lamps of 6.6 amperes, with a rating not exceeding in 200 watt and a minimum lamp life of 1000 hours for continuous use at 100% intensity. The unit shall satisfy its continuous operation even if its one lamp of the three burns out.

b. The PAPI unit shall be composed of a lamp assembly unit, four (4) legs and a concrete base, and shall be secured by means of weak links consisting of frangible legs so that, if an aircraft collides with a unit, the unit will be carried away.

However, the unit shall be less susceptible to damage from jet blast than any other light installations.

c. Each light unit shall be equipped with differential elevation adjustment device so that the lower limit of the white colour part of the beam may be fixed at any desired angle of elevation between 1.30 degrees and at least 4.30 degrees above the horizontal.

d. The light shall be designed such that any deposits of condensation, snow, ice, dirt, etc. on optically transmitting or reflecting surface shall interfere, to the least possible extent, with the light signals, and shall not affect the contrast between the red and white signals as well as the elevation of the transition sector.

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

f. The unit shall be fitted with three (3) cables with the factory molded 2-pole plugs for connection to the isolating transformer via remote unit.

g. Remote monitor system for the differential elevation adjustment angle of inclination shall be provided at each light.

h. The lamp assembly unit shall be made of aluminum or other corrosion-proof materials with lockable latches, and shall be designed to resist the ingress of foreign matter.

2.3.6 INSTALLATION

a. The PAPI unit shall be installed on a solid concrete foundation base, and special care should be taken if the subsoil is known to be unreliable.

b. The distance between the inner unit of the PAPI units nearest to the runway and the runway edge shall be 15 m.

c. The spacing between PAPI units shall be 9 m.

d. The PAPI system comprises a four-unit wing bar located in a line at right angle to the runway.
The unit nearest to the runway shall be set higher than the required approach angle, with progressive reduction in the setting of the units father outboard. The normal difference between the setting angles shall be 20 minutes of arc. This value shall be adjusted in conjunction with ILS glide path setting angle and location, among other things.

e. Distance from the threshold to the PAPI wing bar shall be calculated to provide the optimum compatibility between the visual and non-visual aids for the range of eye-to antenna heights of an airplane that is regularly using the runway.

f. Distance from the threshold to the PAPI wing bar shall be adjusted for differences in elevation between the lens centers and the threshold.

g. The location of each unit indicated on the Drawing shall be calculated in accordance with standards of ICAO, Annex-14, Volume 1. section 5.3.5.

h. Each concrete base shall be constructed with a transformer box. The transformer box shall be made of forged aluminum alloy or aluminum plate with anti-corrosive

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finish, and shall have sufficient room for housing an isolating transformer, connecting devices, and burnt-out lamp detection unit, etc.

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

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

2.3.7 SYSTEM OF POWER SUPPLY

a. PAPI system shall receive power supply from Constant Current Regulator Room (CCR Room) in the Main or Secondary Substations by means of the 6.6-ampere 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.

2.3.8 BRILLIANCY CONTROL

a. PAPI system shall be controlled in more than four (4) brilliancy stages.

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

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2.4 RUNWAY EDGE LIGHTS

2.4.1 SCOPE

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

2.4.2 LIGHTING SYSTEM

a. The runway edge lights shall be placed along the full length of runway and shall be in two parallel rows equidistant from the center line. The distance between two parallel rows shall be 64 m.

b. The runway edge lights shall comprise an elevated type light fittings except the lights which locate in the taxiway pavement area, in which case the lights shall be of surface inset type.

c. The lights shall be installed uniformly at longitudinal intervals of not more than 60 m. The lights on the opposite sides of the runway axis shall be on lines at right angles to that axis.

2.4.3 CHARACTERISTICS

a. Runway edge lights shall be the fixed lights and shall show variable white from the threshold to the point 600 m away from the runway end, and yellow from the runway end.

b. The performance of the runway edge lights shall be in accordance with the specifications of ICAO Annex 14, Volume 1, Appendix 2, Figure 2.11.

c. Aviation yellow color filters shall be of a dichroic type, and shall conform satisfactorily to ICAO, Annex-14, Volume 1, Appendix 1, Figure 1.1 even when the electric current or the light intensity drops to 5% from the 100% rated 6.6 amperes current. The filter shall have the permeability of more than 40%.

d. The light shall be installed at toe-in value of 4.5° toward the runway center line.

2.4.4 LIGHT FITTINGS

a. Elevated lights

1) Elevated runway edge light shall be a bi-directional type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 200 watts and a minimum lamp life of 500 hours for continuous use at 100% intensity.

2) Each light shall be composed of a light-weight anticorrosive lighting fixture consisting of an appropriate lamp assembly with a front glass and a reflector, a supporting pipe and a base plate, suitable for mounting at ground level on the concrete block base, and horizontally adjustable after installation at least within four (4) degrees of allowance to the setting angle.

3) Each light shall be fitted with a factory molded 2-pole plug for plug-in to the receptacle of its own designated insulating transformer which is installed

separately in the vicinity of the light in the transformer box. The plug should be a pressure-relief type.

4) Each light shall be of light weight frangible construction with its rigid base plate to be fixed to a deeply grooved frangible coupling and the supporting pipe.

5) Lighting fixture including frangible coupling shall not be broken by aircraft engine blast.

b. Surface type light fittings

1) The surface inset light shall be a bi-directional type, fitted with two (2) tungsten halogen lamps of 6.6 amperes, with a rating not exceeding 250 watts and a minimum lamp life of 1000 hours for continuous use at 100% intensity.

2) Film cutout shall be inserted between two lamps, and in case of one lamp burned out, a film cutout shall be shorted automatically to make the other lamp live.

3) Each surface light shall be composed of a cover, lamp unit and a base unit box to be inset in the concrete block base underground in the pavement, and equipped with a factory molded 2-pole plugs to plug in the cable receptacle for the single insulating transformer of its own located nearby.

4) Each surface light shall be placed in less than 12.7 mm vertical projection as a minimum bulk above the surrounding ground surface, and shall be consistent with the required photometric characteristics.

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

6) 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.

7) All edges above the pavement shall be rounded to not less than 1.5 mm radius, and the cover of the light 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.

8) Each light shall be suitable for shallow base type installation.

9) The cover and the base unit box of the light shall be made of forged aluminum alloy, properly finished to resist corrosion.

10) 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.

2.4.5 INSTALLATION

a. Elevated type light

1) Elevated runway edge lights shall be installed on the runway shoulder pavement or in the taxiway connecting pavement at the distance of 2.0 m from the runway edge.

2) The elevated runway edge light shall be installed on the base plate by means of the frangible coupling and the supporting pole by fastening the base plate on the concrete base block.

3) The base plate on the concrete base block shall be placed at such a height that the runway shoulder pavement is constructed to the finished level.

4) An aluminum conduit laid inside this concrete base block shall be connected underground first to the flexible stainless steel pipe, and then to the galvanized steel pipe of 50 mm buried in the runway shoulder pavement area, wherefrom, connected to the transformer box which shall be located 9 m off from the runway edge, all as shown in the Drawing.

5) The transformer box shall be fabricated from steel plate or cast iron, and finished to corrosion-proof, and shall have sufficient space for housing an isolating transformer, connecting devices, etc.

6) The 200 W type isolating transformer as specified in the Specification shall be installed for each light in the transformer box located nearby.

7) 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 light with receptacle.

b. Surface type light

1) The surface runway edge light shall be a shallow type inset light, and shall be installed at such a height that the taxiway pavement is constructed to the finished level.

2) The light shall be installed in the recess in the taxiway pavement with its base unit box inset in the pavement. This base unit box shall be connected by a combination of stainless steel flexible pipe of 50 mm and galvanized steel pipe of 50 mm buried in the taxiway and shoulder pavement area, all as shown in the Drawing.

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 as well as the azimuth with respect to the center line are two parameters that shall be met.

4) The corresponding subsections of the elevated runway edge lights as shown above shall apply for the surface type inset lights.

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2.4.6 SYSTEM OF POWER SUPPLY

a. The runway edge lights shall receive power supplied through Constant Current Regulator Room (CCR Room) of the Main AFL Substation by means of the 6.6-ampere interleaved two (2) 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.

2.4.7 BRILLIANCY CONTROL

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

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

2.5 RUNWAY THRESHOLD AND WING BAR LIGHTS

2.5.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the runway threshold and wing bar lights for both runway 17 and runway 35.

2.5.2 LIGHTING SYSTEM

a. The runway threshold lights shall be placed in a row at right angles to the runway axis at 1.0 m outside the extremity of a runway.

b. The runway threshold lights shall be installed to be uniformly spaced at interval of 2.9 m between both sides of rows of runway edge lights.

c. The wing bar lights shall be symmetrically disposed about the runway center line on the same line of the threshold lights in two groups, i.e., wing bars.

d. Each wing bar shall be formed by 5 lights, extending 12 m outward from, and at right angles to the line of the runway edge lights, with the innermost light of each wing bar in the line of the runway edge lights.

e. The wing bar lights shall be placed at intervals of 3 m.

2.5.3 CHARACTERISTICS

a. Runway threshold and wing bar lights shall be fixed unidirectional lights showing green in the direction of approach to the runway.

b. The performance of the threshold lights shall be in accordance with the standards and recommended practices of ICAO, Annex-14, Volume 1, Appendix 2, Figure 2.3.

c. The performance of the threshold wing bar lights shall be in accordance with the standards and recommended practices of ICAO, Annex-14, Volume 1, Appendix 2, Figure 2.4.

d. Aviation green colored filters shall be dichroic type, and shall conform to satisfy the standards and recommended practices of ICAO, Annex 14, Volume 1, Appendix 1, Figure 1.1. even when its electric current or light intensity drops to 5% of the rating current.
The filter shall have the permeability of more than 15 %.

e. The threshold light shall be placed at toe-in value of 3.5° toward the extended runway center line.

f. The threshold wing bar light shall be placed at toe-in value of 2.0° toward the runway center line.

2.5.4 LIGHT FITTINGS

a. Runway threshold light

1) Runway threshold light shall be of an unidirectional surface light type, equipped with two (2) tungsten halogen lamps of 6.6 amperes, with a rating not exceeding 250 watts and a minimum lamp life of 1000 hours for continuous use at 100% intensity.

2) Film cutout shall be inserted between two lamps, and in case of one lamp burnt up, a film cutout shall be shorted automatically to make the other lamp live.

3) Each surface light inset in the pavement shall be fitted with a factory molded 2-pole plug to plug in the receptacle for its own single insulating transformer located in its vicinity. The plug of the light should be a pressure relief type.

4) Each surface light shall be place in less than 12.7 mm vertical projection above the surrounding surface as a minimum bulk, and shall be consistent with the required photometric characteristics.

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

6) 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..

7) All edges above the pavement shall be rounded to not less than 1.5 mm radius, and the cover of the light that meet 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.

8) Each light shall be suitable for shallow base type installation.

9) The cover and the base unit box shall be made of forged aluminum alloy, properly finished to resist corrosion.

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

b. Wing bar lights

1) Wing bar light shall be of an unidirectional elevated light type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 200 watts and a minimum lamp life of 500 hours for continuous use at 100% intensity.

2) Each elevated light shall be fitted with a factory molded 2 poles plug to plug in the receptacle of its own insulating transformer via remote unit. The plug of the light should be a pressure relief type.

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3) Each elevated light shall be a light-weight anticorrosive construction, suitable for mounting on the ground, and horizontally adjustable after installation at least within four (4) degrees of allowance to the setting angle.

4) Each light shall be fastened on the base plate by means of the deeply grooved frangible coupling and the supporting pipe.

5) Light fittings including frangible coupling, supporting pole and base plate shall not be broken by aircraft engine blast.

6) The light shall be made of aluminum alloy, properly finished to resist corrosion.

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

2.5.5 INSTALLATION

Runway threshold lights shall be installed on the runway overrun pavement, and wing bar lights shall be on the overrun pavement or on the runway strips 1.0 m beyond the runway threshold in parallel.

a. Runway threshold lights

1) The runway threshold light shall be installed on the shallow base at such a height that the overrun pavement is constructed to the finished level.

2) The shallow base light shall be inset in the overrun pavement with a suitable base unit box and a cover to fit in the concrete pavement recess. This base unit box shall be connected by a combination of a flexible stainless steel pipe of 50 mm and a galvanized steel pipe of 50 mm buried in the taxiway and shoulder pavement area, all as shown in the Drawing.

3) Each base unit box of the shallow base light shall be connected underground to an adjacent base unit box of other light, and outermost base unit box to be inter-connected underground to the conduit of the concrete base block of the innermost elevated wing bar light.

4) 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 parameters that shall be met.

5) The galvanized steel pipe of 50 mm as described above shall be laid underground between the flexible stainless steel pipe and the transformer box which is placed 16 m off from the runway edge.

6) The transformer box shall be fabricated from steel plate or cast iron, and finished to resist corrosion, and shall have sufficient space for housing an isolating transformer, connecting devices, etc.

7) The 200 W type isolating transformer as specified in the Specification shall be installed for each light in the transformer box.

8) Remote unit as specified in the Specification shall be provided, and housed in the transformer box with the isolating transformer.

9) Primary lead cable of the isolating transformer shall be connected to the series circuit cable with a plug and receptacle, and secondary lead cable shall be connected to the primary lead cable of the remote unit with a receptacle.

b. Wing bar lights

1) The wing bar light shall be installed by means of a frangible coupling and a supporting pole, with its base plate fastened to the concrete base block in the pavement.

2) The base plate of the elevated light shall be installed at such a height that the runway shoulder pavement is constructed to the finished level.

3) The aluminum conduit laid in the concrete base block shall be connected by a combination of a flexible stainless steel pipe of 50 mm and a galvanized steel pipe of 50 mm buried in the runway shoulder pavement area, all as shown in the Drawing.

4) Each wing bar light shall be connected under ground by means of cables to an adjacent wing bar light, and the innermost wing bar light shall be interconnected underground to the outermost threshold light.

5) Furthermore, the outermost ground base unit box shall be connected to the transformer boxes which are placed adjacent to the wing bar in the same manner as described above.

6) The 200 W type isolating transformer as specified in the Specification for each light shall be installed in the transformer boxes.

7) The corresponding subsection in the Specification "Installation of Runway Threshold Lights" as described above shall apply for the wing bar.

2.5.6 SYSTEM OF POWER SUPPLY

a. Both runway 17 and 35 threshold lights and wing bar lights shall received electric power supply through Constant Current Regulators Room (CCR Room) of the Main Substation for runway 17 and the Secondary Substation for runway 35 by means of the 6.6-ampere interleaved two(2) 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.

2.5.7 BRILLIANCY CONTROL

a. The runway threshold lights and wing bar shall be controlled at more than six(6) stages of light brilliancy.

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

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2.6 RUNWAY END LIGHTS

2.6.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the runway end lights for both runway 17 and runway 35.

2.6.2 LIGHTING SYSTEM

a. The runway end lights shall be placed in a row on a line at right angles to the runway axis at a distance of 0.5 m outside the runway extremity.

b. The runway end lights shall be uniformly spaced between the rows of runway edge lights at intervals of 5.8 m, and for the outermost runway end lights at intervals of 3 m.

2.6.3 CHARACTERISTICS

a. Runway end lights shall be the fixed unidirectional lights showing red in the direction of the runway.

b. The performance of the threshold lights shall be in accordance with ICAO, Annex-14, Volume 1, Appendix 2, Figure 2.9.

c. Aviation red colored filters shall be dichroic type, and shall conform satisfactorily to the standards and recommended practices of ICAO Annex-14, Volume 1, Appendix 1, Figure 1.1. even when their electric current or light intensity drops to 5 % from the rated currency.
This colored filter shall have the permeability of more than 13 %.

2.6.4 LIGHT FITTINGS

a. Light shall be of an unidirectional surface type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 200 watts and a minimum lamp life of 500 hours for continuous use at 100% intensity.

b. Each surface light shall be equipped with a factory molded 2 poles plugs to plug in the receptacle for its own single insulating transformer via remote unit. The plug should be a pressure relief type.

c. Each surface light shall be placed in less than 25.4 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 vehicle tires.

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

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

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

2.6.5 INSTALLATION

a. Runway end lights shall be placed on the overrun pavement 0.5 m outside the runway end.

b. The light shall be a shallow base type, and shall be placed at such a height that the overrun pavement is constructed to the finished level.

c. The light shall be installed in the recess of the overrun pavement on the forged aluminum alloy base unit box. This base unit box shall be connected by means of a combination of a stainless steel flexible steel pipe of 50 mm and a galvanized steel pipe of 50 mm buried in the taxiway and shoulder pavement area, as shown in the Drawing.

d. Each base unit box shall be connected underground via cables to an adjacent base unit box of other light, and the outermost base unit box shall finally be connected underground to the nearby transformer box.

e. A jig or fixture is required to hold the forged aluminum alloy base unit box in position in the recess 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 parameters that shall be met.

f. This galvanized steel pipe of 50 mm as described above shall be connected to the nearby transformer box which shall be installed at the distance of 16 m from the runway edge.

g. The transformer box shall be fabricated from steel plate or cast iron, and finished to corrosion-proof, and shall have sufficient space for housing an isolating transformer, connecting devices, etc.

h. The 200 W type isolating transformer specified in the Specification shall be installed for each light in the transformer box.

i. Remote unit as specified in the Specification shall be provided and housed in the transformer box with isolating transformer.

j. Primary lead cable of the isolating transformer shall be connected in series circuit to the cable with a plug and a receptacle, and secondary lead cable shall be connected to the primary lead cable of the remote unit with a receptacle.

k. Primary lead cable of the remote unit shall be connected to secondary lead cable of the isolating transformer with plugs, and secondary lead cable shall be connected to the lead cable of the light fittings with receptacles.

2.6.6 SYSTEM OF POWER SUPPLY

a. Both runway 17 and 35 runway end lights shall receive their power supplied from Constant Current Regulator Room (CCR Room) of the Main AFL Substation for runway 17 and the Secondary Substation for runway 35 by means of the 6.6-ampere interleaved two (2) loop circuits which are for common use with both runway threshold lights and wing bar lights 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.

2.6.7 BRILLIANCY CONTROL

a. The runway end lights shall be controlled in more than six(6) brilliancy stages.

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

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2.7 RUNWAY CENTER LINE LIGHTS

2.7.1 SCOPE

This works shall include all the goods and the services that are required for engineering, supply and installation of the runway center line lighting systems for both Runway 17 and Runway 35.

2.7.2 LIGHTING SYSTEM

a. The center line lights shall be located along the center line of the runway and uniformly offset 60 cm opposite to the exit taxiway side from the runway centerline.

b. The lights shall be located from the runway threshold to the runway end at longitudinal spacing of approximately 15 m.

2.7.3 CHARACTERISTICS

a. Runway centerline lights shall be fixed lights showing variable white from the threshold to the point 900 m from the runway end; alternate red and white from 900 m to 300 m from the runway end; and red from the runway end.

b. The performance of the lights shall be in accordance with ICAI Annex 14, Appendix 2, Figure 2.7.

2.7.4 LIGHT FITTINGS

a. Taxiway edge light shall be of an omnidirectional elevated light type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 50 watts and a minimum lamp life of 500 hours for continuous use at 100% intensity.

b. Each elevated edge light shall be composed of a light-weight anticorrosive fittings consisting of an optical unit, supporting pipe, frangible coupling and the base plate, suitable for ground mounting on the concrete base block, and with its optical unit to be horizontally adjustable after installation within at least four (4) degrees of allowance to the setting angle.

c. Each edge light shall be equipped with a factory molded 2-pole plug for plug-in to the receptacle of the nearby insulating transformer.

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 materials..

2.7.5 INSTALLATION

a. Taxiway edge lights shall be placed on the taxiway shoulder pavement 1.5 m outside the taxiway edge.

b. The light shall be installed on the base plate on the ground by means of a supporting pipe and a frangible coupling.

c. The in-situ concrete base block laid with an aluminum conduit inside shall be constructed as a base foundation to the base plate of the light at such a height that the taxiway shoulder pavement is constructed to the finished level.

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d. This aluminum conduit of the light shall be connected through the flexible stainless steel pipe of 50 mmϕ, and then connected to the galvanized steel pipe of 50 mmϕ under the taxiway shoulder pavement area, all as shown in the Drawing.

e. This galvanized steel pipe of 50 mmϕ as described above shall be connected between the flexible stainless steel pipe and the conduit pipe of the transformer box located 1.5 m away from the shoulder pavement edge.

f. The transformer box shall be fabricated from steel plate or cast iron, properly finished to resist corrosion, and shall have sufficient room for housing the isolating transformer, and connecting devices, etc.

g. The 50 W type isolating transformer as specified in the corresponding subsection shall be installed for each light 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 light with a receptacle.

2.7.6 SYSTEM OF POWER SUPPLY

a. The runway centerline light shall receive power supply from constant current regulator (CCR) of the Main Substation by means of the 6.6-ampere interleaved four (4) loop circuits.

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

2.7.7 BRILLIANCY CONTROL

a. The runway center line light shall be controlled in more than six (6) brilliancy stages.

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

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2.8 RUNWAY TOUCHDOWN ZONE LIGHTS

This work shall include all the goods and services that are required for engineering, supply, and installation of the runway touchdown zone lights for runway 17 and runway 35.

2.8.2 LIGHTING SYSTEM

a. The runway touchdown zone lights shall extend from both thresholds of the runway for a longitudinal distance of 900 m.

b. The light pattern shall be formed by pairs of barrettes symmetrically located about the runway center line.

c. The lateral spacing between the innermost lights of a pair of barrettes shall be equal to the lateral spacing selected for the touchdown zone marking.

d. The longitudinal spacing between pairs of barrettes shall be 30 m.

2.8.3 CHARACTERISTICS

a. A barrette shall be composed of three (3) lights with a spacing between the lights to be 1.5 m.

b. The runway touchdown zone lights shall be the fixed unidirectional lights showing variable white.

c The performance of the light shall be in accordance with ICAO, Annex 14, Appendix 2, Figure 2.5.

d. The lights shall have the toe-in value of 4° angle from left or right in lateral line toward the runway center line.

2.8.4 LIGHT FITTINGS

a. Runway touchdown zone light shall be unidirectional surface type, fitted with one (1) prefocus tungsten halogen lamps of 6.6 ampares, with reflector, having a rating not exceeding in 45 watt and a minimum lamp life of 1500 hours for continuous use at 100% intensity.

b. Each touchdown zone light shall be fitted with a factory molded 2-pole plug to connect itself to the receptacle of the nearby designated insulating transformer of its own.

c. Each touchdown zone light shall be in less than 12.7 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.

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f. All edges above the pavement shall be rounded to not less than 1.5 mm radius, and the cover of the light 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 runway touchdown zone light shall be suitable for shallow base type installation.

h. The shallow base unit box and the cover shall be made of forged aluminum alloy, properly finished to resist corrosion.

i. 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.

2.8.5 INSTALLATION

a. The runway touchdown zone lights shall be a surface light type, inset in the runway pavement in such a height that the runway pavement is constructed to be the finished level.

b. Each shallow base unit box of the runway touchdown zone lights shall be buried in the recess of the runway pavement with a shallow base unit box. This base unit box shall be connected in its bottom base to that of the other light with cables protected by both flexible stainless steel pipe of 50 mmϕ and galvanized steel pipe of 50 mmϕ under the runway pavement area between the lights composing barrettes, all as shown in the Drawing.

c. The outermost base unit box shall be connected underground to the transformer with the 50 mm galvanized steel pipe.

d. 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 of the light with respect to the runway surface and the azimuth with respect to the center line are two parameters that shall be met.

e. The transformer box shall be made of a cast iron or steel plate with anti-corrosive finish, and shall have sufficient space for housing an isolating transformer, connecting devices, and burnt-out lamp detection unit, etc.

f. Suitable isolating transformers to be specified in the Specification shall be installed for each light in the transformer box.

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

2.8.6 SYSTEM OF POWER SUPPLY

a. Runway touchdown zone lights shall receive power supply from Constant Current Regulator Room (CCR Room) of the Main and Secondary AFL Substations by means of the 6.6-ampere interleaved two (2) loop circuits.

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

2.8.7 BRILLIANCY CONTROL

a. Runway touchdown zone lights shall be controlled in more than six(6) brilliancy stages.

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

2.9 TAXIWAY CENTER LINE LIGHTS

2.9.1 SCOPE

This work shall include all the goods and the services that are required for engineering, supply and installation of the taxiway center line lights, except those beyond the stop bars.

2.9.2 LIGHTING SYSTEM

2.9.2.1 Lighting system

Taxiway center line lights shall provide continuous lighting guidance starting from the runway center line to the point on the apron in which aircraft commences maneuvering for parking.

2.9.2.2 Lighting Equipment

a. The taxiway centre line and stop bar lights are connected in a series circuit operating at a constant 6.6 ampere current for 100 per cent light output.

b. Individual lamps in the light fittings are connected to thyristor controlled transformers which derive energy from the primary series circuit.

c. A separate control circuit is provided for each light section in the system. (A light section is a stop bar, the centre line lights in a block and an individual route through a junction.)

d. The series circuits remain energized at all times when the system is in use.

e. The control circuit for each light section provides a small current to the transducers which saturate the iron cores, reducing the lamp currents to a value just below light emission.

f. When the lighting controller operates the controls, the signals generated in turn operate that equipment which controls the control circuits to transducers.

2.9.3 CHARACTERISTICS

a. Taxiway center line lights on a taxiway other than an exit taxiway and on a runway forming part of a standard taxi-route shall be the fixed lights showing green with beam dimensions such that the light is visible only from airplane on or in the vicinity of the taxiway.

b. Taxi way center line lights on an exit taxiway shall be the fixed lights. Alternate taxiway center line lights shall show green and yellow starting from the point near the runway center line to the perimeter of the ILS critical / sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway, and thereafter, all lights shall show green. The lights nearest to the perimeter shall show always yellow. Where aircraft may follow the same center line in both directions, all the taxiway center line lights shall show green to aircraft approaching the runway.

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c. The performance of the lights shall be in accordance with ICAO, Annex 14, Appendix 2, Figure 2.13, 2.14 or 2.15.

d. Care shall be necessary in limiting the light distribution of green lights on or near the runway so as to avoid possible confusion with threshold lights.

e. Taxiway center line lights shall be located along the center line of the taxiway and uniformly offset 30 cm away from the taxiway center line.

f. Taxiway center line lights on a straight section shall be spaced at longitudinal intervals of not more than 15 m.

g. Taxiway center line lights on a curve of less than 400 m radius, the lights shall be spaced at interval of not greater than 7.5 m.

2.9.4 LIGHT FITTINGS

a. Taxiway center line light except rapid exit taxiway light shall be a bi-directional surface type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 100 watt and a minimum lamp life of 500 hours for continuous use at 100% intensity.

b. Taxiway center line light on the rapid exit taxiway shall be an unidirectional surface type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 100 watt and a minimum lamp life of 500 hours for continuous use at 100% intensity.

c. Each surface taxiway center line light shall be fitted with a factory molded one (1) 2-pole plug for connection to the nearby designated insulating transformer of its own. The filters shall be of the dichroic type.

d. Each surface taxiway center line light shall be in less than 12.7 mm vertical projection above the surrounding surface, consistent with the required photometric characteristics.

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 the 18-8 stainless steel or silicon bronze or better materials.

g. 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.

h. Each surface taxiway center line light shall be suitable for shallow or deep base type installation.

i. The base unit box shall be made of 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.

2.9.5 INSTALLATION

a. Taxiway center line light shall be the surface light type, suitable for mounting in the shallow or deep base unit on the same level as the finished pavement surfaces of the runway, taxiway and apron pavements.

b. Each light shall be inset in the recess in the runway and taxiway pavements with its base unit box to be laid below the pavement surface. This base unit box of the light shall be connected each other with cables protected by both flexible stainless steel pipe of 50 mmϕ and galvanized steel pipe of 50 mmϕ buried under the runway and taxiway shoulder pavement areas, all as shown in the Drawing.

c. The galvanized steel pipe of 50 mmϕ described in b. above shall be used for connection between the stainless steel flexible pipe and the conduit of the transformer box located 1.0 m away from the shoulder pavement edge.

d. A jig or fixture shall be required to hold the base unit box in position while the concrete anchor is placed. Elevation of the base unit box with respect to the pavement surface and the azimuth with respect to the taxiway center line are the two parameters that shall be met.

e. For a deep base surface light type, the transformer box located in this base unit box shall be forged aluminum alloy with an anticorrosive finish, and shall have sufficient room inside the box for housing the isolating transformer, connecting devices, remote unit (for future connection), etc.

f. For a shallow base surface light type, the transformer box shall be installed along the taxiway shoulder in the vicinity of the corresponding taxiway center line lights

g. Suitable isolating transformers specified in the Specification shall be installed for each light in the transformer box.

2.9.6 SYSTEM OF POWER SUPPLY

a. Taxiway center line lights shall receive power supply from Constant Current Regulator Room (CCR Room) of the Main or Secondary Substation by means of the 6.6-ampere ten (10) loop series 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.

2.9.7 BRILLIANCY CONTROL

a. Taxiway center line lights which are installed on the rapid taxiway, and taxiways for low visibility conditions shall be controlled in more than six (6) stages of lighting brightness.

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

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2.10 TAXIWAY EDGE LIGHTS

2.10.1 SCOPE

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

2.10.2 LIGHTING SYSTEM

a. The taxiway edge lights shall be placed along the full length of all taxiways and shall be in two (2) parallel rows equidistant from the center line for straight section of the taxiways.

b. The lights on the straight taxiway section shall be installed uniformly at longitudinal intervals of not more than 60 m. The lights on opposite side of the taxiway axis shall be on line at right angle of the taxiway axis.

c. The lights on the curve taxiway section shall be spaced at interval of less than 60 m so that a clear indication of the curve can be secured.

d. The light to be installed at the portion in which one side of the taxiway is integrated with apron pavement section shall be spaced in not more than 30 m, but no light shall be installed on the apron side.

e. Item described in above d. shall apply to the exit taxiway which is connected to the parallel taxiway forming "T" shape.

2.10.3 CHARACTERISTICS

a. Taxiway edge lights shall be the fixed lights showing blue. The lights shall show up to at least 30° above the horizontal, and at all angles in azimuth necessary to provide guidance to a pilot taxing in either direction.

b. At intersection, exit or curve section, the lights shall be shielded as far as practicable so that they cannot be seen in angles of azimuth in which they may be confused with other lights.

c. The performance of the lights shall be in accordance with the IEC specifications (revision work is currently under way).

Following performance will be expected to be achieved in the newly drafted IEC specifications:

Minimum luminous intensity	Beam aperture (Vertical angle)	Beam aperture (Horizontal angle)
2.0 cd	0o to 6°	360°
0.2 cd	More than 6°	360°

Aviation blue shall conform satisfactorily to the standards of ICAO, Volume 1, Appendix 1, Figure 1.1. even when the electric current or light intensity drops to 25% of its rated current. The filter or globe shall have the permeability of more than 2%.

2.10.4 LIGHT FITTINGS

a. Taxiway edge light shall be of an omnidirectional elevated light type, fitted with one (1) tungsten halogen lamp of 6.6 amperes, with a rating not exceeding 50 watts and a minimum lamp life of 500 hours for continuous use at 100% intensity.

b. Each elevated edge light shall be composed of a light-weight anticorrosive fittings consisting of an optical unit, supporting pipe, frangible coupling and the base plate, suitable for ground mounting on the concrete base block, and with its optical unit to be horizontally adjustable after installation within at least four (4) degrees of allowance to the setting angle.

c. Each edge light shall be equipped with a factory molded 2-pole plug for plug-in to the receptacle of the nearby insulating transformer.

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 materials.

2.10.5 INSTALLATION

a. Taxiway edge lights shall be placed on the taxiway shoulder pavement 1.5 m outside the taxiway edge.

b. The light shall be installed on the base plate on the ground by means of a supporting pipe and a frangible coupling.

c. The in-situ concrete base block laid with an aluminum conduit inside shall be constructed as a base foundation to the base plate of the light at such a height that the taxiway shoulder pavement is constructed to the finished level.

d. This aluminum conduit of the light shall be connected through the flexible stainless steel pipe of 50 mmϕ, and then connected to the galvanized steel pipe of 50 mmϕ under the taxiway shoulder pavement area, all as shown in the Drawing.

e. This galvanized steel pipe of 50 mmϕ as described above shall be connected between the flexible stainless steel pipe and the conduit pipe of the transformer box located 1.5 m away from the shoulder pavement edge.

f. The transformer box shall be fabricated from steel plate or cast iron, properly finished to resist corrosion, and shall have sufficient room for housing the isolating transformer, and connecting devices, etc.

g. The 50 W type isolating transformer as specified in the corresponding subsection shall be installed for each light 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 light with a receptacle.

2.10.6 SYSTEM OF POWER SUPPLY

a. The taxiway edge lights shall receive power supply through the Constant Current Regulator Room (CCR Room) of the Main or Secondary AFL Substation by means of the 6.6-ampere six (6) 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.

2.10.7 BRILLIANCY CONTROL

a. The Constant Current Regulators of the taxiway edge lights shall be controlled in more than six (6) stages of light brilliancy.

b. The value of electric current of the lights to be fixed to each suitable stage of light brilliancy shall be approved by the Employer.