Republic of the Philippines

Department of Transportation and Communication

Republic of the Philippines

Detailed Design Study Report of New Bohol Airport Construction and Sustainable Environment Protection Project

Final Report

Appendix-1: Draft Bid Documents

Document Ⅱ: Specifications (Volume-4/4)

Section 8000 Series - Air Navigation Facilities
Section 9000 Series - Aeronautical Ground Lighting Works

September 2013

Japan International Cooperation Agency (JICA)

Japan Airport Consultants, Inc. (JAC)
Nippon Koei Co., Ltd. (NK)
NJS Consultants Co., Ltd. (NJS)
Joint Venture

Republic of the Philippines
DEPARTMENT OF TRANSPORTATION
AND
COMMUNICATIONS

JAPAN
INTERNATIONAL
COOPERATION
AGENCY

NEW BOHOL AIRPORT CONSTRUCTION AND SUSTAINABLE ENVIRONMENT PROTECTION PROJECT

Loan No: PH-P256

DRAFT BID DOCUMENT II

SPECIFICATIONS (VOL-4/4)

Section 8000 Series: Air Navigation Facilities
Section 9000 Series: Aeronautical Ground Lighting Works

August 2013

JICA Design Consultant Joint Venture

JAPAN AIRPORT CONSULTANTS, INC.

NIPPON KOEI CO., LTD.

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New Bohol Airport Construction and Sustainable Environmental Protection Project

Specifications

8000 Series

Air Navigation Facilities

SPECIFICATIONS

Section 8000 Series: Air Navigation Facilities

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SECTION 8050

GENERAL REQUIREMENTS FOR THE 8000 SERIES

1.0 GENERAL

1.1 The provisions of **Section 1140** are applicable and are to be referred to in connection with 8000 series of this Specification.

1.2 The following provisions are additional to, and are to be read in conjunction with, Section 1140, and are particular to 8000 series of this Specification.

2.0 SCOPE OF WORKS

2.1 This 8000 series of the Specification concern the design, manufacture and testing at manufacturer's premises, delivery to Site, carrying out all works, erection, installation, testing at Site, training, setting in operation and handing over in perfect operating and running condition including the Defects Notification Period of one (1) year after issuance of the Taking-Over Certificate.

2.2 Works shown on the Drawings and not mentioned or described in the Specification and works described in the Specification and not shown on the Drawings will nevertheless be considered as included in this scope of Works and their execution will be deemed to be included in the Contract Price.

2.3 The equipment items to be supplied and installed under the Project are tabulated in Table 8050.1.

Table 8050.1 Equipment under the Project

Facility	**Item**	**Remarks**	
Radio Navaids	ILS	ILS Cat-I	Landing Aids for RWY 21 /Facility Performance Cat-1
	VOR/DME	D-VOR/DME	Landing and Take off Aids, en-route fix
ATS & Telecommunications	ATC Consoles	ATC Consoles	Approach, Aerodrome/Ground, FD/Aux, Supervisor Control
	VCCS	VCCS	ATC A/G and Fixed Voice Communications
		Master Clock System	Distribute standard time for all ATS operations
		Voice Recorder (Recorder/Reproducer)	ATC Communication Recording
	Signaling Light	Light Gun	Emergency system
	Siren	Alarm Signal	Alarm for Runway Clearance
	AIR to GROUND	VHF TX.	Aerodrome/Ground and Emergency A/G Communications
		VHF RX.	Ditto
		TRCV Multi channels	Ditto for Back up (for each Frequency)
	*AMHS	Main and Buck up server	ATS Fixed Communications
		Terminal	Operational Terminals for ATN
	*AIS	Terminal	Operational Terminals for AIS
	* Point to Point	VSAT	ATS Communications
	HF Fixed Comm.	HF Transceiver	FSS
	AIR to GROUND	TRCV Multi channels	Fire truck for emergency
	AIR to GROUND	VHF receiver	Fire station for emergency
	Intercom.	Interphone	Maintenance internal Communications
Meteorological Observation System	Observation System	Transmission meter	RVR observation
		CEILOMETER	Ceiling Height Sensor
		ANNEMOMETER	WD/WS Sensor
		BAROMETER	Atmospheric Pressure Sensor
		THERMOMETER	Temperature Sensor
		HYGROMETER	Dew Point Sensor
		Weather Data Processing and Display System	Weather data logging, processing and weather data display

* Note: AMHS, AIS and VSAT System implementation is not included in the scope of work. This is planned to be executed by others under a separate contract.

2.4 The Contractor shall conduct a site survey for ANS prior to designing the antenna type, location and etc.

3.0 DESIGN STANDARDS

The equipment and materials to be supplied and installed under the Project shall be the products of ISO 9001 certified manufacturer or equivalent.

4.0 POWER SUPPLY

4.1 When an AC power supply is employed for the equipment it shall be 230V, 60Hz, single-phase or three-phase.

4.2 The required performance of the equipment shall be satisfied, even if the specified voltage changes ±10% and frequency changes ±5%. The equipment shall, however, function adequately even if the voltage changes ±15%

4.3 The equipment shall be provided with appropriate measures against transient current and surges caused by lightning.

5.0 SYSTEM DESIGN

5.1 System Drawings

Unless otherwise specified, the Contractor shall supply the following design drawings, as a minimum for each system, for the Engineer's approval:

(a) System block and level diagram, showing interference signal types, levels and impedances, equipment and component identification. Diagram shall include signal paths of terminal and control equipment, where applicable.

(b) System control diagram, showing in schematic form the method of system control, including switching and monitoring.

(c) Input-output characteristics for each item of equipment and transmission line, showing signal characteristics and limits and power requirements shall be provided by the Contractor. Data shall include all major intra-system and external system interfaces in detail, and shall be cross-keyed to system block and level diagram in (a) above.

5.2 System Interconnections

(1) The Contractor shall provide, as part of his system design, a complete design for the interconnection of system equipment.

(2) In designing the system interconnections, the Contractor shall be responsible, within the requirements set forth in the Drawings and the Specification, to select the wire and cable wiring methods, cable routing and method of support, location, type and use of cable terminal blocks and boxes and methods of wire and cable termination. In his design, the Contractor shall adhere to the locations specified on the Drawings for cable access into and between areas. If not specified, the Contractor shall indicate where these access openings shall be placed.

(3) The Contractor shall prepare, as a minimum and for the Engineer's approval, the following documents to define the System Interconnections.

(a) Layout drawings of each room or area, in sufficient detail to show cable routing, method of cable supports, location of access openings, cable terminal boxes and distribution frames shall be identified for cross reference to cable running lists.

(b) Cable running lists showing the type and serial number of each cable, cable routing (keyed to layout drawings) and terminal block identification.

(c) Terminal block connection lists, showing the cable number, pair, conductor and shield connections for each terminal block in the system.

(4) In case modification of the Civil Works or Building Works is required as a result of the coordination, the cost thereof shall be deemed to be included in the Contract Price. In order to avoid any damage to the finished Civil Works and Building Works, the coordination for the inter connection shall be completed during preparation of shop drawings, installation drawings and prior to the execution of the Civil Works and Building Works.

5.3 Load Computation

(1) The Contractor shall prepare and submit a revised single line diagram indicating the ratings such as capacity, etc. of every equipment and protective, metering or any ancillary devices based on the requirements of his proposed equipment. A detailed load computation shall accompany the diagram complete with brochures for each major item to be used.

(2) Engineer's approval is required prior to manufacturing and construction work.

6.0 EQUIPMENT DESIGN

6.1 Reliability

Equipment shall be designed for continuous operation with minimum down time. Redundancy of circuit, modules/unit shall be incorporated.

6.2 Interlock Requirements

(1) Bleeder resistors shall be placed across all capacitors or networks having voltages in excess of 250 volts unless the natural discharge time is less than five seconds. Barriers or guards may be used in lieu of interlocks for voltages not in excess of 500 volts, provided that the barrier carries a warning notice indicating the highest voltage exposed by removal of the barrier.

(2) Compartment interlocking is mandatory for voltages in excess of 500 volts. The interlock shall, upon opening the access door or cover, remove the hazardous voltage and mechanically ground the common high voltage bus. Compartment with voltages in excess of 500 volts shall be completely enclosed from the remainder of the assembly and separately interlocked.

6.3 Grounding Hooks

Grounding hooks shall be provided in all transmitting equipment where voltages are in excess of 500 volts. A grounding stud shall be provided for transmitting equipment where voltages are in excess of 250 volts to permit attachment of a portable grounding hook. The permanently attached hook shall be connected through a flexible stranded copper wire to the stud provided at the transmitter main frame. In all other transmitter where only the stud is provided, a hand-operable quick disconnect nut shall be provided to permit attachment of a portable grounding hook.

6.4 Hazardous Radiation

Where appropriate, cabinets and enclosures shall be designed to protect personnel from radiation hazards with all covers in place and equipment, operating, the RF radiation flux density shall not exceed 10 mW per square centimeter at a distance of 30 cm from the cabinet. X-ray radiation shall not exceed 2 millimeter roentgen per hour. If, with covers removed, values in excess of these are obtained, an appropriate warning notice must be attached to the equipment. If tuning or maintenance requires removal of the covers, the stated values shall be the limit under these conditions.

6.5 Provisions for Testing

(1) Extender cards or cords shall be provided for each plug-in type circuit card or equipment module to enable maintenance checks while in an operating condition.

(2) An AC outlet shall be provided at each equipment rack or console to be used for test equipment.

6.6 Painting

(1) The surface of the equipment cabinet shall be painted after rust-preventive treatment as required.

(2) The painting surfaces of iron plates shall be plated and treated with phosphate film for rust-prevention.

(3) The painting colors shall be approved by the Engineer during review of the shop drawings. The Contractor shall submit color sample to the Engineer for his approval.

(4) For parts that are designed not to absorb electric waves, specific paint shall be used to minimize absorption of electric waves.

(5) The MFP (moisture and fungus resistant paint) treatment shall be given, if particularly specified.

6.7 Equipment Identification

An identification plate shall be securely fastened to each complete equipment, and major component. The characters of Civil Aviation Authority of the Philippines, Philippines, item function description, manufacturer's classification, type number, serial number, year of manufacture and manufacturer's name shall appear on the plate. Other useful information may also be included.

6.8 Other Requirements

In case, tables or chairs are required for the appropriate installation or use of equipment, the furniture to meet the requirements shall be supplied. Samples or shop drawings thereof shall be submitted to the Engineer for his prior approval, and the cost thereof shall be deemed to be included in the Contract Price.

7.0 DOCUMENT AND DRAWING

The Contractor is required to provide the following documents and drawings in the course of the Contract.

7.1 Design Documents

(1) The Contractor shall submit three (3) sets of the design documents to the Engineer for approval within one hundred and twenty (120) days from the Commencement Date. The Engineer shall be advised if any change in design is found necessary after the original approval is granted.

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

(3) The design documents shall contain at least the following.

(a) System Diagrams

(i) System Block Diagrams
(ii) Power Distribution Diagram

(b) Equipment Shop Drawings

(i) Composition, Model No. and type
(ii) Technical specification including power supply and consumption, environmental conditions and weight.
(iii) Descriptions of functions of control and indication on the front panels including remote control and monitor.
(iv) Block diagrams showing constituent component and function
(v) Outline drawings of equipment and constituent component showing orthographic projections on three (3) sides and front panel detail.
(vi) Outline drawings of antenna and its characteristics including directivity pattern.
(vii) Color sample for cabinet and panels of equipment.

(c) Mock-up Presentation

Within fourteen (14) days after submission of shop drawings, the Contractor shall make presentation of VFR console to the Engineer by using mock-up consoles for confirmation of operational requirements.

(4) Within one hundred and twenty (120) days from the Commencement Date three (3) draft copies of installation drawings shall be submitted to the Engineer for his approval.

(5) Equipment Installation Drawings shall contain at least the following.
(a) Facility layout

(b) Equipment layout and elevation
(c) Antenna tower and counterpoise plan, elevation and foundation
(d) Design calculations of antenna tower and counterpoise support structure and foundation where so required in technical specifications for navigation system equipment.
(e) Cabling and wiring diagrams
(f) Cabling route, supporting fixtures and protection
(g) Power supply skeleton diagram, showing power consumption of equipment at each output terminal.
(h) Design calculations of main power cable.
(i) Required coordination with the Civil Works and Building Works.

(6) The Contractor shall submit to the Engineer two (2) sets of the revised and approved installation drawings in print copies within twenty-eight (28) days after the Contractor has received the final comments from the Engineer.

7.2 As-Built Drawings and Records

Refer to para 5.0 of **Section 1165** which apply equally herein

7.3 Other Documents

The Contractor shall assist the Employer in the preparation of necessary documents required by the NTC, International Telecommunication Commission for the frequency assignment of the radio equipment to be installed under the project and the issuance of NOTAM or publication in AIP with regard to the facilities to be installed under the Project.

8.0 OPERATION AND MAINTENANCE MANUALS

8.1 General

(1) The provisions of para. 16.0 of **Section 1165** are to be referred to in connection with 8000 series of this Specification.

(2) The following provisions are additional to, and are to be read in conjunction with, para. 16.0 of Section 1165, and are particular to 8000 series of this Specification.

8.2 Draft Manuals

(1) The Contractor shall submit to the Engineer two (2) sets of draft manuals, in English, of an appropriate size acceptable to the Engineer, at least twenty eight (28) days prior to the factory inspection of the related equipment and fifty six (56) days prior to the shipment for those items of equipment which do not require factory inspection. Such manuals shall contain sufficient details to enable the Employer to operate, service, maintain, dismantle, reassemble, adjust and replace the whole of the installations efficiently.

(2) The instruction details are to cover the entire works with all associated ancillary equipment as supplied under the Contract. It will be sufficient to incorporate manufacture's standard brochures as part of the text provided they refer particularly to the equipment supplied and are free of extraneous matter.

(3) The manuals shall include the following information, stipulating in detail the hardware and software components of the system for incorporation in the required tutorial manual.

(a) Purpose of the manuals and composition;

(b) List of all equipment items including manufacturers' names, model numbers, serial numbers, and locations in the pictorials;

(c) Technical characteristics of the equipment describing operation conditions and electrical performance;

(d) Operating instructions describing, in detail, the procedures and directions required to properly and safely operate equipment installed at the site;

(e) Theory and operation of each component describing with pertinent block diagram and/or circuit diagram;

(f) Installation and adjustment describing unpacking, mounting, wiring and method of adjustment of each component;

(g) Maintenance instructions describing, in detail, the procedures and test equipment and tools required to properly maintain the performance of the equipment, repair and operate the equipment installed at the sites, including preventive maintenance schedule and check sheet samples;

(h) Trouble-shooting symptoms list with chart and description of symptoms; aside from above list and chart, provide diagnostic procedures for trouble-shooting for each unit;

(i) Parts lists including manufacturers' names and addresses, telephone numbers, types, model numbers, serial numbers, and the names and catalogue numbers;

(j) Number of transistor, diode, IC, PCB, module and unit by type used in the equipment;

(k) Component layout, block diagrams, schematic diagrams and/or wiring diagrams;

(l) List of accessories, i.e. spare fuse, microphone, cable and other related items;

(m) Description of software and ROM listing in use in the equipment, if any;

8.3 Final Manuals

(1) Six (6) sets of the final manuals shall be submitted to the Engineer. Also, one (1) set of final manual in software media, either in CD or in DVD in latest MS format, shall be submitted to the Engineer.

(2) The final manuals shall be reproduced in a book form of approximately quarto-size bound into strong durable imitation leather covers. The binding should be permanent and any metals used should be rustless. Dye line printing or any other form of semi-permanent reproduction must not be used. If the complete text is unduly bulky, then the manual is to be appropriately subdivided, produced in multi-volume form. The

drawings and diagrams shall be reduced to a convenient size, bound into the volume and not merely inserted into cover pockets.

(3) The name of the prime manufacturer but not that of any sub-contractor may also be inscribed upon the cover after the description of the works. The name of the Employer followed by a brief description of the works is to be inscribed upon the spine of the cover and, if the instructions are contained in several books, they are to be marked with the appropriate volume number.

9.0 PERSONNEL TRAINING

9.1 General

(1) The provisions of **Section 1150** are applicable and are to be referred to in connection with 8000 series of the Specification.

(2) The following provisions are additional to, and are to be read in conjunction with Section 1150, and are particular to 8000 series of the Specification.

9.2 Phases of Training

(1) The Contractor shall conduct training for technical personnel who will operate and maintain the system equipment supplied under this Contract.

(2) The course of training shall be provided in phases as follows:

(a) Factory Training
(b) Local Training
(c) On the Job Training

(3) All training shall be conducted in the English language and be suitable for trainees with the appropriate level of education. A detailed programme for all trainings shall be submitted to the Engineer not later than fifty six (56) days before any training is started.

(4) The Contractor shall update, if deemed necessary by the Engineer, the detailed programme under the Contract not later than twenty eight (28) days before the date when the Contractor intends to start the programme.

(5) The Employer shall nominate candidates for the trainees of the training program who have been, or will be, assigned to the same facility and who have the ability to train maintenance personnel after completion of the factory training. The Contractor shall reserve the right to reject any candidate deemed unsuitable/unqualified and to request the Employer to nominate other candidates.

9.3 Factory Training

Factory training of the Employer's trainees shall be conducted at least covering the following minimum required schedule in the manufacturer's home country before shipment of equipment. The Contractor shall pay all expenses required for such training, such as international flights between Manila and manufacturer's country, local transportation fares, accommodation and subsistence allowance.

Equipment	No of Personnel	5-Day Week
ILS	4	4
D-VOR/DME	4	4
Console and VCCS	8	2
Weather Instrument	2	1

9.4 Local Training

(1) Local training shall be conducted by the Contractor covering the minimum required schedule shown below.

(2) Training facilities shall be provided by the Contractor.

(3) The maximum number of trainees for operation and maintenance shall be ten (10) in total for every equipment subject, as indicated in the schedule below.

(4) The test equipment to be supplied shall also be used for this training provided that the test equipment shall be restored to its original condition after the training.

(5) The Contractor shall include the cost of instruction for the trainees, together with training manuals and material to be used in the courses, in his unit rates or lump sum prices, unless identified separately in the Bills of Quantities.

(6) The minimum required schedule is

Equipment		Number of Days	
		Operation	Maintenance
(i)	ILS		5
(ii)	D-VOR/DME		5
(iii)	Console and VCCS	2	3
(iv)	Voice Recorder	1	2
(v)	VHF Equipment		2
(vi)	HF Equipment		1
(vii)	Weather Instrument		2
(viii)	System Inter Connection		2

9.5 On the Job Training (OJT)

(1) OJT shall be rendered by the Contractor, utilizing the manufacturers' engineers, to the Employer's trainees for the duration of installation and testing.

(2) The Contractor shall include the necessary cost for such OJT in his unit rates or lump sum prices, unless identified separately in the Bills of Quantities.

10.0 TESTS AND INSPECTIONS

10.1 General

(1) The provisions of **Section 1145** are applicable and are to be referred to in connection with 8000 series of this Specification.

(2) The following provisions are additional to, and are to be read in conjunction with, Section 1145, and are particular to 8000 series of this Specification.

10.2 Scope of Testing

(1) The Contractor shall perform all the test activities specified in this Section.

(2) The Contractor shall prepare and submit at least fifty six (56) days prior to any test to be carried out, two (2) sets of detailed test procedures and schedules to the Engineer for consideration and approval. Test procedures shall be comprehensive and shall demonstrate equipment hardware compliance with all the requirements of the Specification.

(3) The entire work to be executed by the Contractor is subject to inspection and test by the Engineer during manufacturing, installation and on completion at the Site, but the approval of the Engineer or the passing of any such inspection or test shall not, however, prejudice the right to reject the items of equipment if they do not comply with the Specification when installed.

(4) Test items are shown as follows:

(a) Tests at factory by the Contractor himself
(b) Witness tests at factory
(c) Preliminary tests at Site by the Contractor himself
(d) Acceptance tests
(e) Reliability test
(f) Flight test
(g) Other tests

(5) The Contractor shall carry out the tests according to each test item under approved test procedures.

10.3 Factory Test

(1) Factory tests shall be made by the Contractor on all equipment to demonstrate that equipment complies with applicable specifications and any additional tests called for by the Engineer to ensure that the equipment to be supplied meets the requirements of the Specification. The methods of testing not covered by any specification or applicable standards shall be agreed with the Engineer.

(2) In case factory test prior to shipment or any kind of test by third party inspector is required by the statutes of the manufacturing country, the cost thereof shall be deemed to be included in the Contractor's unit rates or lump sum prices.

(3) Approval or certification of the equipment by the Engineer, Employer's representative or by a third party inspector, if so required, shall not relieve the Contractor of any of his obligations under this Contract, should it be discovered thereafter that the Contractor failed to comply with his other obligations under this Contract, or that the equipment are not in accordance with the terms of the Specification.

(4) The results of factory tests shall be recorded for submission to the Engineer, copy furnished to the Employer, prior to the shipment of the equipment item.

(5) The following tests (continuous operation test, temperature and humidity tests) shall be included in the factory test and the test results shall satisfy the requirements of individual specifications.

(a) Continuous Operation Test

The continuous operation test shall be executed for all equipment under the conditions stipulated in Division B of the following table. If a different set of test conditions is necessary, it will be designated in individual specification.

Table 8050.2 Measuring Time for Continuous Operation Test

Division	Test Period	Unit: Hours Measuring time						
A	24	0	4	8	24			
B	48	0	4	8	24	48		
C	96	0	4	8	24	48	96	
D	120	0	4	8	24	48	96	120

The objective in the continuous operation test shall be the determination of the following:

(i) Major electrical performance
(ii) Operating current or voltage at each part
(iii) Checking the operation and functions of parts required for ordinary maintenance.
(iv) Temperature of parts prone to temperature-rise
(v) Other required items
(vi) Temperature / humidity corresponding to the continuous operation test time.
(vii) Measurement of insulation resistance and dielectric strength at completion of continuous operation test. The measurement shall satisfy values given in the following table:

Table 8050.3 Value of Insulation Resistance and Dielectric Strength

Circuit	Applied voltage	Insulation resistance	Dielectric strength
DC circuit	Lower than 100v	Higher than 10Mohms	DC 250v
	Higher than 100v but lower than 250v	Higher than 50Mohms	DC 500v
	Higher than 250 v but lower than 10kv	Higher than 100 Mohms	Twice the DC Working voltage
	Circuit exceeding 10kv	Higher than 500Mohms	Twice the DC Working voltage
AC circuit	Lower than 30v	Higher than 5Mohms	AC 250v
	Higher than 30v but lower than 115v	Higher than 10Mohms	AC 1,000v
	Higher than 115v lower than 250v	Higher than 50Mohms	AC 1,500v
	Higher than 250v but lower than 10kv	Higher than 100Mohms	Twice the AC Working voltage

Notes:

1) Execute the dielectric strength test by applying the voltage specified in the above table for 1 minute

2) Execute the dielectric strength test after detaching meters, semiconductors, electric capacitors and other such parts that are regarded as unsuitable for executing the dielectric strength test, with the Engineer's approval.
3) This test may be executed at an AC voltage corresponding to ½ of the DC voltage, if AC voltage is applicable to a DC circuit.
4) If the standards of the electrical parts differ from those specified in the above table, the above table shall not apply to these particular parts.

(b) Temperature/Humidity Test

The temperature/humidity test shall be executed for the selected equipment in the following manner,

(i) In case the number of the same kind of equipment is three (3) or less, the test shall be executed for all items of equipment.

(ii) In case the number of the same kind of equipment is more than three (3), the test shall be executed for the number of items of equipment obtained by calculating the square root of the total number of equipment, rounded to the integer, increased by one (1) for any fraction 0.5 or more.

Test conditions under Division F of the following table applies to this test. However, if test conditions under a division other than F is necessary, it will be specified in individual specifications.

Provided that, if the execution of this is remarkably difficult or the execution of this test is unsuitable for the performance of the equipment with good reason, this test may be omitted with the Engineer's approval.

Table 8050.4 Temperature and Humidity Range

Division	Minimum temp (^{o}C)	Maximum temp (^{o}C)	Humidity (%)
A	+ 5	+35	Up to 90
B	-10	+40	- do -
C	-20	+50	- do -
D	-30	+60	- do -
E	-40	+60	- do -
F	+10	+45	- do -

(7) The tests shall contain the information specified below:

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

(b) A record of any engineering changes necessary to correct design deficiencies.

(8) The suitability of diagnostics and technical manuals provided by the Contractor and their capability of off-line failure isolation and repair shall be proven by the Contractor.

(9) Should the equipment, materials or any portion thereof fail under test to give the required performance, further tests which are considered necessary by the Engineer shall be carried out by the Contractor and the whole cost of the repeated tests shall be

borne by the Contractor. This applies to tests carried out at Contractor's works as well as sub-contractor's works.

10.4 Tests and Inspection at Site

(1) The whole of the Works covered by this Contract is subject to inspection and test by the Engineer during installation and on completion at the Site, but such approval shall not, however, prejudice the right to reject the system if it does not comply with the Specification when installed, or to give complete satisfaction in service. The costs of all tests and inspection are to be borne by the Contractor.

(2) The Contractor shall accept participation of other Employer's personnel in all tests on site if so requested by the Employer for the purpose of on-the-job training. In this case, the Contractor shall assume full responsibilities for test results. The cost of inspection to be incurred by on-the-job trainees, if any, shall be borne by the Contractor.

(3) Should the system or any portion thereof fail under test 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 including all charges to be incurred by the Engineer and Employer's representative(s) for such test(s).

(4) If any item fails to comply with the requirements of the Specification in any respect whatsoever at any stage of manufacture, test, installation or on completion at Site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or repair as directed by the Engineer, the Contractor shall submit the item for further inspection and/or test. In the event the defect of any item is of such nature that the requirements of the Specification cannot be fulfilled by adjustment or repair, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer.

(5) Commissioning Tests comprise Acceptance Test, Reliability Test and Flight Test of each relevant system.

(6) The Contractor can use the test equipment supplied under the Project for this purpose.

10.5 Preliminary Test and Acceptance Test

(1) After completion of installation work, the Contractor shall conduct preliminary inspection and test of the system by himself in accordance with the approved test procedure in order to make sure that the quality of the installation work and the performance of the completed system comply with the specified requirements. The test items of the preliminary test and the acceptance test shall be the same. The preliminary test shall be witnessed by the Engineer and a representative from the Employer.

(2) The Contractor shall submit to the Engineer three (3) sets of preliminary test reports which shall comprise test data of system equipment, test equipment, spare parts and physical inspection of equipment installation. These reports shall include the following:

(a) Test Report for Equipment, Test Equipment and Spare Parts

(i) List of equipment composition including model number, quantity and relevant specifications
(ii) Mechanical check of equipment for appearance, structure, finish, marking and label
(iii) Electrical test, including test item, test procedures, specified value and method of measurement of electrical performance of equipment
(iv) Relevant test data sheets
(v) Meter reading sheets

(b) Test Report for Equipment Installation

(i) Physical inspection of equipment, antenna and cable installation
(ii) Electrical test procedure for ground resistance, insulation resistance
(iii) Relevant test data sheets

(c) Inventory Check List

In addition to the test reports mentioned above, list of system equipment, test equipment, tools, spare parts and consumable materials including item number, type/model and quantity shall be submitted. Final inventory check will be conducted separately based on the inventory check list by the Employer after successful completion of the reliability test or flight test, if so required, of the system.

(3) Application for acceptance tests of the system including test equipment and spare parts shall be made after it has been confirmed by the Contractor of its compliance with the Specification. No acceptance tests shall be commenced without prior approval of the Engineer of the schedule and procedure to be followed. At least ten (10) working day's notice of the Contractor's readiness to start each acceptance test shall be given to the Engineer. The Contractor shall conduct the acceptance tests which, however, shall be carried out under the direction of the Engineer.

(4) The test equipment to be supplied shall also be tested in accordance with the approved procedure, and all spare modules and units shall also be tested. The spare modules and units to be supplied shall be tested by temporary placement at the appropriate slot of the equipment and operation. The test equipment and spare parts tested shall be restored to their original condition for long storage after the acceptance test and placed at the designated location.

(5) If the system fails to pass the acceptance test, retest shall be scheduled only after the Contractor has proven satisfactory correction of the defect to the Engineer.

(6) If the system posses the acceptance test but minor deficiencies which do not affect performance of the facility have been found during physical inspection of the acceptance test, the Engineer shall issue written instruction to the Contractor to correct the physical deficiencies. The Contractor shall correct these physical deficiencies prior to the reliability test and confirm the correction of the minor deficiencies during the reliability test of the system mentioned hereunder.

10.6 Reliability Test

(1) The performance and the guaranteed data of the system equipment shown in the Contract Documents shall be proven by the Contractor in reliability tests after successful acceptance test in accordance with the Specification.

(2) The reliability tests shall be governed by the acceptance standards as set out in the Specification or as directed by the Engineer.

(3) The reliability tests shall be performed under normal operating conditions for at least fifteen (15) consecutive days immediately after successful completion of the acceptance test. The Contractor shall not be entitled to replace or readjust essential parts of the Works during the reliability tests.

(4) If, as a result of the reliability test, the Engineer decides that such equipment is defective, or not in accordance with the Contract, he shall notify the Contractor accordingly stating in writing his objections and reasons therefor. The Contractor shall immediately correct the defect or ensure that the system equipment complies with the Contract. Thereafter, if required by the Engineer, the tests shall be repeated under the same terms and conditions.

(5) Should the systems or any portion thereof fail under test 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.

(6) Even if the system complies with the requirements of the reliability test, the succeeding flight test be scheduled unless the physical deficiencies have been corrected to the satisfaction of the Engineer.

10.7 Flight Tests

(1) Within twenty eight (28) calendar days after the successful completion of reliability test, all Radio Navigation Aids shall undergo flight tests by the Employer. These tests shall conform to those set out in the ICAO Manual DOC-8071 (Manual on Testing of Radio Navigational Aids).

(2) The Employer shall provide the aircraft and personnel necessary for the flight tests, and shall notify the Contractor of the date of the commencement of the flight test within twenty eight (28) calendar days after successful completion of the reliability test.

(3) The contractor shall provide accommodation and transportation between Manila to site necessary for Employer’s personnel related to flight tests.

(3) During flight tests to be witnessed by the Engineer and Employer’s representative, the Contractor shall make available at the site his personnel for the purpose of assisting the Employer’s flight test crew, representative and the Engineer to carry out the flight test smoothly and satisfactorily.

(4) The Contractor at his own expense shall be responsible for and make good such defects as found during the flight tests.

(5) In the event of retesting by flight test as a result of any such defects, the Contractor shall make available at the site his personnel who witnessed the initial flight test. The cost of the repeated flight test shall be borne by the Contractor.

10.8 Tests on Completion

The Acceptance Tests, Reliability Tests and Flight Tests shall be considered as the Tests on Completion as defined and referred to in the Conditions of Contract. The Taking-Over

Certificate for the Works will not be issued until these tests are executed to the satisfaction of the Engineer.

10.9 Other Tests

The Contractor shall carry out any test other than specified herein above wherever so required by the Engineer. All tests shall be carried out in the presence of the Engineer and Employer's representative to their complete satisfaction.

10.10 Rejection

If any item fails to comply with the requirements specified in the Specification in any respect whatsoever at any stage of manufacture, test, erection or on final completion, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment, correction or repair 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 Specification cannot 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.

11.0 SHIPMENT AND DELIVERY TO SITE

11.1 The provisions of para 8.0 of **Section 1135** and Materials are to be referred to in connection with 8000 series of this Specification.

11.2 The following provisions are additional to, and to be read in conjunction with, para 8.0 of Section 1135 and are particular to 8000 series of this Specification.

11.3 The Contractor shall, when necessary and appropriate, crate or box the commodities for ocean shipment in such manner as to protect them from damage in transit, and shall be responsible for and make good any and all damages due to improper crating prior to shipment. All shipment shall be insured with a reputable insurance company acceptable to the Employer. Any material or article that might be lost shall be boxed or wired in bundles and plainly marked for identification.

11.4 The Contractor shall ship the goods consigned to the:

Department of Transportation and Communications
Columbia Tower
Ortigas Avenue
Mandaluyong City
Metro Manila
Republic of the Philippines

11.5 With each shipment, the Contractor shall furnish the Employer by air mail, with advance copies of shipping documents, invoices and other pertinent papers on which shall be shown, in addition to the usual date, a description of the articles furnished, the shipping weight of each item, name of the project for which the articles are intended, date of shipment, name of vessel on which shipped and the expected date of arrival in the Port of TAGBILALAN, Philippines.

11.6 Each shipment, when crated, shall have, in addition to the customary markings, the name of the Project to which the Goods are intended and identifying marks of the Goods.

11.7 Other packages in the presence of flammable and fragile stores, etc., shall in addition to the above, bear markings in accordance with the regulations of the shipping and insurance organization concerned.

11.8 The crated Goods shall be stored in a proper warehouse provided by the Contractor after being released from Customs until transshipment to the Site. Transshipment of the Goods to the Site can commence only after the Engineer has confirmed that the equipment buildings would be ready for equipment installation by the time of its arrival at the site. The crated Goods shall not be placed outside the buildings for more than two (2) weeks. The equipment, except installation material and engine generators, shall be stored in the air conditioned rooms as soon as unpacked from the crates.

12.0 EQUIPMENT INSTALLATION

12.1 Materials used for installation of the equipment shall be of the optimum quality.

12.2 Fixing and mounting of equipment shall be done in such a way that they will be sufficiently stable and rigid. Workmanship shall be such that finished works are presentable. All metallic components shall be effectively grounded.

12.3 The facility and equipment to be installed in the building or on the Site are shown on the Drawings for equipment supply and installation; however, the equipment layouts, as shown on the Drawings, are typical. The Contractor may propose revised and dimensioned drawings showing equipment layouts based on actual dimensions of the offered equipment. In designing layouts the following shall be fully detailed.

(a) Functional operation
(b) Efficient circulation of personnel
(c) Space for necessary circulation of personnel
(d) Easy access for maintenance including space to accommodate temporary test equipment
(e) Minimum physical interference between operating functions and between operation and maintenance.
(f) Allowance for expansion with minimum service interruption.

12.4 The equipment configuration and design proposed by the Contractor shall be checked against the size of doors, width of corridors and stairs, height of ceiling, location of cable rack hanger bolts, cable pit, duct, conduit and PVC pipe, location of lights, foundation bolts, engine bed, cable entrance, slot on the wall, openings, handholes and capacity of air-conditioning, etc. in the Drawings for Building Works and Civil Works and if modification is required, cost thereof shall be deemed to be included in the rates and lump sums that are entered in the Bills of Quantities for the equipment items.

12.5 In the replacement of the existing equipment and facilities with new ones under the Project, operation of the existing facilities shall not be interrupted in principle. In case the interruption of the operation is required, it shall be as short as possible. Any intended interruption of the operation shall be reported in advance to the Engineer for his approval.

12.6 In case the Contractor has to remove the existing equipment and facilities for installation of the new equipment under the Project, he shall submit in advance to the Engineer for his approval, a list of equipment to be removed, and the Contractor shall deposit equipment and materials in a place to be designated by the Engineer.

12.7 In case an existing equipment is to be relocated, the equipment shall be properly overhauled and reconditioned. The overhauled and reconditioned equipment shall also be under the guarantee of the Contractor for the Defect Notification Period.

13.0 INTERCONNECTING WIRING

13.1 General

Telephone type distribution frame as described below shall be used to terminate single and multipair indoor and outdoor cable and to provide accessible cross-connection points between the various equipments. Signal and control interconnections between equipment shall be accomplished by terminating the interfaced wiring at a suitable distributing frame terminal block and making all cross-connections between the terminals on the blocks. At least 20% additional capacity shall be built into the design of interconnections to allow for future expansion of the system. All cables installed in the building shall be continuous between the terminations at equipment, MDF, terminal board or power distribution board without splicing.

13.2 Audio-Frequency Circuits

All interconnecting wiring of audio-frequency (AF) communications circuits may be accomplished with single or multipair shielded cable. In the case of multipair cables, the shields shall be electrically insulated from each other. Each shielded drain wire shall be connected to its own terminal on the terminal block. Each shield shall be grounded at one and only one point. The connection of multipair cables to terminal blocks shall be in accordance with the colour coding of the cable manufacturer. Colour coding of cable conductors shall be uniform from cable to cable and shall differ only with regard to the number of cable pairs.

13.3 Control Wiring

All direct-current (DC) signal interconnecting wiring may be accomplished with multipair unshielded cables of types normally used in telephone practice. In instances where a minimum number of conductors is required, single pair shielded audio cable may be used. Out-going and return wires shall be preferably run together for each control circuit. However, the practices used shall be those which minimize undesirable cross talk between control circuits, and between control and voice or telegram communications.

13.4 RF Interconnection

Radio frequency interconnections between equipment shall meet the performance requirement stated in the facilities specifications. Coaxial cable of the types specified therein shall be used.

13.5 Power Wiring

Cable and wire for lighting and power systems shall not be installed in the same cable rack used for RF, voice, data, signalling and control cables.

13.6 Spacing and Cables

Special care shall be given in the planning of system interconnections, to provide adequate spacing between power wiring and cables carrying audio and low-level DC control signals, to minimize undesirable coupled interference. Likewise, adequate spacing should be provided between audio and control cables which differ greatly in signal level.

13.7 Distribution Frame

(1) MDF (Main Distribution Frame) which provides mounting for terminal blocks and line protectors shall be installed at the equipment room of Operation Building. Other cable termination shall be provided by Terminal Boxes.

(2) All cable terminal assemblies shall be completely enclosed in metal cabinets of the same quality, design and finish as electronic equipment cabinets.

(3) All terminals to be used for interconnecting outside cables shall be provided with line protectors capable of protecting from voltage surges, spikes, impulse or transients caused by lightning.

(4) Line protectors shall be of MOV type and ratings for particular type of termination shall be proposed by the Contractor.

13.8 Cable Terminal Boxes

(1) Cable terminal boxes shall consist of an approved type metal cabinet with a hinged and lockable door, and containing one or more cable terminal blocks, plus fanning strips and cable support hardware as required. Boxes shall be weatherproof if used in exterior locations.

(2) Cable terminal boxes shall be installed at all locations required by the Drawings and Specification, except that in rooms having console enclosures built into the wall, boxes may be located inside the enclosure. Cable terminal boxes may also be utilized at intermediate points in the cable routing to supplement the distribution frames.

13.9 Cable Support System

(1) A cable support system shall be provided to carry the cables which interconnect the various equipment. The system shall utilize cable rack, in principle, to provide a safe, permanent and economical installation of good appearance. Wire ways and conduit may be used where appropriate.

(2) At no time shall cables be left unsupported or unprotected. In case of cable installation along cable trench, cable rack shall be installed on the cable trench, and cable installed on the cable rack.

(3) Cable shall be fastened securely to transverse members of the cable rack.

(4) Where cable or cable rack passes through building interior wall, the cable hole or cable rack slot shall be covered by steel or plastic plate approved by the Engineer.

13.10 Cable Identification

(1) Each cable shall have identification tags permanently attached to it at each end, intermediate position preferably middle of cable rack and at eye level position of the cable rack in the EPS at every floor. It shall be made of non corrosive metal or plastic plates which is engraved or stamped, with identification number of cable, voltage and conductor size.

(2) Cable identification numbers shall comply with the cable schedule which shall be prepared by the Contractor according to cable as actually installed. Those cable schedules shall indicate the cable number, cable size, voltage, number of conductor,

conductor's size, termination and connection at each end and cable route. The cable schedules shall be placed inside hard transparent plastic cases and provided beside every MDF, terminal board and power distribution board concerned.

13.11 Demarcation of Common Items Provision

(1) Communication, power and control cables of the Air Navigation Works (ANS Works) as well as Building Works shall be installed between equipment, terminal boards, or power distribution boards along cable rack, duct, pit and conduit pipes handholes, etc. ANS Works consists of NAV, ATS and Meteorological Works.

(2) In order to assure smooth implementation of the installation work, proper coordination shall be made among different Works including Civil Works. Installation drawings, work drawings and relevant shop drawings shall be prepared after due coordination.

(3) The common items such as cable rack, duct and grounding system shall be installed under Electrical works. The demarcation of providing these items among different Works for smooth and efficient execution shall be as follows:

Items	To Be Done Under
Operation Building / Control Tower	
MDF	Electrical works
TB for ATS, NAV and Met EQ	ditto
PDB for ATS, NAV and Met EQ	ditto
Grounding system for equipment	ditto
Electronic ground conductor of grounding system for equipment (Between test box and all system equipment)	ditto
Handhole for system equipment	ditto
Power distribution board for lighting and power	ditto
TTB (Telephone Terminal Board)	ditto
Cable duct, conduits, sleeve	ditto
Cable Racks	ditto
Grounding system for transformer	ditto
Handhole for lighting and power	Civil works
Passenger Terminal Building	
Terminal board and PTB for FOBS office	Electrical works
Power distribution board for lighting and power	ditto

TTB (Telephone Terminal Board)	ditto
Cable duct, conduits, sleeve	ditto
Grounding system for transformer	ditto
Fire Station	
Terminal board and PDB at Fire Observation Room	ditto
Power distribution board for lighting and power	Electrical Works
TTB (Telephone Terminal Board)	ditto
Cable ducts, conduits, sleeve	ditto
Grounding system for transformer	ditto

13.12 Interface with the Other Work Equipment

In case system equipment is to be connected with equipment installed by other contract such as VSAT, AIS Terminal etc., the necessary interface, if any, with such existing equipment for satisfactory performance of the system shall be provided by the Contractor. The cost thereof shall be deemed to be included in the Contract Price.

14.0 GROUNDING SYSTEM FOR EQUIPMENT

14.1 The Contractor shall design and provide an electronic grounding system which shall meet the following requirements:

(a) Provide safety to personnel and equipment from power line faults, lightning and surges.

(b) Provide a common reference ground plane for electronic equipment which will minimize electronic system noise and electromagnetic interference (EMI).

14.2 The grounding system design shall be based on single-point grounding and the avoidance of group loops. However, the Contractor shall develop his own design and shall be responsible for meeting facility and equipment performance specifications. The Contractor's proposal shall be submitted to the Engineer for approval. The cost thereof shall be deemed to be included in the Contract Price.

14.3 The electronic ground conductor shall be PVC insulated stranded copper wire of 22 mm^2 or larger. One such conductor shall run from each equipment area or grouping of related electronic equipment and be terminated at the grounding test terminal box. Electronic ground conductors shall not be interconnected except at the common point.

14.4 Each cabinet and isolated item of electronic equipment shall be individually connected to the electronic ground conductor by the shortest possible route. The connecting jumper wire shall be 8 mm^2 or the size of the power feeder to the electronic equipment cabinet, whichever is larger. In addition, cabinets which are installed side-by-side shall be bonded together by copper wire jumpers, of 8 mm^2 or larger.

14.5 Care shall be taken to assure that ground loops are not created inadvertently.

14.6 The copper grounding plates and copper coated steel rods shall be installed underground to a depth of not less than 1.0 m. The grounding resistance of the system as a whole shall not exceed ten (10) ohms. However, in case less value of grounding resistance is required to assure performance of the equipment to be installed by the Contractor, the grounding system shall be so installed by the Contractor as to assure the performance of the required grounding as mentioned above. Cost thereof shall be deemed to be included in the Contract Price.

14.7 Grounding electrodes, wire and test terminal box for all new buildings shall be provided under the Building Works.

14.8 For the grounding system of the equipment to be installed in control tower and operation building, VOR building, LLZ building and GS building, the grounding electrodes, wire and test terminal box shall be installed under the ANS.

14.9 Concrete marker with appropriate notation approved by the Engineer shall be installed above every grounding electrode.

15.0 LIGHTNING PROTECTION SYSTEM

15.1 Lightning Protection for Building, Outdoor Structure and Sensor

(1) Lightning protection system composed of lightning rods, conductors and grounding system shall be provided for the antenna towers, masts, weather sensor poles, to be installed under the Contract. Separate grounding system shall be provided for lightning protection apart from the grounding systems aforementioned.

(2) The copper grounding plates and copper coated steel rods shall be installed underground to a depth of not less than 1.0 m. The grounding resistance of the system as a whole shall not exceed ten (10) ohms. Grounding wire for lightning arrestor shall be stranded copper wire of not less than 38 mm^2.

(3) Concrete marker with appropriate notation approved by the Engineer shall be installed above every grounding electrode.

(4) Grounding test terminal box shall be installed at an appropriate location suitable for testing in the buildings.

(5) All joint sections of antenna towers and masts shall be connected by bonding and jumper wires to reduce the contact resistance.

15.2 Lightning Protection for Outdoor Cable

(1) Bare stranded copper wires of 14 mm^2 shall be laid above cables and cable conduits for the entire length of outdoor cable routes in order to protect the cable from high surge current induced by lightning. Grounding electrodes shall be placed at least every 200 meters interval and the grounding resistance of the grounding electrode shall not exceed twenty (20) ohms and the grounding resistance of the grounding system as a whole shall not exceed ten (10) ohms.

(2) Surge protection devices for the equipment, such as lightning arrestors, varistors and zener diodes, shall be used to suppress voltage surges, spikes, impulse or transient as caused by lightning, electric utility switching and other source coming from the

grounds into the equipment and through outdoor control and communication cables connected to them.

(3) All power cable installed outside shall be connected with the power line inside building through lightning resistant isolation transformer.

(4) Grounding electrodes of the lightning protection system shall be separated from other grounding electrodes by not less than five (5) m.

16.0 ANTENNA SYSTEM

16.1 General

An antenna system referred to herein shall consist of the antenna, antenna support tower or mast, antenna grounding and lightning protection devices, guys, and anchors, antenna coupling, equipment room or building.

All support structures shall be capable of withstanding the conditions specified in para 4.0 "Environmental Conditions" of Section 1140 of this Specification.

16.2 Electrical Design

The electrical performance requirements of individual components of the antenna systems are covered by equipment specifications for the specific location and function involved. The Contractor shall, in addition, assure that these components are electrically connected at the various interface points and that the combination is efficient and reliable for the intended service.

16.3 Towers and Guys

(1) All structural steel components of antenna tower and guy cables shall be hot dip galvanized bridge strand, alumoweld or equivalent, prestressed by the manufacturer.

(2) Towers and guys shall be designed to withstand simultaneously the loads from wind pressure, cable dynamic forces and structural dead weight plus supplementary loading from antennas, curtains, screen, ladders, transmission lines and other required attachments. The loads must be sustained independently, that is, the towers must support any combination of adjacent antennas in the raised or lowered position (lowered position occurs during erection).

(3) Marking and lighting shall be in accordance with the ICAO "Obstruction Marking and Lighting" regulations.

(4) Guy cables shall be fabricated as a single assembly ready for installation. Each guy shall be provided with insulators and broken into segments of appropriate lengths where required to assure proper electrical performance of the antenna.

16.4 Foundations

(1) Foundations for antenna support tower and guy anchors shall be designed to accommodate the specific load requirements of the towers with which they will be used. In this regard it is expected that separate designs shall be required not only for each tower, but for different guys on the same tower.

(2) The Contractor shall submit to the Engineer a design drawing or drawings containing details of the design of each guy anchor which is required and certified to be in accordance with loading requirements.

(3) The weight of all materials in the foundation, including earth, shall be considered so that resistance to uplift shall provide a minimum safety factor of "2".

16.5 Antenna Mechanical Design

(1) All antennas shall be designed to withstand the environmental conditions specified in para 4.0 "Environmental Conditions" of **Section 1140** of this Specification. The minimum life expectancy of the antenna system shall be 15 years, based upon a maintenance program as follows:

(a) Visual inspection and antenna guy check and adjustment if required, every 3 months.

(b) Annual inspection of paint and general cleanliness and corrective measures as required.

(2) Attention shall be given in the design to protection against deterioration of insulators and other parts by corrosion from blowing sand, saline wind and by build-up of pulverized sand on insulating parts.

(3) The weight of the antenna shall be completely self supporting and shall connect to coaxial lines without external matching transformer. The antenna shall have an inherent low resistance path to ground for static discharge and lightning protection.

(4) Antennas shall be supplied complete with all mounting and support hardware for mounting on towers or buildings as required.

16.6 Suspended Wire Antennas

(1) The antenna feed line and radiator assembly shall be prefabricated by the Contractor as a single assembly ready for installation.

(2) All materials used in fabricating the radiation and feed line assembly shall be carefully selected to be mutually compatible and must provide a structure free from the deleterious effects of galvanic action and corrosion. The radiators with end fittings must be capable of retaining the design loads with a minimum safety factor of 2 and the Contractor shall perform pull tests to demonstrate the mechanical adequacy of radiators and end fittings.

(3) The antenna radiator assembly shall be supported from its outer ends by a suitable dielectric support member.

(4) Dielectric material used for feed line spacers in the radiators and feed line assembly shall be impervious to the effects of arcing or corona, and shall not deteriorate either mechanically or electrically after long exposure to ultra-violet light. The material shall have a low electrical loss in the frequency bands in the equipment specifications. The ultimate load strength for the catenary members shall be adequate for the design loads with a minimum safety factor of 2. The contractor shall conduct tensile tests to demonstrate compliance with the above.

(5) The catenary shall be constructed of dielectric rope or fiberglass rod of suitable electrical and mechanical characteristics. If fiberglass rods are used, the antenna shall include a structural fuse to provide protection in the event that the environmental loading exceeds those specified. The Contractor shall supply baluns, impedance transformers or multi-couplers where required to provide input impedance level and other electrical characteristics as specified in the equipment specifications. The transformer container shall be finished with polyurethane paint, in suitable colour, to assure adequate radiative heat transfer with minimum absorption of solar energy. Drawings of the antennas, in sufficient detail to show the overall dimensions, materials, and general configuration of the major elements of the antennas, are to be submitted for approval of the Engineer.

16.7 Coaxial Lines

(1) Coaxial lines supplied by the Contractor shall meet the performance requirements of the facilities specifications.

(2) Connectors from coaxial lines to antenna or antenna coupling units shall be weatherproof types. Coaxial lines to antennas mounted on buildings shall be enclosed in conduit or ducts for mechanical protection in the run between equipment and antenna.

(3) Transmission lines shall be continuous and without splices from building termination to antenna, unless otherwise directed by the Engineer.

16.8 Antenna Ground Systems

(1) The specifications herein cover the requirements for antenna ground systems in locations not otherwise specified.

(2) The system shall provide field grounding facilities for one isolated antenna or an entire field, as may be required. In either case, the ground system for antennas shall be interconnected with and bonded to the station ground.

(3) The portions of the antenna system which shall be grounded include antenna support towers, metallic poles, antenna coupling units and baluns, coaxial transmission line sheaths, antennas which have inherent d-c connections which can be grounded, and guys for antenna support towers or poles. In addition to the above, metallic fences and other metallic structures in the area of the antenna system shall be grounded.

(4) The ground system shall include, as a minimum, the following elements:

(a) Copper wire, bare, stranded, not less than 38 mm^2, for grounding conductors and the buried ground system.

(b) Copper wire, bare, stranded, not less than 14 mm^2, for grounding jumpers and miscellaneous bonding.

(c) Pressure clamps and bolts, cast bronze, for ground system interconnection.

(d) Lightning arrestors or horn gaps for antenna interface with coaxial line coupling units or baluns.

(e) Static drain resistors or chokes for antenna and guy insulators.

(5) The Contractor shall submit his proposal in detail for the proposed Antenna Ground System and the cost of the work is deemed to be included in the Contract Price, where not measured separately.

(6) The total resistance of the antenna ground system to true earth shall be measured before connection of the system to station ground at the common point near the electronic equipment building. The value of this resistance shall not exceed ten (10) ohms, when measured by an a-c fall of potential principle and the three-terminal test method. The Contractor shall extend or modify the ground system as necessary to secure this value of resistance.

16.9 Coordinates and altitude of antenna

The coordinates and altitude from GPS satellite datum (WGS 84) of the antenna of the radio facilities listed below shall be obtained by the Contractor as soon as actual location of the antenna has been determined. The coordinates and altitude of the antenna top in the Philippines Reference System 1992 (PRS92) shall also be obtained. The coordinates in PRS92 shall be shown in 1/50,000 scale topographic map issued by the NAMRIA. The geodetic survey shall be conducted by qualified surveyor and the data shall be submitted to the Engineer at least three (3) months before scheduled commissioning of the systems.

Systems	Location
VHF Communication	Center of Tx and Rx antenna pole / Operation Building roof top
HF Communication	Center of HF antenna
VOR/DME	Center of VOR antenna
ILS LLZ	Center of LLZ antenna
GS	Center of GS Middle antenna
T-DME	Center of T-DME antenna

17.0 OBSTRUCTION LIGHTING AND MARKING

17.1 Obstruction Lighting

(1) Obstruction lights with daylight switch, accessories, and necessary wiring shall be provided and mounted on the weather sensor pole, LLZ antenna, GS antenna VOR/DME antenna to be installed under the Contract. Other obstruction lights shall also be provided and connected where required in the Specification and/or Drawings.

(2) The Contractor shall supply omni-directional, low intensity obstruction lights having red light distribution of an intensity of not less than 25 candelas (red) over a beam width of 10^{o} in the vertical plane. The maximum beam intensity shall be not less than 40 candelas (red) and shall occur at approximately 7.5^{o} above the horizontal.

(3) The obstruction light shall consist of 230V AC 100W incandescent lamp, steel sheet housing, glass filter or aviation red and high quality one-piece pressed heat-resistant glass.

17.2 Obstruction Marking

Obstruction markings shall be done according to the ICAO provisions for the antenna towers, weather sensor poles, LLZ antenna, GS antenna, T-DME antenna and VOR/DME antenna to be installed under the Contract. The markings shall also be done for the other objects if so

required in the Specification and/or Drawings. Colour to be used for the marking shall be Munsell N9.5 and Munsell 2.5 YR 6/13.

17.3 VOR Aerodrome Check-Point Sign

VOR aerodrome check point marking and sign shall be made according to Chapter 5.4.4 of Annex 14 of ICAO. The marking and sign shall be made at the location specified by the Engineer.

18.0 OUTDOOR CABLE INSTALLATION

18.1 Cables

(1) Communication cables to be laid outdoor shall be, unless otherwise specified, 0.9 mm color coded polyethylene insulated polyvinyl-chloride sheathed cable (e.g. CPEV cable), and number of pairs shall include spare pairs of whichever is greater of 5 pairs or 20% of actually required pairs. The ends of these spare pairs shall also be terminated at the terminal block. Cable shall be manufactured in accordance with JIS or equivalent standards.

(2) All power cables, except where otherwise specified, shall be Cross-linked Polyethylene Insulated Polyvinyl-Chloride Sheathed power cables (e.g. CV Cable) or equivalent.

(3) All control cables, except where otherwise specified, shall be Polyvinyl-Chloride Insulated, Polyvinyl-Chloride Sheathed control cables (e.g. CVV Cable) or equivalent.

(4) Cable shall be manufactured in accordance with IEC or equivalent standards.

18.2 Galvanized Steel Pipe for Cable Conduit

Galvanized steel piping with anti corrosive covering shall be installed under paved areas and its physical characteristics shall comply with IEC or equivalent standard.

18.3 PVC Pipe for Cable Conduit

PVC conduit hall be installed under unpaved areas and its physical characteristics shall comply nominal diameter 100 mm with IEC or equivalent standard.

18.4 Vinyl Sheets

(1) Vinyl sheet specified hereunder shall be installed above all outdoor cables for their entire length.

(2) Vinyl sheets to be buried along cable trench shall satisfy the following requirements and shall be buried about 30 cm over all underground cables or conduits.

- Material : Polyethylene
- Thickness : More than 0.15 mm
- Width : More than 150 mm
- Strength for Stretching : More than 1.0 kgf/mm^2
- Increase Rate : More than 300%
- Strength for Tearing Up : More than 4 kgf/mm

- Color : Orange
- Markings : "DANGER: CAUTION, HIGH VOLTAGE AND COMMUNICATION CABLE OWNED BY ATO LAID UNDER THIS SHEET" (in Black or blue color)

18.5 Underground Cable

(1) Outdoor cable shall be, in principle, installed underground through galvanized steel pipe or of PVC conduit. The depth from the top of the conduit pipe and to finished grade shall be as follows:

(a) In case of road crossing or runway crossing, the depth shall be 1.2 m and galvanized steel pipe shall be used.

(b) In case of underneath the paved parking area, the depth shall be 800 mm and galvanized steel pipe shall be used.

(c) The depth shall be 600 mm and PVC pipe shall be used at all other places.

(2) The cable conduits shall be sealed properly at both ends for protection of cables against rodents and inner edge at both ends of each pipe shall be chamfered to avoid damage to cable during the installation.

(3) No cable shall be installed until the inside of conduit pipes have been cleaned and after satisfactory mandrel test.

(4) Sum of cross-sectional area of cables installed in a conduit pipe shall be less than forty percent (40%) of inner cross-sectional area of the conduit pipe.

(5) Cable for power and lighting shall be in separate conduit from any communication and signal cables.

(6) A concrete marker with appropriate size and notation approved by the Engineer shall be installed above the underground cable conduit at the middle of handholes. Where the distance between the handholes is less than fifty (50) m, installation of the marker may be omitted.

(7) Where a spare conduit pipe is installed along a new cable conduit, a pulling rope or wire shall be placed in the spare conduit pipe between handholes or manholes. The end of the pulling rope or wire inside the handhole or manhole shall be at least one (1) meter long.

18.6 Access Basin and Handhole

(1) Access basin for outdoor cables located adjacent to a new building shall be constructed under the Building Works. However, the number and position of sleeves for all conduit pipes required under the Project at each access basin shall be determined and provided under this Section of the Works.

(2) Handholes shall be installed along underground cable conduit at an interval of not more than 150 m and at every corner of cable conduit route so that installation of cable inside the cable conduit can be executed without difficulties.

(3) Cable shall not be spliced, except where underground cable conduit is longer than normally obtainable on a single roll. In case cable splicing along underground cable conduit is required, it shall be made inside a handhole.

(4) In case splicing of cable requires a larger size than the standard handhole, a larger handhole shall be provided by the Contractor. The cost thereof shall be deemed to be included in the Contract Price.

(5) End of the conduit pipe inside handhole and access basin shall be provided with bell mouthed PVC sleeve so that cable will not be damaged during the installation.

(6) Each cable inside every handhole shall have identification tags permanently attached to it.

(7) Handhole cover shall be water tight type with neoprene packing with relief mark of POWER.COM. The cover to be installed in runway strip or outside of runway strip shall have 25 ton bearing strength, it permanently attached to the handhole by galvanized chain.

(8) The cover bearing strength shall be spheroid graphite iron casting (IEC or equivalent standard). The cover frames bearing strength shall be the same gray iron casting. The handhole cover and frame shall be painted with synthetic resin paint.

(9) Handhole with 25 ton bearing strength cover shall be of reinforced concrete.

(10) The Contractor shall furnish and install cable supports and accessories required to make neat cable installation inside access basin and handhole. Appropriate measures shall be taken against the adverse effect of inductive reactance due to mixed installation of cables for power, lighting and communications inside the same access basin or handhole, if any.

18.7 Cable Entrance

(1) Cable entrance of a new building will be provided under the Building Works. However, the required number of penetrating pipes, size and location thereof including for other Works shall be determined under this Section of the Works. In case modification from the Drawings is required, the cost thereof shall be deemed to be included in the Contract Price.

(2) Where cable passes through a building exterior wall and ground floor, cable holes shall be completely filled properly.

(3) In the case of openings through which fire may spread from one floor to the other, such holes through floor or walls for the pipe and cables shall be sealed with fire resistant materials.

19.0 GALVANIZED WORK

19.1 All metallic structures and accessories to be installed outdoor such as antenna tower, counterpoise, cable rack, guy wire and their accessories, etc. shall be galvanized at the factory before their installation at site.

19.2 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, oil, rust and adherent matter shall be completed before the galvanizing process is commenced.

19.3 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.

19.4 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 gm. per sq. meter of area covered.

19.5 Galvanized wire shall comply with JIS G 8641 or equivalent authorized standard of the country of 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.

19.6 All galvanized parts shall be protected from injury to the 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.

20.0 CLEANING AND PAINTING

20.1 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 correct solvent and polished bright where required.

20.2 All metal works, which are normally painted after manufacture, except where finish painted, galvanized or polished in the factory, shall be well brushed down and given one coat of paint before shipment.

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

20.4 Before erection at the Site, all exposed steelwork including bare pipe surface and handrails, 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 colors approved by the Engineer.

20.5 For hot surfaces such as exhaust pipes, etc., silicone based paints shall be used.

20.6 Surface of all panels which shall be given one epoxy prime coat before assembling and two finish coats at factory.

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

21.0 OTHER REQUIREMENTS

21.1 Locks

(1) Three keys shall be supplied for each lock called for under this Specification. Locks and keys for all equipment under a particular group to be designated by the Engineer shall be interchangeable.

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

(3) A rack or cabinet of approved design shall be supplied for the accommodation of padlocks and/or keys supplied under this Contract while they are not in use. The padlocks and keys shall be engraved with a suitable identifying code or inscription and this shall be repeated on the racks or cabinets on engraved labels attached thereto.

22.0 CIVIL WORKS AND BUILDING WORKS

(1) All civil works necessary in the installation of facilities and equipment, and involving any material, labor, method of construction, Plant, construction equipment, tools, devices and the like, shall be furnished and performed completely, in accordance with the requirements of the Specifications for Civil Works (2000 Series) and Building Works (4000, 5000 and 6000 series).

(2) In order to protect cables from bush fire and being entwined by vines, the base of the following equipment shall be concrete paved for 2 m diameter around and 100 mm thick.

HF antenna tower
Weather sensor mast
VOR monitor antenna
ILS antenna

23.0 TEST EQUIPMENT

(1) Test equipment required for day to day observations and measurements on the equipment shall be provided on an adequate scale, but not necessarily limited to those items specified in Table 8050.5. The test equipment as recommended by the manufacturer, if other than those items included in Table 8050.5 shall be proposed by the Contractor and is deemed to be included in the Contract Price.

(2) Test equipment supplied under the Contract shall not be used by the Contractor for installation purposes. The test equipment can be used for preliminary test and commissioning tests of equipment so that the value of the test data of the commissioning test can be referred in the future when CAAP use the test equipment for maintenance.

(3) Test equipment shall be provided with all necessary accessories for measuring and with adequate supply of spares.

Table 8050.5 TEST EQUIPMENT (1/2)

Item No.	Test Equipment and Accessory	Model	Qty	Remarks
1.	Audio analyzer	8903B	1 set	Agilent Technologies
	1) Main Accessory			
	- CCITT weighing filter	Opt-011	1 set	
	- CCIR weighing filter	Opt-052	1 set	
	- C-message weighing filter	Opt-053	1 set	
	- "A" weighing filter	Opt-015	1 set	
	- Combined front/rack flange kit	Opt-909	1 set	
2.	Spectrum analyzer	E4407B	1 set	Agilent Technologies
	1) Main Accessory			
	- FM demodulation / deviation	Opt-BAA	1 set	
	- Soft Carrying / operating vase	Opt-AYT	1 set	
	- RS 232 & Parallel Printing Interface	Opt-1AX	1 set	
3.	Universal counter	53131A	1 set	Agilent Technologies
	1) Main Accessory			
	- High stability time base	Opt-010	1 set	
	- 3 GHz channel with BNC connector	Opt-030	1 set	
4.	Oscilloscope	DSO6014A	2 sets	Agilent Technologies
	1) Main Accessory per set			
	- Fine – pitch probe kit	10072A	1 set	
	- IC clip accessory kit	10075A	1 set	
6.	RF signal generator	ESG-D2000A	2 sets	Agilent Technologies
	1) Main Accessory per set			
	- High stability time base	Opt-1E5	1 set	
7.	Digital multi-meter	34401A	2 sets	Agilent Technologies
	1) Main Accessory per set			
	- Deluxe test lead set	34132A	1 set	
	- DC coupled current probe	34134A	1 set	
	- High voltage probe	34136A	1 set	
	- Bench link meter software	34812A	1 set	
8.	Radio communication test set	2955B	1 set	Marconi
	1) Main Accessory			
	- Sensitive receiver	Opt-001	1 set	
9.	Handheld multi-meter		1 set	Yokogawa
	1) Main Accessory per set			
	- Clamp-on current probe	96001	1 set	
	- Carrying case	93003	1 each	
	- Surface type thermal probe	751104	1 each	
	- Clip test adapter	B9646HF	1 set	
10.	Through line power meter (VHF/UHF)	TLP-801A-04	1 set	Fujisoku Corporation
11.	Through line power meter (VHF/UHF)	TLP-801A-22	1 set	Fujisoku Corporation
12.	Through line power meter (HF)	TLP-53W-52	1 set	Fujisoku Corporation
13.	Termination power meter (LF/HF)	TP-5J3C	1 set	Fujisoku Corporation
14.	Dummy load	DL-5300	1 set	Fujisoku Corporation
15.	Test mobile cart	1183A	4 sets	Agilent Technologies
16.	Cables and adapters		1 lot	Agilent Technologies
	(Required for maintenance)			

(4) Test equipment except for the stationary type shall be easy to transport. If the weight of the test equipment is such that it cannot be conveniently carried around, suitable mobile cart shall be supplied.

(5) All test equipment to be used on AC circuits shall be suitable for single-phase two wires, 230V, 60 Hz circuits with provision of ground pole and be capable of satisfactory operation within voltage variation of plus or minus 10%.

(6) Test equipment shall be provided with calibration data sheet of the test equipment.

(7) Local training of completed facility shall cover training for all test equipment which will be supplied to the facility site. The test equipment to be supplied under the Project shall be used for this purpose.

24.0 TOOLS AND APPLIANCES

24.1 The provisions of para. 17.0 of **Section 1165** are applicable and are to be referred to in connection with 8000 series of this Specification.

24.2 The following provisions are additional to, and are to be read in conjunction with para. 17.0 of Section 1165, and are particular to 8000 series of this Specification.

(1) The tools and appliances shall be supplied in the required number to the EQ room, LLZ, GS/T-DME and VOR/DME sites.

(2) A comprehensive list of tools as recommended by the manufacturer shall be included in the scope of Works, and is deemed to be included in the Contract Price.

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

(4) The smaller items of tools and appliances shall be suitably arranged in fitted boxes.

(5) The tools and appliances supplied under this Contract shall not be used for installation purposes.

(6) The tools and appliances with appropriate boxes shall be handed over to the Engineer before turn-over of the facility.

25.0 SPARE PARTS, ETC.

25.1 The provisions of Section 1165 are applicable and are to be referred to in connection with 8000 series of this Specification.

25.2 The following provisions are additional to, and are to be read in conjunction with Section 1165, and are particular to 8000 series of this Specification.

(1) The Contractor shall supply spare parts including spare modules, units and expendable items sufficient for two (2) years normal operation of equipment.

(2) The spare parts shall be supplied before issuance of the Taking-Over Certificate.

(3) These spare parts modules and units shall be tested at the relevant system equipment installed under the Project during the acceptance test of the system equipment, then properly treated and packed again for long time storage under the climatic conditions prevailing at the Site.

(4) These spare parts including expendable items shall not be used for the correction of any defect of the system equipment during Defects Notification Period. In exceptional cases the Employer may permit such usage but the Contractor shall immediately replenish any stock used.

(5) The Contractor shall be responsible for the spare parts list as recommended by the manufacturers. This list shall be prepared by the Contractor and submitted to the Engineer within one hundred and twenty (120) days from the Commencement Date. Thus, during the two (2) years period after issuance of the Performance Certificate, should any defect occur which would require replacement of parts other than the spare parts recommended by the manufacturer, the Contractor shall supply as soon as possible the needed spare parts at his own expense.

(6) Twenty (20) sets of the fuses to be used in the equipment, and the surge protection devices required to be installed for the termination of outdoor communication and control cable against high surge current for each kind, size and rating, shall be supplied as spares. These spares shall be included in the spare parts list for two (2) years normal operation.

(7) Each spare part shall be clearly marked or labeled on the outside of its packing with its description and purpose and, when more than one spare part 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 a detailed list enclosed. Also, containers and other packages shall be suitably marked and numbered for purposes of identification.

(8) All such cases, containers, cable drums or other packages are likely to be opened for such examination as the Engineer may reasonably decide, All such opening and subsequent re-packing shall be at the expense of the Contractor.

(9) The Contractor shall assure readiness to deliver any spare parts for the equipment supplied, for at least ten (10) years after the issuance of the Performance Certificate.

26.0 WORKBENCH AND STORAGE CABINET

Workbenches, chairs and storage cabinets for EQ Room, LLZ, GS/T-DME and VOR/DME sites shall be provided. Catalogues and detailed description of these items must be submitted to the Engineer for approval.

27.0 MEASUREMENT AND RATES

27.1 The rates and lump sums shall be full compensation for all plant, materials, labour, equipment, transport, temporary works, establishment charges, overheads, profits and taxes required to complete the work contained in this Section of the Specification and/or shown on the Drawings.

27.2 The rates shall further include for:

(a) Contractor’s design, training, spare parts, test and commissioning

(b) Measuring equipment, tools and appliances

SECTION 8100

ILS (INSTRUMENT LANDING SYSTEM)

1.0 GENERAL

1.1 Scope of Work

The work of this Section is to supply, install, adjust and set into operation the Instrument Landing System (ILS) required for Runway 21 approach operated Category I, generally described as follows:

(1) LLZ (Localizer)

(a) One (1) set of dual 2-frequency type LLZ shall be installed at for RWY 21 approach (near RWY 03 THR);

(b) LLZ antenna shall be located on the extended RWY center line;

(c) LLZ Building shall be located out of LLZ CRITICAL AREA;

(d) The power for LLZ equipment shall be supplied from the Electric Room of LLZ Building by AC 230V 1 Phase;

(e) Cable rack shall be laid in LLZ EQ Room;

(f) Control cables shall be laid from LLZ Building to Operation Building EQ Room.

(2) GS (Glide Slope)

(a) One (1) set of dual 2-frequency type GS shall be installed for RWY-21 approach at the west side of the RWY;

(b) GS antenna shall be located 120m from the RWY centre line. Distance from RWY THR shall be proposed by the Contractor in accordance with the final terrain conditions;

(c) GS Building shall be located behind the GS antenna;

(d) The power for GS/T-DME equipment shall be supplied from the Electric Room of GS Building by AC 230V 1 Phase;

(e) Cable rack shall be laid in GS EQ Room;

(f) Control cables shall be laid from GS Building to Operation Building EQ Room.

(3) T-DME (Terminal-Distance Measuring Equipment)

(a) One (1) set of dual T-DME shall be installed in the GS site.

(b) T-DME antenna shall be located on or at the side of the GS antenna.
(c) T-DME equipment shall be installed in the GS Building.

(4) Remote Control and Monitoring Equipment

(a) The remote control and monitoring equipment shall be installed in the Operation Building EQ Room.

(b) Navaids monitoring display units shall be mounted on FD/Aux Control Console in VFR Room.

(5) Supply of Equipment

LLZ Ground Calibration Equipment shall be supplied.

1.2 Design Conditions

(1) The ILS equipment shall meet the standards and recommendations of the ICAO Annex 10 related to the ILS facility performance Category-I.

(2) The central equipment shall be solid state, duplicated, equipped with automatic and manual normal/standby switchover and operating from the D.C. power supply unit.

(3) The operational frequency shall be allocated and noticed before manufacturing.

(4) The main power source is supplied with low voltage (one phase 2 wires, 230 volts, 60 Hz) from electric room.

(5) The parts (i.e. component units of the equipment) shall be manually compatible / interchangeable as much as possible and integrated to provide functions and operations as intended.

(6) Ground Check Point Marker for LLZ shall be installed.

1.3 Equipment

The Contractor shall supply the following equipment:

(a) Localizer, Glide Slope and T-DME equipment

- System of transmitting and monitoring antennas with masts or bases, and the marking and lighting for denoting obstacles
- Dual transmitting system (one is normal operation, other standby)
- Dual monitoring system
- Control and normal/standby switchover unit
- Remote control and monitoring unit
- Non-break D.C. power supply unit
- Equipment buildings fully equipped (air-conditioning, lighting, distribution switchboard, terminal board, etc.)
- PDB (Power Distribution Board) and TB (Terminal Board)
- Cable racks and duct
- Power cable from Power House to each site Building
- Communication cables from Control Tower & Operation building to each site Building
- Distribution of cables including connections
- Antenna feeder cables
- Lightning protection system

(b) Remote Control and Monitoring System

- Remote control and monitoring unit
- Navaids monitoring display unit
- Distribution cables including connections.

(c) Ground Calibration Equipment

- Standard antenna set
- ILS Monitor equipment and accessories

1.4 Approval Requirement

(1) Each submission for approval of items listed under this Section shall be accompanied by specific information.

(2) The Contractor shall state in detail how he intends to carry out installation of the ILS.

(3) Calculations and details for coverage and field strength of the ILS system shall be proposed.

(4) The type and radiation pattern of the antenna system of the ILS shall be proposed by the Contractor.

2.0 LOCALIZER EQUIPMENT

2.1 General Specifications

(1) The operational radio frequency will be allocated in LLZ Frequency Band 108 to 111.975MHz.

(2) The system shall be 2-frequency type.

(3) Identification

The Localizer equipment shall transmit the identification signal according to the recommendations of ICAO Annex 10 Volume I (Para 3.1.3.9).

(4) Course structure

Bend in the course line shall not have amplitudes which exceed the recommendations of ICAO Annex 10 Volume I (Para 3.1.3.4).

(5) Coverage

(a) The Localizer coverage sector shall extend from the center of the localizer antenna system to distances of:

- 46.3 km (25 NM) within plus or minus 10 degrees from the front course line

- 31.5 km (17 NM) between 10 degrees and 35 degrees from the front course line

(b) The total coverage is not required. The signals shall be receivable, to distances specified, up to a surface extending outward from the localizer antenna and inclined at 7 degrees above the horizontal.

(6) Monitoring system

(a) The Localizer operating shall be monitored by integral and field detectors.

(b) In case of deviations, quoted in ICAO Annex 10 Volume I (Para 3.1.3.11), a general alarm shall be generated when both monitors indicate the same deviation.

(c) The alarm shall cause the automatic switchover (or shut down if the standby transmitter is out of order).

(d) The total period of radiation of erroneous signal including the period of switchover shall not exceed 10 (ten) seconds.

(7) BITE

The Localizer equipment shall be equipped with Built-In Test Equipment (BITE) to minimize the lead time required to repair and to carry out the system checking / monitoring functions for fault reporting to the local status monitor unit at site and Remote Control and Monitoring System (RCMS) at remote site.

2.2 Antenna System

(1) Antenna system shall be of a suitable and recognized type of appropriate numbers of element, and capable of operation over the entire 108 to 111.975MHz band.

(2) The antenna system shall radiate horizontally polarized electromagnetic waves effectively within the assigned frequency band without tuning requirements.

(3) Vertical polarized emission on a course line shall not exceed that which causes a DDM error of 0.016 when an aircraft is in a roll attitude of 20 degrees from horizontal.

(4) Half Power Beam Width of the carrier with sideband radiation pattern shall be with a sector of not more than plus or minus 4 degrees from course line.

(5) The carrier with sideband and sideband only patterns in horizontal plane, and DDM and SDM patterns shall be submitted for approval by the Contractor.

(6) The power distribution network shall be free from any tuning and making extensive use of strip line techniques.

(7) The front to back ratio shall take 20 dB or more.

(8) The antenna structure(s) shall be weatherproofed against corrosion.

(9) The antenna system shall be provided with obstruction lighting consisting of a set of red lights uniformly distributed and with obstruction marking consisting of orange or alternatively orange and white paint.

2.3 Transmitting Unit

(1) The transmitting unit shall have the following characteristics :

- Frequency band : 108 to 111.975 MHz
- Frequency tolerance : Plus or minus 0.002 % or less (Two radio frequency carriers are used)
- Spurious emission : Less than 60 dB below fundamental
- Output impedance : 50 ohms (nominal)
- Output power : Adjustable within a minimum range of 3 dB

(2) The identification signal shall be programmed by switches or jumpers.

(3) The modulating tones should be 90 Hz and 150 Hz within plus or minus 1.5 percent where practicable.

(4) The sum of the modulation depth of the radio frequency carrier due to the 90 Hz and 150 Hz tones should not exceed 95 percent within the required coverage.

2.4 Monitoring System

(1) The monitoring system shall include integral and field detectors.

(2) Monitors shall furnish full indications of all parameters together with their associated local alarm indications and selected remote alarm indications.

(3) The alarms generated by monitors, and having caused transfer or shutdown shall be memorized so as to facilitate trouble shooting.

(4) Monitor alarm signal shall be sent to the local control to initiate change over with any one or a combination of deviations from established conditions arising and persisting for a period ranging within ten (10) seconds.

2.5 Control and Switchover Unit

This unit shall be responsible for all the necessary supervision and control functions, especially:

(a) Setting the transmitters into and out of operation

(b) Maintenance; during maintenance operations, it shall be possible to disconnect the automatic control functions.

(c) Selection of the normal transmitting unit.

(d) Automatic switchover (or shutdown) of the transmitting unit in case of general alarm generated by the monitoring system in the conditions defined in this part.

3.0 GLIDE SLOPE EQUIPMENT

3.1 General specifications

(1) The operational radio frequency will be allocated in GS frequency band.

(2) The system shall be 2-frequency type.

(3) Glide path structure

Bends in the course line shall not have amplitudes which exceed the recommendations of ICAO Annex 10 Volume I (Para 3.1.5.4)

(4) Coverage

The Glide Slope equipment shall provide glide path signals within the following air space to allow satisfactory operation of a typical aircraft:

Azimuth	:	8 degrees of each side of the ILS course center
Elevation	:	from 0.45 to 1.75 times of nominal glide path angle above horizontal plane
Distance	:	at least 18.5 km (10 NM)

(5) Glide path angle

(a) The ILS glide path angle should be three (3) degrees.

(b) The Glide Slope equipment should be capable of adjustment to produce a radiated glide path from two (2) to four (4) degrees with respect to the horizontal.

(6) Displacement sensitivity

The angular displacement sensitivity shall be as symmetrical as practicable. The nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at an angular displacement of :

- 0.12 times 3(deg) below path with a tolerance of plus or minus 0.02 times 3(deg);
- 0.12 times 3(deg) above path with a tolerance of plus 0.02 times 3(deg) and minus 0.05 times 3(deg)

(7) Monitoring system

(a) The Glide Slope operation shall be monitored by integral and field detectors.

(b) In case of deviations, quoted in ICAO Annex 10 Volume I (para 3.1.5.7), a general alarm shall be generated when both monitors indicate the same deviation. This alarm shall cause the automatic switchover (or shutdown if the standby transmitter is out of order).

(c) The total period of radiation of erroneous signal including the period of switchover shall not exceed six (6) seconds.

(8) BITE

The Glide Slope equipment shall be equipped with Built-In Test Equipment (BITE) to minimize the lead time required to repair and to carry out the system checking / monitoring functions for fault reporting to the local status monitor unit at site and Remote Control and Monitoring System (RCMS) at remote site.

3.2 Antenna System

(1) Antenna system shall be capable of operation over entire 328.6 to 335.4 MHz.

(2) The antenna system shall radiate horizontally polarized electromagnetic waves effectively within the assigned frequency band without tuning requirements.

(3) The front to back ratio shall take 15 dB or more.

(4) The antenna mast shall be auto stable/self supporting and frangible.

(5) The antenna structures shall be weatherproofed against corrosion.

(6) The antenna system shall be provided with obstruction lighting consisting of a set of red lights uniformly distributed and with obstruction marking consisting of alternatively orange and white paint.

3.3 Transmitting Unit

The transmitting unit shall have the following characteristics :

- Frequency band : 328.6 to 335.4 MHz
- Frequency tolerance : Plus or minus 0.002% or less (Two radio frequency carriers are used)
- Spurious emission : Less than 60 dB below fundamental
- Output impedance : 50 ohms (nominal)
- Output power : Adjustable with a minimum range of 3 dB.

3.4 Monitoring System

(1) The monitoring system shall include integral and field detectors.

(2) Monitors shall furnish full indications of all parameters together with their associated local alarm indications and selected remote alarm indications.

(3) The alarm generated by monitors, and having caused transfer or shutdown shall be memorized so as to facilitate trouble-shooting.

(4) Monitor alarm signal shall be sent to the local control to initiate changeover with any one or a combination of deviations from established conditions arising and persisting for a period ranging from 1 to 6 seconds.

3.5 Control and Switchover Unit

This unit shall be responsible for all the necessary supervision and control function, especially:

(a) Setting the transmitters into and out of operation

(b) Maintenance during maintenance operations, it shall be possible to disconnect the automatic control functions

(c) Selection of the normal transmitting unit

(d) Automatic switchover (or shutdown) of the transmitting unit in case of general alarm generated by the monitoring system in the conditions defined in this part.

4.0 T-DME EQUIPMENT

4.1 General Specification

(1) The DME equipment shall conform to the standards and recommendations in ICAO Annex 10 Volume I (Para 3.5 DME/N).

(2) The DME equipment shall be fully solid state and composed of modules, units and printed circuit boards.

(3) Dual DME equipment shall be contained in cabinet to operate as main and stand-by equipment. Maintenance on one equipment shall be accomplished without disturbing the other equipment.

(4) The DME equipment shall be designed to be fully remote controlled and all necessary interface equipment shall be supplied and installed.

(5) The DME equipment shall be equipped with Built-In Test Equipment (BITE) to minimize the lead time required to repair and to carry out the system checking / monitoring functions for fault reporting to the local status monitor unit at site and Remote Maintenance Monitoring System (RMMS) at remote site.

(6) The DME system shall comprise dual transponders, dual power supply, dual local monitoring unit, control and status monitor, and antenna system.

4.2 Performance Requirements

(1) General

- Transponder capacity	:	100 interrogators
- Frequency range	:	960 to 1,215 MHz
- Frequency setting	:	Synthesizer controlled
- Channels	:	252ch (X and Y)
- Reply delay	:	X ch : 35 to 55 microseconds, adjustable Y ch : 44 to 60 microseconds, adjustable
- Total system error	:	Not exceed plus or minus 370m (0.2 NM)

(2) Transmitter

- Operating frequency	:	962 to 1,213 MHz
- Frequency stability	:	Plus or minus 0.002% or less
- Peak output power	:	100 W
- Spectrum	:	DME/N, per ICAO Annex 10
- Transmission rate	:	700 to 2,700 pp/s plus or minus 90 pp/s
- Spurious radiation	:	80 dB or more

(3) Receiver

- Operating frequency	:	1,025 to 1,150 MHz
- Frequency stability	:	Plus or minus 0.002% or less
- Sensitivity	:	Minus 91 dBm or better

- Recovery time : Within 8 microseconds
- Blanking time : With in 60 microseconds
- Echo suppression : Long and short distance

(4) Local monitoring unit

(a) The DME equipment shall be provided with dual local monitors for parallel operation.

(b) Local monitors shall furnish full indications of all parameters together with their associated local alarm indications and selected remote alarm indications. The monitor system shall be based on digital signal processing.

(c) Local monitors shall be capable of operation with the local or remote control and status unit arrangements providing aural and visual indications of the DME status.

(d) Provision shall be included for continuous monitoring and execution of changeover from selected transponder to stand-by, or to shutdown if the performance is beyond specified tolerances.

(e) Monitor data shall be maintained to indicate the existence of an out-of-limit condition, to transfer automatically after a programmable delay to the stand-by transponder or to shutdown all radiation in case of malfunction. In addition any indication given or action taken shall be memorized.

(f) Monitoring parameters and alarm limits

- Reply delay : 0.8 plus or minus 0.2microsecond, adjustable
- Pulse spacing : 0.8 plus or minus 0.2microsecond, adjustable
- Reply efficiency : 10% below nominal, adjustable
- Power : 3 dB, adjustable
- Transmitter pulse rate : Less than 700 plus or minus 50 pp/s, more than 2,790 plus or minus 100 pp/s, adjustable
- Identification : Absence: 45 plus or minus 5 seconds, adjustable
  Continuous: 5 plus or minus 0.5 second, adjustable
- Pulse width : Plus or minus 0.5microsecond, adjustable
- Pulse rise time : Exceed 3.5 microseconds, adjustable
- Receiver sensitivity : 6 dB, adjustable
- Failure of monitor : Self-check on monitoring system
- Associated power supply : Outside tolerance

(g) Failure of one monitor assembly shall not affect the operation of the DME but shall provide a warning.

(5) Local control and status monitor

(a) This function shall be integrated with local control and status monitor of ILS as described previously.

(b) The control and status display unit associated with the transponder cabinet shall be provided with the following functions:

(i) Control item

- Local / remote selection
- Transponder ON / OFF
- No. 1 Transponder/ No. 2 Transponder selection
- Shutdown
- Transfer reset
- Alarm silence
- Alarm bypass

(ii) Display item

- Local / remote
- No. 1 Transponder ON
- No. 2 Transponder ON
- Shutdown
- Transfer

(c) Means shall be provided to disable monitor and control function actions during equipment calibration (monitor bypass, local / remote control).

(6) Automatic changeover and measurement requirements

(a) The changeover circuits shall provide the function of interchange between the working transponder and stand-by transponder, when an alarm signal is detected. When the alarm condition continues after the transponder is automatically changed over, the equipment shall shutdown.

(b) Measurement functions shall be built into the transponder circuitry to check waveforms and power levels of the DME signals for alignment and maintenance purposes.

(c) Test points shall be provided for necessary measurements of different parameters with controls for calibration of all alarms.

(d) RF dummy loads shall be provided to terminate the unused transponder outputs.

(e) When AC input source fails, the battery of DC power supply equipment shall automatically take over the load without interrupting the operation of the equipment.

(f) During normal operation, the battery shall be float charged, ready for back-up operation.

(7) Built –in test equipment (BITE)

(a) As maintenance will be greatly reduced by the provision of built-in test equipment, all replaceable units and cards shall have BITE function.

(b) The BITE function shall be kept completely independent from the monitoring operation.

(c) Oscilloscope shall be built in the equipment for measurement of DME parameter.

(8) Remote control and status monitor

(a) This function shall be integrated with Remote Control and Monitoring System of ILS.

(b) The remote control and status unit shall be provided with the following functions:

- Visual indication of the operation status of DME equipment
- An aural and visual indication of a subsystem of abnormal monitor condition, and an abnormal power supply condition
- Alarm silence
- Start or stop or changeover the transponder
- Select either the main or stand-by transponder

(c) The remote control system shall be capable of reading and recording all parameters of equipment including its BITE, providing remote trend analysis and remote fault analysis via PC terminal.

(9) Operational status monitor unit

(a) The operational status monitor unit shall be provided with the visual indication of the operating status of the DME equipment.

(b) The operational status monitor unit shall be provided with the following functions:

- Operation / failure indication
- Alarm for failure and shut down
- Alarm silence control
- Dimmer control

(c) The operational status monitor unit shall be included as part of the navaids monitor panel of the new VFR console as specified in **Section 8300** of this Specification.

(10) Antenna system

A fiberglass reinforced polyester cover for weather protection shall enclose antenna elements.

-	Type	:	Broadband uni-directional antenna
-	Frequency range	:	960 to 1,215 MHz
-	Polarization	:	Vertical
-	Impedance	:	50 ohms (nominal)
-	Gain	:	3 dB or more
-	VSWR	:	1.5 or less

5.0 REMOTE CONTROL SYSTEM

5.1 Remote control and monitoring of the Localizer, Glide Slope, T-DME shall be integrated as a general ILS Remote Control and Monitoring System.

5.2 **The ILS Remote Control System shall consist of**

(a) The Remote Control and Monitoring Unit, to be installed in the main equipment room of the Operation Building.

(b) The Navaids Monitoring Display Unit, to be inserted into the FD/Aux Control Console.

5.3 The system shall indicate the limit of the capability of each equipment.

5.4 **For each equipment, the remote controls shall consist of at least:**

- Equipment ON/OFF
- Operating Transmitter (Transponder) No. 1/No. 2
- Transfer reset.

5.5 **The remote monitoring shall consist of at least :**

- Equipment ON/OFF
- Operating transmitter (Transponder) No. 1/No. 2
- Transmitter (Transponder) TRANSFER/SHUTDOWN
- Monitor alarm
- Control LOCAL/REMOTE
- AC power supply failure
- Battery alarm
- Air conditioning failure

5.6 The Navaids Monitoring Display Unit shall indicate the status of ILS and VOR/DME.

5.7 The Navaids Monitoring Display Unit shall have the following function:

- Operation/Failure

6.0 D.C. POWER SUPPLY UNIT

6.1 This unit shall be designed and provided to supply the ILS equipment, i.e.: Localizer, Glide Slope / T-DME and remote control system with D.C. power source in the following conditions :

(a) With the mains power on (A.C. source) :
regulated D.C. power supply of the equipment together with the battery maintenance charging.

(b) With the mains power off (failure of the A.C. source) :
the instantaneous (uninterrupted) regulated power supply of the equipment via the battery.

(c) When the mains power comes on again (return to service of the A.C. source):
regulated power supply of the equipment, as well as recharging the battery.

6.2 **The D.C. power supply shall be solid-state and composed of:**

- Two rectifier/charger units
- One set of batteries

(a) Rectifier/Charge Unit.

(i) Input
- 1-phase 2-wires AC 230V, 60 Hz
- Voltage tolerance: plus or minus 10 %
- Frequency tolerance: plus or minus 5 %

(ii) Output
- Voltage: D.C. 24 V (nominal)
- Ripple voltage: less than 100 mV (p-p) with battery connected.

(iii) The battery charger shall be capable of charging batteries which are initially completely discharged.

(iv) Automatic protection against battery over-charging shall be incorporated in the power supply unit.

(b) Battery

(i) The battery should be of the sealed type (stationary industrial type) and should be enclosed in the steel cabinet.

(ii) It shall be of sufficient capacity to provide for the correct operating of the equipment during following hours in case of a mains power failure:

- Localizer with remote control system : 1 hour or more
- Glide Slope/T-DME with remote control system : 1 hour or more

7.0 GROUND CALIBRATION EQUIPMENT

7.1 Standard Antenna Set

Type : for LLZ and VOR

7.2 ILS Monitor Equipment and Accessories

DDM Indicator
Paper Recorder
and necessary equipment for ground check

SECTION 8200

VOR/DME

1.0 GENERAL

1.1 Scope of Work

The work of this Section is to supply, install, adjust and set into operation the D-VOR/DME, generally described as follows:

(1) VOR

(a) One (1) dual Doppler type 100W VOR with 30m diameter counterpoise shall be installed at VOR site which is located west side from RWY centre.

(b) VOR/DME Building shall be located under the counterpoise of VOR.

(c) The power for VOR/DME equipment shall be supplied from the Electrical Room of VOR/DME Building by AC 230V 1 Phase. Power cable shall be laid from above electric room to the EQ Room of VOR/DME Building.

(d) Cable rack shall be laid in EQ Room.

(e) Control cable shall be laid from VOR/DME Building to Operation Building EQ Room via buried underground piping.

(2) DME

(a) One (1) dual 1kW DME shall be installed at VOR site which is located west side from RWY centre.

(b) DME antenna shall be coaxially co-located with VOR antenna.

(3) Remote Control and Monitoring System

(a) The remote control and monitoring equipment shall be installed in the Operation Building EQ Room

(b) Status signal of VOR/DME shall be sent to ILS Remote Control and Monitoring System for Navaids monitoring display units.

(c) One separate audio alarm of the Remote Control and Monitoring System of VOR/DME including VOR/DME AC power supply failure status shall be installed in Operation Building ANS nap room.

(4) DC Power Supply System

(a) One (1) DC Power Supply System with batteries shall be installed in VOR/DME Building EQ Room.

(b) DC Power Supply shall be able to supply the power and operate the VOR/DME for at least one (1) hour in case of AC power failure.

1.2 Design Conditions

(1) The VOR/DME equipment shall meet the standards and recommendations of the ICAO Annex 10 related to the VOR and DME facilities.

(2) The central equipment shall be solid state, duplicated, equipped with automatic and manual normal/standby switchover and operating from the D.C. Power Supply System.

(3) The operational frequency shall be allocated and noticed before manufacturing.

(4) The main power source is supplied with low voltage (one phase 2 wires, 230 volts, 60 Hz) from electric room.

(5) The parts (i.e. component units of the equipment) shall be manually compatible / interchangeable as much as possible and integrated to provide functions and operations as intended.

1.3 Equipment

The Contractor shall supply the following equipment:

(a) D-VOR and DME equipment

- System of transmitting and monitoring antennas with masts or bases, and the marking and lighting for denoting obstacles
- Dual transmitting system (one is normal operation, other standby)
- Dual monitoring system
- Control and normal/standby switchover unit
- Remote control and monitoring unit
- Non-break D.C. power supply unit
- Equipment building fully equipped (air-conditioning, lighting, distribution switchboard, terminal board, etc.)
- PDB and TB.
- Power cable from Electric Room
- Communication cables from Operation Building
- Distribution cables including connections
- Antenna feeder cables
- Lightning protection system

(b) Remote Control and Monitoring System

- Remote control and monitoring unit
- Distribution cables including connections.

(c) Counterpoise

- 30m diameter Counterpoise System with foundation

1.4 Approval Requirement

(1) Each submission for approval of items listed under this Section shall be accompanied by specific information.

(2) The Contractor shall state in detail how he intends to carry out installation of the D-

VOR/DME.

(3) Calculations and details for coverage and field strength of the VOR and DME system shall be proposed.

(4) The type and radiation pattern of the antenna system of the D-VOR/DME shall be proposed by the Contractor.

2.0 DOPPLER VHF OMNI-DIRECTIONAL RADIO RANGE (D-VOR)

2.1 General Specification

(1) The DVOR equipment shall be fully solid state and composed of modules, units and printed circuit boards.

(2) The DVOR equipment shall not contain any continuously rotating parts, except cooling fan.

(3) Dual transmitters shall be contained in cabinet to operate as main and stand-by equipment. Maintenance on one (1) equipment shall be accomplished without disturbing the other equipment.

(4) The DVOR equipment shall be designed to be fully remote controlled and all necessary interface equipment shall be supplied and installed.

(5) The DVOR equipment shall be equipped with Built-In Test Equipment (BITE) to minimize the lead time required to repair and to carry out the system checking / monitoring functions for fault reporting to the local status monitor unit at site and Remote Maintenance Monitoring System (RMMS) at remote site.

(6) The DVOR system shall consist of dual transmitters, dual power supply, dual local monitoring unit, local control and status monitor, and antenna system.

2.2 Performance Requirements

(1) Transmitter

(a) General

-	Type	:	Double sideband doppler VOR
-	Frequency range	:	111.975to 117.975 MHz
-	Operation frequency	:	Tunable within the frequency range
-	Channel spacing	:	50 kHz
-	Frequency setting	:	Synthesizer controlled
-	Frequency stability	:	Plus or minus 0.002%
-	Output power	:	100W
-	Output impedance	:	50 ohms
-	Operation method	:	Continuous operation
-	Power supply voltage	:	230V AC single-phase, 60 Hz and DC source in case of AC source failure

(b) Carrier transmitter

(i) Modulation frequency

- Reference phase : 30 Hz plus or minus 1%
- Identification : 1,020 Hz plus or minus 60 Hz

(ii) Modulation depth

- Reference phase : 30% plus or minus 2%
- Identification : 0 to 20% adjustable

(iii) Spurious radiation : Minus 60 dB or less

(c) Sideband transmitter

- Sub-carrier frequency : 9,960 Hz plus or minus 1%
- Spacing : Upper sideband : Plus 9,960 Hz from carrier

  Lower sideband : Minus 9,960 Hz from carrier
- Modulation frequency : 30 Hz plus or minus 1%
- Modulation depth : 30% plus or minus 2%
- Deviation ratio : 16 plus or minus 1

(d) The sideband signals shall be routed to their antennas via a distributor, which shall be of an electronic switching design.

(e) The phase of the 30Hz reference modulation shall be programmable at least $\pm 50^{o}$ in steps of 0.1^{o}.

(f) The power amplifiers shall operate into a 50 ohm load. They shall withstand without damage any open or short circuit at the transmitter output or within the antenna system (infinite VSWR). In case of short or open circuit a warning indicator shall be provided.

(2) Monitoring system

(a) The DVOR equipment shall be provided with dual local monitors for parallel operation.

(b) Local monitors shall furnish full indications of all parameters together with their associated local alarm indications and selected remote alarm indications. The monitor system shall be based on digital signal processing.

(c) Local monitors shall be capable of operation with the local or remote control and status unit arrangements providing aural and visual indications of the DVOR status.

(d) Provision shall be included for continuous monitoring and execution of changeover from selected transmitter to stand-by, or to shutdown if the performance is beyond specified tolerances.

(e) Monitor data shall be maintained to indicate the existence of an out-of-limit condition, to transfer automatically after a programmable delay to the stand-by transmitter or to shutdown all radiation in case of malfunction. In addition any indication given or action taken shall be memorized.

(f) Monitoring parameters and alarm limits

-	Bearing information	:	Plus or minus 1.0 degree, adjustable
-	30 Hz AM modulation depth	:	15% below nominal, adjustable
-	30 Hz FM modulation depth	:	15% below nominal, adjustable
-	Sub-carrier modulation depth	:	15% below nominal, adjustable
-	Code failure	:	Continuous or absent tone
-	Failure of antennas	:	Alarm for detection of antenna failure
-	Failure of monitor	:	Self-check on bearing monitor
-	Associated power supply	:	Outside tolerance

(g) Failure of one monitor assembly shall not affect the operation of the DVOR but shall provide a warning.

(3) Local control and status monitor

(a) The control of signal generator shall be digital throughout.

(b) The control and status monitor shall be provided with the following functions:

(i) Control item

- Local / remote selection
- TX ON / OFF
- No. 1 TX / No. 2 TX selection
- Shutdown
- Transfer reset
- Alarm silence
- Alarm bypass
- Equipment parameters

(ii) Display item

- Local / remote
- No. 1 TX ON
- No. 2 TX ON
- Shutdown
- Transfer
- Equipment parameters

(c) This function shall be executed through a desktop type PC terminal.

(d) This unit shall be used during equipment calibration (monitor bypass, local / remote control).

(e) Any fault or failure of the said unit shall not affect the operation of the equipment.

(4) Automatic changeover and measurement requirements

(a) The changeover circuits shall provide the function of interchange between the working transmitter and stand-by transmitter, when an alarm signal is detected. When the alarm condition continues after the transmitter is automatically changed over, the equipment shall shutdown.

(b) Measurement functions shall be built into the transmitter circuitry to check waveforms and power levels of the DVOR signals for alignment and maintenance purposes.

(c) Test points shall be provided for necessary measurements of different parameters with controls for calibration of all alarms.

(d) RF dummy loads shall be provided to terminate the unused transmitter outputs.

(e) When AC input source fails, the battery shall automatically take over the load without interrupting the operation of the equipment.

(f) During normal operation, the battery shall be float charged, ready for back-up operation.

(g) Separate charger shall be provided.

(5) Test signal generator

(a) The test signal generator shall generate the reference signal and variable phase signal for calibrating the monitors:

(b) In order to facilitate ground checks, a DVOR test generator shall be an integral part of the equipment. Its high accuracy navigation signal outputs shall be connected to the monitors for correct performance verification.

(c) The generation of the test signals shall be such as to make unnecessary any further calibration and / or adjustments.

(d) Monitor checks via the test signal generator shall not affect normal DVOR operation.

(6) Built –in test equipment (BITE)

(a) As maintenance will be greatly reduced by the provision of built-in test equipment, all replaceable units and cards shall have BITE function.

(b) The BITE function shall be kept completely independent from the monitoring operation.

(7) Remote control and status monitor

(a) The remote control and status monitor shall be PC based terminal and shall be contained in a 19 inches cabinet, or set on a suitable table, with other necessary equipment.

(b) The remote control and status monitor shall be provided with the following functions:

- Visual indication of the operation status of DVOR equipment
- An aural and visual indication of a subsystem of abnormal monitor condition, and an abnormal power supply condition
- Alarm silence
- Capability to start or stop or changeover the transmitter
- Capability to select either the main or stand-by transmitter

(c) The remote control system shall be capable of reading and recording all parameters of equipment including its BITE, providing remote trend analysis and remote fault analysis via PC terminal. The PC terminal shall be the product of an ISO 9001 certified manufacturer.

(8) Operational status monitor unit

(a) The operational status monitor unit shall be provided with the visual indication of the operating status of the DVOR equipment.

(b) The operational status monitor unit shall be provided with the following functions:

- Operation / failure indication
- Alarm for failure and shut down
- Alarm silence control
- Dimmer control

(c) The operational status monitor unit shall be included as part of the navaids monitor panel of the new VFR console as specified in **Section 8300** of this Specification.

(9) Antenna system

(a) Carrier and sideband antenna

(i) Characteristics are as follows:

- Type : Alford loop antenna
- Frequency range : 111.975 to 117.975MHz
- Polarization : Horizontal
- Impedance : 50 ohms (nominal)

(ii) A fiberglass reinforced polyester cover for weather protection shall enclose each antenna element.

(iii) DME antenna collocation shall be carried out by means of a support mast centrally located on the DVOR counterpoise.

(b) Next field Monitor antenna

- Type : Dipole antenna
- Frequency range : 111.975 to 117.975MHz
- Polarization : Horizontal
- Impedance : 50 ohms (nominal)

(c) Counterpoise

(i) Carrier and sideband antennas shall be mounted at a circular counterpoise of 30m diameter.

(ii) Counterpoise shall be galvanized.

(iii) Height of the counterpoise shall be so determined that no part of the antenna system penetrates the transitional surface.

(iv) The access to the counterpoise shall be lockable and by means of a steel ladder. The reflection grid as part of the counterpoise shall not suffer any damage when it is walked on.

(10) Theodolite pad

A theodolite pad with waterproof AC outlet and an outlet for a pair of communication cable on the counterpoise shall be provided at an appropriate location.

3.0 DISTANCE MEASURING EQUIPMENT (DME)

3.1 General Specification

(1) The DME equipment shall conform to the standards and recommendations in ICAO Annex 10 Volume I (Para 3.5 DME/N)..

(2) The DME equipment shall be fully solid state and composed of modules, units and printed circuit boards.

(3) Dual DME equipment shall be contained in cabinet to operate as main and stand-by equipment. Maintenance on one equipment shall be accomplished without disturbing the other equipment.

(4) The DME equipment shall be designed to be fully remote controlled and all necessary interface equipment shall be supplied and installed.

(5) The DME equipment shall be equipped with Built-In Test Equipment (BITE) to minimize the lead time required to repair and to carry out the system checking / monitoring functions for fault reporting to the local status monitor unit at site and Remote Maintenance Monitoring System (RMMS) at remote site.

(6) The DME system shall comprise dual transponders, dual power supply, dual local monitoring unit, control and status monitor, and antenna system.

3.2 Performance Requirements

(1) General

- Transponder capacity : 100 interrogators
- Frequency range : 960 to 1,215 MHz
- Frequency setting : Synthesizer controlled
- Channels : 252 (X and Y)

- Reply delay : X ch : 35 to 55 microseconds, adjustable
  Y ch : 44 to 60 microseconds, adjustable
- Total system error : Not exceed plus or minus 370m (0.2 NM)

(2) Transmitter

- Operating frequency : 962 to 1,213 MHz
- Frequency stability : Plus or minus 0.002% or less
- Peak output power : 1 kW
- Spectrum : DME/N, per ICAO annex 10
- Transmission rate : 700 to 2,700 pps plus or minus 90 pps
- Spurious radiation : 80 dB or more

(3) Receiver

- Operating frequency : 1,025 to 1,150 MHz
- Frequency stability : Plus or minus 0.002% or less
- Sensitivity : Minus 87 dBm or better
- Recovery time : Within 8 microseconds
- Blanking time : With in 60 microseconds
- Echo suppression : Long and short distance

(4) Local monitoring unit

(a) The DME equipment shall be provided with dual local monitors for parallel operation.

(b) Local monitors shall furnish full indications of all parameters together with their associated local alarm indications and selected remote alarm indications. The monitor system shall be based on digital signal processing.

(c) Local monitors shall be capable of operation with the local or remote control and status unit arrangements providing aural and visual indications of the DME status.

(d) Provision shall be included for continuous monitoring and execution of changeover from selected transponder to stand-by, or to shutdown if the performance is beyond specified tolerances.

(e) Monitor data shall be maintained to indicate the existence of an out-of-limit condition, to transfer automatically after a programmable delay to the stand-by transponder or to shutdown all radiation in case of malfunction. In addition any indication given or action taken shall be memorized.

(f) Monitoring parameters and alarm limits

- Reply delay : 0.8 plus or minus 0.2 microsecond, adjustable
- Pulse spacing : 0.8 plus or minus 0.2 microsecond, adjustable
- Reply efficiency : 10% below nominal, adjustable
- Power : 3 dB, adjustable

-	Transmitter pulse rate	:	Less than 700 plus or minus 50 pps, more than 2,790 plus or minus 100 pps, adjustable
-	Identification	:	Absence: 45 plus or minus 5 seconds, adjustable Continuous: 5 plus or minus 0.5 second, adjustable
-	Pulse width	:	Plus or minus 0.5 micro-second, adjustable
-	Pulse rise time	:	Exceed 3.5 microseconds, adjustable
-	Receiver sensitivity	:	6 dB, adjustable
-	Failure of monitor	:	Self-check on monitoring system
-	Associated power supply	:	Outside tolerance

(g) Failure of one monitor assembly shall not affect the operation of the DME but shall provide a warning.

(5) Local control and status monitor

(a) This function shall be integrated with local control and status monitor of VOR as described previously.

(b) The control and status display unit associated with the transponder cabinet shall be provided with the following functions:

(i) Control item

– Local / remote selection
– Transponder ON / OFF
– No. 1 Transponder/ No. 2 Transponder selection
– Shutdown
– Transfer reset
– Alarm silence
– Alarm bypass
– Equipment parameters

(ii) Display item

– Local / remote
– No. 1 Transponder ON
– No. 2 Transponder ON
– Shutdown
– Transfer
– Equipment parameters

(c) Means shall be provided to disable monitor and control function actions during equipment calibration (monitor bypass, local / remote control).

(6) Automatic changeover and measurement requirements

(a) The changeover circuits shall provide the function of interchange between the working transponder and stand-by transponder, when an

alarm signal is detected. When the alarm condition continues after the transponder is automatically changed over, the equipment shall shutdown.

(b) Measurement functions shall be built into the transponder circuitry to check waveforms and power levels of the DME signals for alignment and maintenance purposes.

(c) Test points shall be provided for necessary measurements of different parameters with controls for calibration of all alarms.

(d) RF dummy loads shall be provided to terminate the unused transponder outputs.

(e) When AC input source fails, the battery shall automatically take over the load without interrupting the operation of the equipment.

(f) During normal operation, the battery shall be float charged, ready for back-up operation.

(7) Built –in test equipment (BITE)

(a) As maintenance will be greatly reduced by the provision of built-in test equipment, all replaceable units and cards shall have BITE function.

(b) The BITE function shall be kept completely independent from the monitoring operation.

(c) Oscilloscope shall be built in the equipment for measurement of DME parameter.

(8) Remote control and status monitor

(a) This function shall be integrated with VOR as described previously.

(b) The remote control and status unit shall be provided with the following functions:

- Visual indication of the operation status of DME equipment
- An aural and visual indication of a subsystem of abnormal monitor condition, and an abnormal power supply condition
- Alarm silence
- Start or stop or changeover the transponder
- Select either the main or stand-by transponder

(c) The remote control system shall be capable of reading and recording all parameters of equipment including its BITE, providing remote trend analysis and remote fault analysis via PC terminal.

(9) Operational status monitor unit

(a) The operational status monitor unit shall be provided with the visual indication of the operating status of the DME equipment.

(b) The operational status monitor unit shall be provided with the following functions:

- Operation / failure indication
- Alarm for failure and shut down
- Alarm silence control
- Dimmer control

(c) The operational status monitor unit shall be included as part of the navaids monitor panel of the new VFR console as specified in **Section 8300** of this Specification.

(9) Antenna system

A fiberglass reinforced polyester cover for weather protection shall enclose antenna elements.

-	Type	:	Broadband omni-directional antenna
-	Frequency range	:	960 to 1,215 MHz
-	Polarization	:	Vertical
-	Impedance	:	50 ohms (nominal)
-	Gain	:	9 dB or more
-	VSWR	:	1.5 or less

(10) Obstruction light

The DME antenna shall be fitted with tandem obstruction lights.

4.0 DC POWER SUPPLY SYSTEM

4.1 General Specification

(1) These specifications set forth the technical requirements for battery backup DC power supply to be used for VOR/DME with remote control system.

(2) The DC power supply shall consist of a set of batteries and rectifier / charger unit.

(3) Batteries shall have the capacity to supply the power and operate the above-cited equipment for at least one (1) hour, in case of AC power failure.

(4) The batteries shall be continuously float-charged.

(5) The battery charger shall be capable of charging batteries from a completely discharged condition.

(6) Automatic protection against battery over-charging shall be incorporated in the power supply unit.

(7) In the event of AC power failure, the batteries shall automatically take over the power supply without disrupting the operation of the said equipment.

(8) Charger shall be equipped with indicating instruments, switches and indication lamps for maintenance purposes. The instruments and switches shall indicate and control at

least the following items:

- Voltage monitoring meter of DC output
- Current monitoring meter of DC output
- Switches for AC input and DC output
- Switch for select DC output or battery
- AC source indicator
- Operation indicator for charger, charging condition

4.2. Performance Requirement

(1) Rectifier / charger unit

(a) Rating : Continuous

(b) Cooling method : Air-cooling

(c) AC input

- Phase : Single-phase, 2 wires
- Frequency : 60 Hz
- Voltage : AC 230 V plus or minus 15%

(d) DC output

- Voltage : DC 22 V ~ 48 V according to DC input of VOR and DME
- Ripple voltage : Less than 100 mV (p-p) with battery connected
- Capacity : VOR and DME both dual operation
- Terminal (outlet) : more than 2

(2) Battery

- Type : Sealed type (stationary industrial type)
- Capacity : 1 hour

(3) Operational Status

"Load on AC main" and "Load on Battery" signal shall be provided for remote monitoring.

SECTION 8300

ATS AND TELECOMMUNICATION

1.0 GENERAL

1.1 Scope of Work

The work of this Section is to supply, install, adjust and set into operation the ATS and Telecommunications System required for ATC, FOBS and FSS generally described as follows:

(1) ATC Console, VCCS, Master Clock and Digital Voice Recording System

(a) Control Tower VFR Room

(i) Approach Control Console, Aerodrome Control Console, FD/Aux Control Console and Supervisor Control Console shall be supplied and installed.

(ii) Digital slave clock panel shall be mounted on Approach Control Console, Aerodrome Control Console, FD/Aux Control Console and Supervisor Control Console.

(iii) Recording monitor for Digital Voice Recording System shall be mounted on FD/Aux Control Console.

(iv) Terminal Board and Power Distribution Board shall be installed.

(v) Necessary cables shall be laid among equipment, Terminal Board and Power Distribution Board.

(vi) At least 20 headsets and 6 hand microphones shall be supplied.

(b) Operation Building Equipment Room

(i) VCCS, Master Clock, digital voice recorder, PC type reproducer and wall mount type slave clock shall be installed.

(ii) MDF and Power Distribution Board shall be installed.

(iii) Necessary cables shall be laid among equipment, MDF and Power Distribution Board.

(iv) Recording media for more than 30 days shall be supplied.

(c) Operation Building FOBS Room

(i) Wall mount type slave clock shall be installed.

(iii) Necessary cables shall be laid between the clock and Terminal Board.

(d) Operation Building FSS Room

(i) Terminal Board and Power Distribution Board shall be installed.

(ii) Necessary cables shall be laid between the clock and Terminal Board.

(e) Fire Station

(i) Crash Phone shall be installed in Command Room.

(ii) Terminal Board and Power Distribution Board shall be installed.

(iii) Necessary cables shall be laid between crash phone and Terminal Board.

(2) VHF Air Ground Communication and HF Communication

(a) Operation Building EQ Room

(i) Four (4) 50W VHF AM transmitters (2 frequencies dual), Four (4) AM receivers (2 frequencies dual) and two (2) 100W HF transceivers.

(ii) Necessary cables shall be laid among equipment, MDF and Power Distribution Board.

(iii) Three (3) headsets and two (2) hand microphones shall be supplied.

(b) ATC Control Tower VFR Room

(i) Two (2) panel mount type 10W AM transceivers shall be mounted on Approach Control Console and Aerodrome Console with battery and DC Power Supply System.

(ii) One (1) 5W FM transceiver shall be mounted on Aerodrome Control Console with battery and DC Power Supply System.

(iii) Necessary cables shall be laid among equipment, Terminal Board and Power Distribution Board.

(c) Fire Station

(i) One (1) VHF A/G monitor receiver shall be installed in Command Room and antenna with accessories shall be installed on the roof.

(ii) Operational Desk shall be supplied.

(iii) Necessary cables shall be laid among receiver, antenna and Power Distribution Board.

(d) Fire Truck

One (1) VHF AM antenna and one (1) mobile 10W VHF transceiver shall be installed on the fire truck.

(e) ATC Control Tower Roof

(i) Two (2) VHF AM antennae and one (1) VHF FM antenna and antenna accessories shall be installed on the roof.

(ii) Necessary cables shall be laid between transceivers and antennae.

(f) Operation Building Roof

(i) Two (2) VHF antenna towers with Two (2) VHF antennae shall be installed on the roof.

(iii) Necessary cables shall be laid between receivers and antennae, and transmitters and antennae.

(g) Outside of Operation Building

(i) One (1) HF antenna with tower shall be installed externally in front of the Operation Building as shown on the Drawings.

(ii) Necessary cables and cable duct with handhole shall be laid between HF transceiver and HF antenna.

(6) Maintenance Intercom System

(a) Operation Building EQ Room

(i) One (1) 24ch PABX for maintenance intercom shall be installed.

(ii) Necessary cables shall be laid among equipment, MDF and Power Distribution Board.

(b) Supply and Installation

(i) Twenty four (24) handsets shall be supplied and installed in the following rooms.

- ANS FIC Room
- EQ Room
- VFR Room
- LLZ EQ Room
- LLZ Electric Room
- GS EQ Room
- GS Electric Room
- VOR/DME EQ Room
- VOR/DME Electric Room
- RWY03 Met Site
- RWY21 Met Site
- Fire Station
- Power House (2)

(10 sets will be spare)

(ii) Necessary cables shall be laid between handset and Terminal Board.

(5) Others

(a) Signaling Lamp

One signaling lamp shall be installed in ATC Control Tower VFR Room.

(b) Siren

Two sirens shall be installed on the ATC Control Tower roof.

(c) Binoculars

One set of binoculars shall be supplied.

(d) 20 kVA UPS by electrical works

(i) One 20 KVA UPS shall be installed in Operation Building EQ Room.

(ii) UPS shall be able to supply the maximum power output for at least 30 minutes.

(e) Foundation related to VSAT antenna by building works

One foundation with anchor bolt related to VSAT antenna by Other shall be installed on the Operation Building EQ Room.

(f) Cable Rack and Duct by electrical works

(i) Cable rack shall be laid in Operation Building EQ Room, FOBS Room, FSS Room, 1st Floor corridor, 2nd Floor corridor and cable shaft of Control Tower.

(ii) Cable rack shall be laid on the roof of Operation Building and the roof of ATC Control Tower.

(g) Cables

(i) Power cable shall be laid between room and room in the buildings. (Power cable shall be laid from Electric Room to the room in the buildings by electrical works.)

(ii) Communication cable shall be laid between Operation Building EQ Room and FSS Room and between Operation Building EQ Room and VFR Room. (Communication cable between Buildings shall be supplied and laid by electrical Works).

1.2 Design Conditions

(1) The central equipment shall be solid state, duplicated, equipped with automatic and manual normal/standby switchover unit where applicable.

(2) The main power source is supplied with low voltage (3 phase 3 wires, 230 volts, 60 Hz) from electric room.

(3) The parts (i.e. component units of the equipment) shall be manually compatible/interchangeable and integrated to provide functions and operations as intended.

1.3 Equipment

The Contractor shall supply the following equipment:

(a) ATC Consoles, VCCS and Master Clock

- Approach Control Console
- Aerodrome / Ground Control Console
- FD/Aux Control Console
- Supervisor Control Console
- VCCS
- Master Clock System (GPS)
  - 5 panel type slave clocks
  - 2 wall type slave clocks

(b) Digital Voice Recording System

- Main and stand/by Digital Voice Recording System
- PC type reproducer
- Recording monitor (at FD/Aux Console)
- Spare recording media for more than 30 days

(c) VHF Air Ground Communications System

- VHF 50W transmitter (4 sets)

  with change over circuits, rack and antenna system.

  (Dual configuration for 2 frequencies)
- VHF receiver (4 sets)

  with change over circuits, rack and antenna system.

  (Dual configuration for 2 frequencies)
- Panel mounted type VHF 10W AM transceiver (2 sets) with antenna system.
- Battery & DC power supply system for AM and FM transceiver to be located at VFR room.
- Desktop type VHF 10W AM transceiver (1set) with antenna system for FSS radio room.
- Mobile type VHF 10 W AM transceiver (1set) with antenna system for fire truck.
- Panel mounted type VHF 5W FM transceiver (1set) with antenna system.
- Walky-talky VHF 5W FM transceiver (6sets) with batteries and chargers
- Mulch channel VHF receiver (1sets) with antenna system for fire station.

(d) HF Communications System

- 100W HF transceiver (2 sets) with antenna system

  (Dual Configuration)
- Remote control unit (at FD/Aux Console)

  (With handsets and headsets)

(g) Maintenance Intercom system

- 24 ch Maintenance Intercom System
- 24 handsets

(h) Others

- Signaling lamp (light gun) with suspending tool and power supply
- Siren (2)
- Binocular
- 20 kVA UPS (3 phase)
- Cable rack and duct
- PDBs, MDF and TBs
- Power cables
- Communication cables
- Antenna feeder cables
- Lightning protection system

1.4 Approval Requirement

(1) Each submission for approval of items listed under this Section shall be accompanied by specific information.

(2) The Contractor shall state in detail how he intends to carry out installation of the ATS and Communications System.

2.0 ATC CONSOLE AND VCCS

2.1 General Specification

(1) These specifications set forth the requirements for the following consoles:

(a) Approach Control Console
(b) FD/Aux Console
(c) Aerodrome Control Console
(d) Supervisor Console

(2) The consoles shall be designed to provide operators with maximum comfort for carrying out their task correctly, especially by avoiding any unnecessary causes of visual or aural fatigue.

(3) Their design shall also be based on standardization, high reliability, easy maintenance and troubleshooting, flexibility and interchangeability by use of modular components and panels.

(4) The Contractor shall submit shop drawings for review of the Engineer. Subsequently, at an appropriate timing, presentation with a mock-up of the console shall be made to discuss the operational requirements with the Employer before manufacturing. The cost therefore shall be deemed to be included in the Contract Price.

(5) Factory test shall be conducted on the completely assembled console together with all components thereof.

(6) VCCS shall have the following correspondents:

(a) for ATS Direct Speech Circuits function:

- MANILA ACC
- MACTAN TMA

(b) for Inter Console communication function:

- Approach Control Console
- FD/Aux Control Console
- Aerodrome Control Console
- Supervisor Console

(c) for ATS Intercom function:

- Approach Control Console
- FD/Aux Control Console
- Aerodrome Control Console
- Supervisor Console
- FOBS Briefing Room
- EQ Room
- ATC FIC Room
- FSS FIC Room
- ANS FIC Room

2.2 Configuration Requirements

(1) VFR console shall consist of 1-aerodrome control console, 1-flight data/Aux console, 1-approach control console, 1- supervisor control console and VCCS, and each console shall incorporate the components enumerated below, except those marked with asterisks for which adequate space shall be reserved.

(2) Aerodrome control console

(a) Digital clock panel
(b) Gooseneck lamp with dimmer control panel
(c) Siren control panel
(d) Runway in use indicator and control panel
(e) Speaker panel
(f) Voice control panel
(g) Communication control panel
  (i) Intercom control (12 ch)
  (ii) Hot line control (6ch/12ch)
  (iii) Direct Speech Circuits and Inter-Console Comm. control
(h) Crash phone (including handset for Fire Station)
(i) Radio control panel (6ch)
(j) Weather data Display
(k) WD/WS Indicator
(l) VHF AM transceiver
(m) VHF FM transceiver

(3) Flight data / Aux console

(a) Digital clock panel
(b) Gooseneck lamp with dimmer control panel
(c) Navaids monitor display unit
(d) Flight strip bay (movable)
(e) Speaker panel
(f) Voice control panel
(g) Handset panel
(h) Communication control panel:
Intercom control panel (12 ch)
(i) Public telephone key pad
(j) AGL display
(k) FIDS display
(l) Recording Monitor panel

(4) Approach control console

(a) Digital clock panel
(b) Gooseneck lamp with dimmer control panel
(c) Speaker panel
(d) Voice control panel
(e) Communication control panel
(i) Intercom control (12ch)
(ii) Hot line control (6ch/12ch)
(iii) Direct Speech Circuits and Inter-Console Comm. control
(f) Radio control panel (6ch)
(g) Weather data Display
(h) WD/WS Indicator
(i) VHF AM transceivers

(5) Supervisor Control Console

(a) Digital clock panel
(b) Gooseneck lamp with dimmer control pane
(c) Speaker panel
(d) Voice control panel
(e) Communication control panel
(i) Intercom control (12ch)
(ii) Hot line control (6ch/12ch)
(iii) Direct Speech Circuits and Inter-Console Comm. control
(f) Radio control panel (6ch)
(g) Recording Monitor panel

(6) VCCS

(a) I/O interface unit
(b) Time signal generator using GPS

2.3 Functional Requirements

(1) Intercom control panel

(a) Intercom system shall provide communications with various facilities as specified on the Drawings.

(b) Intercom control panel shall be used for selecting and controlling desired intercom channel. Headset or handset shall be provided to be used for actual communication.

(c) Active intercom channel as used by other position shall be indicated on the panel.

(d) Audible chime and visual indicator shall be provided for incoming call.

(e) Call indicator shall be distinguishable from active channel indication and normal indication.

(f) At least three (3) spare channels with telephone sets shall be provided in addition to the required number of channels specified in the relevant equipment sections.

(2) Radio control panel

(a) Radio control panel shall be used together with voice control panel, and PTT switch for controlling VHF transmitters and receivers for radio communication

(b) The radio control panel shall indicate the status of radio communication, i.e., whether Tx or Rx operation, selected frequency and main/standby channel.

(c) The radio control panel shall consist of main/standby select panel, frequency select panel and speaker panel.

(d) Main/stand-by select panel shall have the function to select main or stand-by of VHF transmitters and receivers. Independent selection of Tx and Rx main/standby units shall be provided.

(e) The frequency select panel shall have the function to select the desired frequency. The selected frequency shall be displayed on the panel.

(f) All or any combination of the transmission/reception channels can be selected at the same time and their corresponding transmitter and receiver indicators are displayed.

(g) Receiving circuit shall have a function, which breaks speaker circuit synchronously with operation of press-to-talk mechanism, and which can also lower sound volume of earphone circuit.

(h) Speaker and headset circuits shall have independent volume controls.

(i) The duration from the pressing of PTT switch at the console to the full activation of the transmitter shall be specified by the manufacturer.

(3) Hot line control panel

Hot line control panel shall be used for controlling direct speech communication; such as between VFR, MACTAN TMA and MANILA ACC controller position by using leased line or VSAT line, and headset or handset shall be used for actual communication.

(4) Voice control panel

Voice control panel shall have the following functions:

- Selection of instruments for voice communication, such as headset, hand microphone or handset for communication
- Adjustment of earphones volume
- Buzzer off operation
- Press-to-talk operation

(5) VCCS

(a) Isolation devices shall be provided at the I/O terminal of interface unit.

(b) Individual interface unit shall be provided for each connection.

(c) Interface unit shall be interchangeable.

(d) Removing cards shall be possible, without removing the power, during normal operation.

(e) I/O jacks and test jacks shall be provided for monitoring and maintenance purpose.

(f) A short or open termination at the I/O lines shall not cause damage/fault to the equipment.

(g) The equipment shall provide quick and easy adjustment of audio signaling level/setting without interruption to the operation.

(h) Terminal for recording shall be provided for each individual console position.

(i) Switching shall be fully digital employing microprocessor technology. The use of mechanical relay shall be limited as much as possible.

(j) All cards, modules shall have BITE function and status indication shall be provided.

(k) Non-break DC power supply unit for VCCS shall be able to supply the power to the VCCS equipment for at least 10 mins. normal operation when there is AC input failure.

(6) Navigation aids monitor display unit (supply under NAV work)

Navaids monitor display unit shall indicate the operational status of navaids, such as ILS, VOR, DME, in the following manner and, in case trouble occurs therein, warning shall be indicated by visual and audible signals.

- Operation/failure
- Alarm for shutdown and failure
- Alarm silence
- Dimmer control

(7) Digital clock panel

(a) Digital clock panel shall indicate the present time in hours, minutes and seconds.

(b) Brightness shall be adjustable and readings shall be legible even in bright daylight in the VFR room conditions.

(c) The time signal generator shall feed the time signal, which is to be installed in the console control rack.

(8) Jack box

The jack boxes in aerodrome control console and approach control console of VFR console assembly shall be those with double jacks, one for active and another for monitor only.

(9) Runway-use indicator and control panel

(a) Runway in use indicator shall be installed at an appropriate location in the VFR room so that the controllers on duty can know the runway in use and the meteorological condition of the airport at a glance without disturbing their line of sight for the air traffic control. The indicator shall comply with the following requirement:

- Size shall be W 600 mm x H 200 mm
- Runway in use and VMC or IMC shall be indicated.
- LED shall be used and the brightness thereof shall be adjustable through the control panel on the console and LED indication shall be legible even in bright daylight in the VFR room condition.

(b) Following items shall be controlled through runway in use indicator control panel:

- Designation number of active runway
- VMC or IMC
- Brightness of the indicator

2.4 Performance Requirements

(1) Time signal generator

- Time indication : 6 digit (hour/minute/second) 7 segment LED type
- Accuracy : Within 20 seconds per year

(2) Recording channel of VCCS

- Output level : 0 dBm plus or minus 2 dB, adjustable
- Line impedance : 10 kΩ (nominal)

(3) Intercom telephone unit for Consoles

Type : Push button and hands free type with over ride function

(4) Non-break D.C. power supply

- Input : AC 230V 1 phase
- Ability : 10 minutes VCCS normal operation when AC power failure.

2.5 Accessories

The following accessories shall be provided for the VFR console:

Item	Quantity
1) Revolving armchair with castors	4
2) Headset	20
3) Hand microphone	6

3.0 DIGITAL VOICE RECORDER

3.1 General Specification

(1) The communication recorder shall be consist of duplicated Main and Stand/by Recording system, control and display system, time/ date system, and monitor system.

(2) Equipment shall be capable of unattended continuous operation up to 24 hours, each deck being capable of not less than twenty five (25) hours continuous operation.

(3) Changing over from one deck to another shall be made automatically with an adjustable overlapping period of 5 to 10 minutes to ensure uninterrupted recording.

(4) Disappearance of signal or failure of any part or unit of equipment, or a break of media shall effect instantaneous and automatic changeover to the other unit.

(5) Audio and visual alarms shall be provided to indicate such failure and/or transfer. In addition any indication given or action taken shall be indicated and stored in the memory.

(6) The communication recorder shall be mounted in cabinet-type rack.

3.2 Functional Requirement

(1) Double decks shall be identical and interchangeable. Each tape deck shall function as a stand-by for the other in the event of a media run-out, media breakage, or any other failure potentially leading to the interruption of the recording function. The transfer from one tape deck to the other shall be automatic, with manual override.

(2) Two decks shall be possible for the media on either deck for playback without affecting the operation of the other deck in any way. It shall also be possible for the two decks in a given system to simultaneously record.

(3) A cassette recording output jack shall be provided in addition to the headphone jack to facilitate re-recording procedures.

(4) The time/date system shall display the month, day, hour, minute and second of each recording.

(5) The time/date system shall permit programming of the deck transfer function.

(6) A backup battery shall be provided with the crystal controlled time base oscillator, which shall continue the timing circuits of the time generator for a minimum eighteen (18) hours during an external power failure. Upon restoration of external power, real time /date shall be generated and displayed.

(7) On-line monitoring of recorded information shall be provided.

3.3 Performance Requirement

(1) Recorder / reproducer

- Recording system : Digital recording
- Input channels : 40 channels or more
- Input impedance : 600 ohms or 10 kohms (selectable)
- Input level : Minus 10 dBm plus or minus 10 dB
- Output impedance : 600 ohms
- Output level
  - Line output : 0 dBm plus or minus 3 dB
  - Speaker output : More than 1 watt
  - Headphone output : More than 200 milliwatts
- Frequency response : Within 3 dB from 300 to 3,400 Hz
- S / N ratio : 40 dB or better
- Cross talk level : Minus 40 dB or less
- Sampling frequency : 8 kHz (for reference)
- Encoding : 8 bits LOG-PCM (for reference)
- Audio replay quality : ADPCM 24 kbps or better (for reference)
- Recording time : 25 hours / media or more
- Archive media : DVD
- Fast-forward & rewind time : 5 minutes or shorter
- Operation method : Continuous operation
- Power supply voltage : 230V AC single phase, 60 Hz

(2) Monitor panel

(a) The monitor panel shall be provided with the aural and visual indication of the operating status of the communication recorder.

(b) The monitor panel shall be provided with the following functions:

- Operation/failure indication
- Alarm for failure and system down
- Alarm silence control
- Dimmer control

(c) The monitor panel shall be installed to console at the VFR room.

3.4 Accessories

The following accessories shall be provided with each communication recorder:

Item	Quantity

1)	Media	more than 30 days
2)	Cleaner	5
3)	Headphone	1
4)	Microphone	1

4.0 VHF AIR GROUND COMMUNICATION

4.1 General

(1) This transmitter and receiver shall be designed to be fully remote controlled and all necessary interface equipment shall be supplied and installed.

(2) The equipment shall be fully solid state and composed of modules and printed circuit boards.

4.2 VHF Transmitter

(1) General requirement

(a) Transmitter shall be contained in a 19 inches cabinet together with other necessary equipment.

(b) Automatic Level Compensation (ALC) circuit shall be provided for increasing average modulation degree without causing over modulation.

(c) Side tone output circuit shall be provided for monitoring.

(d) Operating frequency shall be presentable by switch-programmable synthesizer controlled oscillator.

(e) Built-in meter or display shall be provided on front panel for routine checking, RF output power, power supply, modulation depth and VSWR.

(f) Front panel of transmitter shall include a suitable jack for a microphone and three principal switches for:

- ON / OFF switch
- Control (local / remote) switch
- PTT / TONE switch

(2) Performance requirement

-	Frequency range	:	118 to135.975 MHz
-	Number of preset channel	:	Up to 100 channel
-	Operation frequency	:	Tunable within the frequency range
-	Channel spacing	:	25 kHz
-	Type of emission	:	A3E, VDL mode2
-	Frequency setting	:	Synthesizer controlled
-	Frequency stability	:	Plus or minus 0.002% or less
-	RF output power	:	50W (out put point of transmitter)
-	Output impedance	:	50 ohms (nominal)
-	Spurious radiation	:	Minus 80 dB or less
-	Line input impedance	:	600 ohms balanced
-	Line input level	:	Minus 15 dBm to plus 5 dBm continuously adjustable

- Frequency response : Within 3 dB from 300 Hz to 3 kHz
- Distortion : Less than 5% when modulated in 90% at 1 kHz
- S / N ratio : 45 dB or better when modulated in 90% at 1 kHz
- Power supply voltage : 230V AC single-phase, 60 Hz (nominal)
- Operation method : Press-to-talk
- PTT terminal : Dry contact for remote indicator

4.3 VHF Receiver

(1) General requirement

(a) Receiver shall be contained in a 19inches wide rack or cabinet together with other necessary equipment.

(b) Squelch on-off switch and squelch level control including squelch terminal shall be provided.

(c) Operating frequency shall be pre-settable by switch-programmable synthesizer controlled oscillator.

(2) Performance requirement

- Frequency range : 118 to 135.975MHz
- Number of preset channel : Up to 100 channel
- Operation frequency : Tunable within the frequency range
- Channel spacing : 25 kHz
- Type of mode : A3E, VDL mode2
- Frequency setting : Synthesizer controlled
- Frequency stability : Plus or minus 0.002% or less
- RF input impedance : 50 ohms (nominal)
- Sensitivity : S / N 10 dB or better for 1 microvolt input, 30% modulation at 1 kHz
- Selectivity : Plus or minus 7.5 kHz at 6 dB down point
  Plus or minus 25 KHz at 80 dB down point
- Image rejection ratio : 70 dB or more
- Spurious response : 80 dB or more
- AGC characteristics : Within 3 dB for 10 microvolts to 100 millivolts
- Monitor output : More than 500 milli-watts
- Line output impedance : 600 ohms balanced
- Line output level : Minus 10dBm to plus 5dBm continuously adjustable
- Frequency response : Within 3 dB from 300 Hz to 3 KHz
- Distortion : Less than 10%
- Squelch type : Carrier to noise
- Squelch control : Continuously adjustable and on/off control
- Power supply voltage : 230V AC single-phase, 60Hz (nominal)
- Operation method : Continuous operation
- Squelch terminal : Dry contact for remote indicator

4.4 Antenna Changeover

(1) General requirement

This antenna changeover shall be responsible for all the necessary monitoring and control functions, especially:

(a) Setting the transmitter/receiver into main, standby or maintenance.

(b) Selection of the normal transmitter/receiver unit.
(c) Main transmitter and receiver shall be connected on respective antenna.

(d) Standby transmitter shall be connected to dummy load.

(e) Standby receiver shall be connected to appropriate terminating element.

(f) When receiver is on maintenance mode, its antenna input shall be connected to test input jack available on the panel for injection of appropriate test signal.

(g) The reliability and availability figure of this unit shall be equal to or greater than that of the transmitter or receiver whichever is higher.

(2) Performance requirement

(a) Monitoring

The following status indications shall be provided:

- Power ON
- Remote / local
- No.1 operation (main) / No.2 operation (standby)
- No.1 alarm / No.2 alarm

(b) Remote control function

The following control functions shall be provided:

- Power ON
- No.1 (main) / No.2 (standby) selection
- Squelch ON / OFF function (receiver)

(c) Local control function

The following control functions shall be provided:

- Power on of antenna changeover
- Remote / local selection
- No.1 (main) / No.2 (standby) selection
- Alarm reset

(3) In case of removal of power to this unit, the switch configuration shall not be affected.

4.5 VHF Antenna

Performance requirement

- Type : Ground plane type
- Frequency range : 118 to 135.975 MHz
- Polarization : Vertical
- Impedance : 50 ohms (nominal)
- Gain : Plus 1 dBi or more

- VSWR : Less than 1.5

4.6 Accessories

Microphone and earphone of the type acceptable to the Engineer shall be provided for each transmitter and receiver respectively for maintenance purpose.

4.7 VHF AM Transceiver

(1) General Specification

(a) This transceiver is Panel Mount Type VHF AM radio set for air-ground communication at the airport.

(b) The equipment shall be fully solid state and composed of modules and printed circuit boards.

(c) The transceiver shall be provided with the terminal for recording.

(d) The transceiver shall be operated by AC/DC voltage, to be installed at the VFR room, FSS Radio Room and fire trucks.

(e) The 10W transceiver for VFR room shall be panel mounted on the console and the 2 antenna shall be installed on the VFR rooftop.

(f) Battery backup DC power supply capable of running for more than four (4) hours shall be provided for the 10W transceivers to be located on the VFR console.

(g) Operating frequency shall be presentable by switch-programmable synthesizer controlled oscillator.

(2) Performance Requirement

(a) General

- Frequency range : 118to 135.975 MHz
- Number of preset channels : More than 4 channels
- Channel spacing : 25 kHz
- Type of emission : A3E
- Frequency setting : Synthesizer controlled
- Operation method : Press-to-talk
- Frequency stability : Plus or minus 0.002% or less
- Duty cycle : Continuous
- Power supply voltage : Selectable for 12V and 24V DC and 230V AC

(b) Transmitter

- RF output power : 10W (out put point of transmitter)
- Output impedance : 50 ohms (nominal)
- Spurious radiation : Minus 60 dBc or less
- Frequency response : Within 3 dB from 300 Hz to 3 kHz
- Distortion : Less than 5% when modulated in 90% at 1 kHz
- S/N ratio : 40 dB or better when modulated in 80%

at 1 kHz

(c) Receiver

- RF input impedance	:	50 ohms (nominal)
- Sensitivity	:	S / N 10 dB or better for 1 microvolt input, 30% modulation at 1 kHz
- Selectivity	:	Plus or minus 7.5 kHz at 6 dB down point Plus or minus 25 kHz at 80 dB down point
- Image rejection ratio	:	70 dB or more
- Spurious response	:	80 dB or more
- AGC characteristics	:	Within 3 dB for 10 microvolts to 100 millivolts
- Audio output	:	More than 3 watts continuously adjustable
- Frequency response	:	Within 3 dB from 300 Hz to 3 kHz
- Distortion	:	Less than 10%
- Squelch type	:	Carrier to noise
- Squelch control	:	Continuously adjustable and on / off control

(d) VHF antenna

- Type	:	Broadband omnidirectional dipole
- Frequency range	:	118 to135.975 MHz
- Polarization	:	Vertical
- Impedance	:	50 ohms (nominal)
- Gain	:	Plus 1 dBi or more
- VSWR	:	Less than 1.5

4.8 VHF FM Transceiver

(1) General Requirement

(a) The VHF FM transceiver shall consist of a base type and portable type.

(b) The equipment shall be fully solid state and composed of modules and printed circuit boards.

(c) The base type transceiver shall be provided with the terminal for recording.

(d) The base type transceiver shall be operated by AC/DC voltage. Portable type transceiver shall be operated by rechargeable battery and shall be supplied with its corresponding battery charger.

(e) The base type transceiver shall be panel mounted on the VFR console and the antenna shall be installed on the VFR rooftop.

(f) The portable type transceiver shall be hand held type.

(g) Battery backup DC power supply capable of running for more than four (4) hours shall be provided for the base type transceiver at the VFR room.

(2) Performance Requirement

(a) General

- Frequency range	:	138 to 174 MHz
- Number of preset channels	:	More than 10 channels
- Channel spacing	:	25 KHz
- Type of emission	:	F3E
- Frequency setting	:	Synthesizer controlled
- Operation method	:	Press-to-talk
- Frequency stability	:	Plus or minus 0.002% or less
- Duty cycle	:	Continuous
- Power supply voltage	:	12V (nominal) not exceed 13.8V DC
- Input voltage of portable charger	:	230V AC

(b) Transmitter

- RF output power	:	5W or more (out put point of transmitter)
- Output impedance	:	50 ohms (nominal)
- Spurious radiation	:	Minus 70 dB or less
- Frequency response	:	Within 3 dB from 300 Hz to 3 KHz
- Distortion	:	Less than 5% when modulated in 70% at 1 KHz
- S / N ratio	:	More than 40 dB when modulated in 70% at 1 KHz

(c) Receiver

- RF input impedance	:	50 ohms (nominal)
- Sensitivity	:	Less than 0.3 microvolt for 12 dB SINAD
- Selectivity	:	Plus or minus 25 kHz at 70 dB down point
- Blocking	:	More than 90 dB at plus or minus 1 MHz point
- Intermodulation	:	70 dB or more
- Spurious response	:	80 dB or more
- Audio output	:	More than 3 watt (base type) More than 500 milliwatt (portable type)
- Frequency response	:	Within 3 dB from 300 Hz to 3 KHz
- Distortion	:	Less than 5%
- Squelch control	:	Continuously adjustable and on / off control

(d) VHF antenna (Base type transceiver)

- Type	:	Broadband omnidirectional dipole
- Frequency range	:	138 to 174 MHz
- Polarization	:	Vertical
- Impedance	:	50 ohms (nominal)
- Gain	:	Plus 1 dBi or more
- VSWR	:	Less than 1.5

5.0 HF COMMUNICATION

5.1 The equipment shall be fully solid state and composed of modules and printed circuit boards.

5.2 The system configuration of the HF communication equipment is shown below:

Item	Quantity
(a) HF SSB transceiver	2 sets
(b) Remote control unit	1 set
(c) Dipole type HF antenna	1 set
(d) Headset	6 sets
(e) Hand microphone	2 sets

5.3 The equipment shall be up-to-date design and employ the latest microprocessor techniques.

(1) General requirement

(a) Dual transceiver shall be contained in a 19 inches cabinet to operate as main and stand-by equipment together with other necessary equipment.

(b) This transceiver shall be designed to be local/remote controlled and all necessary interface equipment shall be supplied and installed.

(c) Remote control unit shall be provided with the following functions:

- Main/stand-by selection
- Local/remote selection
- Frequency channel selection
- Selected frequency display
- Frequency clarifier control
- IF and AF gain control
- Receiver signal control

(2) Performance requirement of HF transceiver

(a) General

- Frequency range	:	2 to 20 MHz
- Frequency increments	:	100 Hz step
- Number of preset channel	:	100 user stations programmable spot frequency channels
- Type of emission	:	J3E (USB), R3E (USB), H3E (USB), J7B (DATA) and F1B (FSK)
- Frequency setting	:	Synthesizer controlled
- Frequency stability	:	Plus or minus 10 Hz
- Power supply voltage	:	Single phase 230V AC 60 Hz

(b) Transmitter

- RF output power	:	100W (output point of transmitter)
- Output impedance	:	50 ohms (nominal)
- Spurious suppression	:	Minus 50 dB or less
- Intermodulation distortion	:	Less than minus 32 dB below PEP
- Carrier suppression	:	Less than minus 50 dB refer to PEP (J3E)
- Line input impedance	:	600 ohms balanced
- Line input level	:	Minus 20 dBm to plus 10 dBm

			continuously adjustable
-	Frequency response	:	Within 3 dB from 300 Hz to 3 KHz

(c) Receiver

-	Sensitivity	:	0.5 microvolt or less at 10 dB S+N / N for 500 milliwatts output (J3E / J7B / F1B)
-	Selectivity	:	3 KHz band: 2.4 to 3 KHz at minus 6 dB bandwidth, 4.1 KHz or less at minus 60 dB bandwidth
-	Spurious response	:	70 dB or more
-	AGC characteristic	:	Less than 10 dB of output variation for 3 microvolts to 100 millivolts by antenna input change
-	Monitor output	:	More than 500 milliwatts
-	Line output	:	0 dBm at 600 ohms

(d) HF antenna

-	Type	:	Broadband omnidirectional dipole
-	Dipole length	:	Less than 10m
-	Frequency range	:	2 to 20 MHz
-	Polarization	:	Horizontal

(e) HF antenna tuner

-	Frequency range	:	2 to 20 MHz
-	Number of preset channel	:	100 channels or more
-	Input power	:	At least 200W PEP
-	Matching SWR	:	1.5 or less
-	Tuning time	:	Less than 10 seconds for initial tuning Less than 50 milliseconds for preset channel

8.0 MAINTENANCE INTERCOM

8.1 The equipment shall be fully solid state and composed of modules and printed circuit boards.

8.2 **Maintenance Inter-phone System shall have the following correspondents:**

- ANS FIC Room
- EQ Room
- VFR Room
- LLZ EQ Room
- LLZ Electric Room
- GS EQ Room
- GS Electric room
- VOR/DME EQ Room
- VOR/DME Electric Room
- RWY 03 Met Site
- RWY 21 Met Site
- Fire Station
- Power House (2)

9.0 OTHERS

9.1 Signaling Lamp (Air Traffic Light Gun)

(1) General Requirement

(a) Light gun shall consist of cylindrical body, bore scope, switch grip, handgrip and trigger.

(b) Light gun shall be spring-loaded with a tension permitting operation by single finger pressure without undue strain.

(c) Switch grip shall be designed for changing the color of the light beam and shall have around its vertical three color select positions, enabling the light gun to emit alternate color signals of red, green and white.

(d) Trigger shall be suitable for flashing continuous or intermittent signals (at least four words per minutes).

(e) Five (5) spare bulbs shall be provided for each unit.

(2) Performance Requirement

- Light intensity	:	Not less than 6,000 cd (color light)
- Light color	:	Red, green and white
- Light angle	:	The beam spread shall be not less than 1 degree nor greater than 3 degrees, with negligible light beyond 3 degrees.
- Power supply voltage	:	Single phase 230V AC 60 Hz

9.2 Siren

(1) General Requirement

These sirens will be installed on the VFR roof to warn people in advance of approaching aircraft or departing aircraft. Special care shall be taken against the ingress of insects, and pilferage.

(2) Performance Requirement

- Type	:	Mechanical omni-directional
- Audible radius	:	More than 1,000 m (Environmental noise level : 50 phon)
- Power supply voltage	:	Single phase 230V AC 60 Hz

9.3 Binocular

(1) General Requirement

These binoculars will be provided as visual aid to the aerodrome controller to see distant aircraft and objects.

(2) Performance Requirement

-	Type	:	Individual focusing prism binocular
-	Magnification	:	10 times
-	Objective diameter	:	70 mm
-	Angle of coverage	:	5.1 degree
-	Field of view at 1000m	:	89 m
-	Exit pupil	:	7 mm
-	Relative brightness	:	49
-	Adjustment of diopter	:	+ 2D to – 4D
-	Interpupillary distance	:	53 to 78 mm
-	Accessory	:	Case, rubber eyecups

9.4 Uninterruptible Power Supply Equipment (UPS)

(1) General requirement

(a) These specifications set forth the technical requirements for the Uninterruptible Power Supply (UPS) with rated capacity of 20 KVA which will be installed in the EQ Room of the Operation Building by electrical works.

(b) The UPS shall be designed to provide uninterruptible power at prevailing environmental conditions.

(c) The UPS shall be comprised of one set of CVCF including rectifier, inverter, by-pass circuit, uninterruptible changeover switch and output, and one set of valve regulated lead-acid stationary type or nickel cadmium alkaline battery. Battery shall be mounted in the UPS cubicle.

(d) The UPS shall operate synchronously with commercial power.

(e) When AC input is normal, rectifier shall supply the DC power to the inverter and make float charge of the battery prepared in case for AC input power failure. The inverter shall supply power to the load.

(f) Upon failure or excessive deterioration of the main supply, the inverter shall continue to supply the critical load from battery power without interruption or disturbance.

(g) The capacity of the battery shall be sufficient to supply full power for at least thirty (30) minutes.

(h) When main power is restored, the rectifier/charger shall again power the inverter without interruption or disturbance to the critical load, while at the same time recharging the battery. The rectifier/charger shall include a current limitation device to preserve the life span of the battery.

(i) In the event of battery malfunction or if the total capacity of the battery is already discharged and the main power is still abnormal, the power shall be cut-off from the load and will not be transferred to the abnormal main supply.

(j) In the event of overloads exceeding the system capabilities (short-circuits, heavy inrush currents, etc.) or inverter shutdown (manual for maintenance or automatic for internal faults), the static bypass transfer switch shall instantaneously transfer the critical load to the bypass source without

interruption.

(k) The UPS shall include a manually operated mechanical bypass system for maintenance purposes. To avoid the danger of working on live parts, this system shall be designed to isolate the inverter and the automatic bypass circuit while maintaining load power via the bypass source. Transfer to the maintenance bypass shall take place without interruption to the critical load. Similarly, an isolating device shall be provided to isolate the rectifier/charger from the main supply.

(l) The UPS shall be neatly a arranged self-standing cubicle type, fabricated from steel sheet.

(2) Performance Requirement

(a) The UPS shall have the following technical characteristics:

- Rating : Continuous
- Conversion : High frequency switched mode rectifier by the Insulated Gate Bipolar Transistor (IGBT)
- Inversion : High frequency switched mode inverter by the IGBT
- Cooling : Forced air-cooling
- AC Input
  - Phase : Three-phase, 3 wires
  - Rated Frequency : 60 Hz
  - Frequency Fluctuation : Plus or minus 5%
  - Rated Voltage : 230V AC
  - Voltage Fluctuation : Plus or minus 15%
- AC Output
  - Output Capacity : 20 KVA
  - Phase : Three-phase, 3 wires
  - Rated Frequency : 60 Hz
  - Frequency Accuracy (at free running) : Plus or minus 0.1 Hz or less
  - Synchronized Range : Plus or minus 3% or less
  - Rated Voltage : 230V AC
  - Voltage Accuracy : Plus or minus 2% or less
  - Voltage Fluctuation : Within 5% at transient full load change
  - Wave Form Distortion : 3% or less at rated input and output
  - Power Factor : 0.8 to 1.0 lagging
  - Overload Capacity : 120%, 1 minute
- Efficiency : 90% or more
- Sound Noise : 50 dBA at the point of 1 meter apart from the front panel and 1 meter above the floor level

(b) Front panel of the UPS shall be equipped with LCD instrument, operating box and graphic panel for maintenance purpose.

(c) UPS operation shall be displayed with LED on the UPS system block diagram shown on the graphic panel.

(d) Inside of the operation box shall be provided with the switches as follows:

- Operation
- Stop
- Reset

(e) The following measurements shall be indicated on the LCD instrument.

- Input/output voltage of each phase for three phase
- Input/output current
- Input/output frequency
- Battery charging current
- Battery voltage
- Output peak current
- Available battery time
- Percentage load

(f) Front of operation box shall have alarm buzzer for maintenance purpose as follows:

- Abnormal output voltage
- Abnormal DC voltage
- Fuse out
- MCCB Trip
- Fan stop
- Battery voltage low
- Fault

(g) Operational status monitor unit

(i) The operational status monitor unit shall be provided with the audible and visible indication of the operating status of the UPS.

(ii) The operational status monitor unit shall be provided with the following functions:

– Operation/failure indication
– Alarm for failure
– Alarm silence control
– Main/battery supply or protection

(h) Lightning surge protection shall be provided on the AC input terminals of the equipment.

(i) Dry contact for the following items shall be provided for remote monitoring

- Operation on bypass
- Operation on battery
- Impending battery shutdown
- Normal

(j) UPS shall be the product of an ISO 9001 certified manufacturer.

SECTION 8400

METEOROLOGICAL OBSERVATION SYSTEM

1.0 General

1.1 Scope of Work

(1) The weather instruments shall collect the weather information for aircraft operation at New BOHOL Airport which will be established as Precision Approach Airport.

(2) RWY- 03 side Weather Site

(a) One wind sensor (wind speed and wind direction) and accessories shall be installed.

(b) Necessary cables and cable duct shall be laid at the site and from the site to the LLZ Building.

(3) RWY-21 side Weather Site

(a) One wind sensor (wind speed and wind direction), air temperature/dew point sensor, air pressure sensor, RVR sensor and accessories shall be installed.

(b) Necessary cables, cable ducts and handholes shall be laid at the site and from the site to the GS Building.

(4) RWY-21 ceilometer Site

(a) One ceilometer and accessories shall be installed.

(b) Necessary cable shall be laid from the site to the GS Building.

(c) Necessary cable ducts and handholes shall be laid at the site and from main duct to the site.

(5) Operation Building Equipment Room

(a) One weather data processing unit shall be installed.

(b) Necessary cables shall be laid between processor and MDF.

(c) One modem for weather data monitor display in PTB FOBS Briefing Room shall be installed.

(6) ATC Control Tower VFR Room

(a) Two weather data monitor displays shall be installed on the Approach Control Console and Aerodrome Control Console.

(b) Two wind data indicator displays shall be installed on the Approach Control Console and Aerodrome Control Console.

(c) Necessary cables shall be laid between weather data monitor displays and Terminal Board and between weather data monitor displays and Power Distribution Board.

(7) PTB FOBS Briefing Room

(a) One weather data monitor display and one modem shall be installed.

(b) Necessary cables shall be laid between weather data monitor display and Terminal Board and between weather data monitor display and Power Distribution Board.

1.2 Design Condition

(1) The weather instrument shall conform to the following standards, recommendations, and regulations.

(a) ICAO ANNEX 3

(b) Word Meteorological Organization (WMO) Technical Regulations

(2) The weather sensors will be installed along the runway. Special care shall be taken against the ingress of insects and pilferage. The required frangibility of the installation shall be complied with.

(3) Lightning protection system shall be provided.

1.3 Equipment

The weather instruments shall comprise the following sensors and subsystems:

(a) Weather sensor

- 2 Wind speed / Wind direction sensor
  RWY 21 and RWY 03 MET site
- Temperature / Dew-point sensor
  RWY 21 MET site
- Barometric pressure sensor
  RWY 21 MET site
- RVR sensor
  RWY 21 MET site
- Cloud height sensor
  Ceilometer site
- Lightning protection
- Obstruction lights
- System accessories

(b) Weather Data Processing and Display system

- Weather data processing unit
  EQ Room
- Wind data (WD/WS) indicator
  Aerodrome Control Console
  Approach Control Console

- Weather data monitor display
  Aerodrome Control Console
  Approach Control Console
  FOBS Briefing Room (PTB)

1.4 Approval Requirement

(1) Each submission for approval of items listed under this Section shall be accompanied by specific information.

(2) The Contractor shall state in detail how he intends to carry out installation of the Meteorological System.

2.0 FUNCTIONAL REQUIREMENT

2.1 Wind data

(1) Wind sensor shall measure wind speed and direction at the representative point of the airport surface.

(2) The data obtained from wind sensors shall be transmitted to the weather station, located at the weather sensor 1 site.

2.2 Temperature data

(1) A platinum resistance sensing element-based temperature sensor shall be used for ambient air temperature measurement.

(2) The sensor shall be installed inside of naturally ventilated solar radiation shield, protecting the measurement result from the effect of direct solar radiation.

(3) The data obtained from the temperature sensor shall be transmitted to the weather station, located at the weather sensor 1 site.

2.3 Barometric pressure data

(1) Three independent pressure transducers, located inside of the weather station shall measure atmospheric pressure.

(2) The values of each individual pressure transducer shall be monitored and in case the values of one sensor are beyond the tolerance, the values of that pressure sensor shall be disregarded.

2.4 RVR data

(1) The RVR System shall be a fully automated assessment and reporting system for the operations.

(2) The system shall meet the accuracy requirements of ICAO in the range of 50-3,000 m.

(3) Direct transmission and receiving method, or scatter method, of visibility determination is acceptable. If direct transmission method used, base line should be 75 m, if scatter method used then range = 50 - 3000m

2.5 Cloud height data

(1) The Ceilometer shall report in real time cloud height up to 12000 feet above ground level in a very reliable way.

(2) The power level of the radiation shall be determined considering the following viewpoints:
- The human eye safety
- The resulting Signal-to-Noise Ratio needed for 12000 ft
- Maximizing the useful life of the expensive laser.

2.6 Weather Data Processing system

(1) The weather data processing system shall consist of sensor and data transceiving interfaces, data processing unit data storage unit and power supply unit.

(2) The sensors shall be connected in the weather data processing system, which shall collect the sensor data continuously and transmit them to the display system at the control tower etc.

(3) The weather data processing system shall have its own processor and shall operate under a real time operating system.

(4) The weather data processing system shall be expandable in the future so that new sensors could be installed in it easily through software reconfiguration.

2.7 Display system

(1) Wind direction and speed data indicator

(a) The wind data indicator shall be multi-channel and capable of visualizing up to three (3) wind sensor sites on a single indicator. Unit measurement shall be both in m/s and in Knots, selectable by turning of the indicator knob.

(b) The brightness of the display shall be possible to control and display shall be legible even in bright daylight in the VFR room conditions.

(c) A separate LED-display line for the designation number of the runway being monitored shall be included in the indicator.

(2) Weather data display

(a) The Weather data display shall be capable of displaying simultaneously Wind Speed, Wind Direction, QNH, QFE ambient air temperature, dew point, RVR and Cloud height values.

(b) The data indicator unit shall be capable of displaying several pages of information, selectable with a switch mounted on the indicator. On each page, the user shall be advised which information is being displayed.

(c) The brightness of the display shall be possible to control and the display shall be legible even in bright daylight in the VFR room conditions.

3.0 PERFORMANCE REQUIREMENT

3.1 Wind Sensors

(1) Wind speed sensor

- Type : 3-cup anemometer, opto-chopper
- Measurement range : 0 to 75 m/s (0 to 146 knots)
- Threshold : 0.4 m/s (0.8 knots)
- Accuracy : Plus or minus 0.1 m/s (0.2 knot) for winds below 10 m/s (19 knots)
  Plus or minus 2% for winds between 10 m/s (19 knots) and 75 m/s (146 knots)

(2) Wind direction sensor

- Type : Wind vane, optical code disc
- Measurement range : 0 to 360 degrees
- Threshold : 0.3 m/s (0.6 knot)
- Resolution : 5.6 degrees
- Accuracy : Plus or minus 3 degrees

3.2 Temperature Sensor

- Type : Pt-100 platinum resistance element with radiation shield
- Measurement range : Minus 5 to 60 degrees Centigrade
- Sensitivity : 0.3 ohms/^{o}C
- Accuracy : Plus or minus 0.2 degree

3.3 Barometric Pressure Sensor

- Type : Capacitive, aneroid capsule or solid state silicon pressure sensor
- Measurement range : 500 to 1050 hPa
- Resolution : 0.1 hPa
- Accuracy : Plus or minus 0.3 hPa

3.4 RVR Data

- Measuring Range (Meteorological visibility) : 50 to 3,000 m
- Accuracy : Meets the ICAO recommendations in specified ranges
- Transmission Measurement accuracy : ± 1 %
- Transmission Measurement resolution : 0.1%
- Update interval : 2 to 30 seconds
- Output data message : Visibility data, luminance data, status data
- Power supply : Single phase 2-wires, AC 230V ± 10%, 60 Hz
- Background Luminance shall be Meter Interface
- A connector provided for interfacing the Background Luminance Meter on the Light Projector.

3.5 Cloud Height Data

- Measurement range : 0 ~ 12,000 ft.
- Cloud reporting range : 50 ~ 12,000 ft.
- Accuracy : ± 20 ft. or 2% whichever is greater (measured with hard target)
- Resolution : 50 ft.
- 12,000 ft acquisition time : 30 s max.
- Tolerance of precipitation : to 7.5 mm/h (0.3 in/h); range limited
- Power Supply : Single phase 2-wires, AC 230V ± 10%, 60 Hz.

3.6 Weather Data Processing system

- Processor : Intel 3.0GHz Core i5 or higher
- Memory : 4GB RAM or more
- HD : 100GB, SATA 3G b/s, 7200rpm or more
- Interfaces : Digital input / output, differential analog inputs, voltage and current outputs
- Ports : 4-serial ports
- Data transfer rate : 300 to 19200 baud, programmable rate and frame

3.7 Display system

(1) Wind direction and speed data indicator

(a) Display

(i) Direction : Two 36-segment LED circles, one for instant or average direction. One for direction variance

(ii) Speed : 3-digit 7-segment LED display, three fields (average, maximum, minimum)

(iii) Information : Two 2-digit 7-segment LED display for runway designation number.

(b) Display brightness : Switch selector on the front panel

(c) Channel selection : Switch selector on the front panel selecting runway or site to be displayed

(d) Display modes : Switch selector on the front panel

(i) 10 min. : 10 minutes average speed and direction, speed extremes, direction variance

(ii) 2 min. : 2 minutes average speed and direction, speed extremes, direction variance where applicable.

(iii) Instant : Instant speed and direction, 6 seconds speed extremes and

direction variance

(e) Display range

(i)	Direction	:	0 to 360 degrees
(ii)	Speed	:	0 to 60 m/s (0 to 117 knots)

(f) Display resolution

(i)	Direction	:	At least 10 degrees
(ii)	Speed	:	At least 0.1 m/s (0.2 knot) at 0.5 m/s (1.0 knot)

(2) Weather Data Display

- Display computer	:	IBM PC / AT interchangeable device (industry standard), product of ISO 9001 certified manufacturer
- Processor	:	Intel 3.0GHz Core i5 or higher
- Memory	:	4GB RAM or more
- Video RAM	:	1536MB RAM or more
- Ports	:	1-serial port and 1-parallel port
- Card slots	:	PCI, 3-PCI / ISA, 1-ISA
- Hard drive	:	100GB, SATA 3G b/s, 7200rpm or more
- DVD	:	16X DVD +/- RW Dual Layer
- Peripherals	:	Keyboard: U.S. type keyboard
	:	Mouse: PS 2 or USB
- Color display	:	Type: LCD Size: 17 inches or bigger
- Printer	:	Type: Ink jet printer
- Operation system	:	Latest Windows OS

New Bohol Airport Construction and Sustainable Environmental Protection Project

Specifications

Section 9000 Series
Aeronautical Ground Lighting Works

SPECIFICATIONS

SECTION 9000 SERIES: AERONAUTICAL GROUND LIGHTING WORKS

INDEX

SECTION 9050

GENERAL REQUIREMENTS FOR THE 9000 SERIES

1.0 GENERAL

1.1 The provisions of **Section 1140** are applicable to some items of Plant and systems and are to be referred to in connection with 9000 series of the Specification.

1.2 The following provisions are additional to, and are to be read in conjunction with, Section 1140, and are particular to 9000 series of the Specification.

2.0 SCOPE OF WORKS

2.1 This 9000 series of the Specification concerns the design (where applicable), manufacture and testing at manufacturer's premises, delivery to Site, carrying out all works, installation, testing at Site, training, setting in operation and handing over in perfect operating and running condition.

2.2 Works shown on the Drawings and not mentioned or described in the Specification and works described in the Specification and not shown on the Drawings will nevertheless be considered as included in this scope of Works and their execution will be deemed to be included in the Contract Price.

2.3 Any matter not provided in the Specification shall be determined through consultation between the Engineer and the Contractor.

2.4 The Specification covers the following work items:

(1) Runway 21 Precision Approach Category I Lighting System (PALS)
(2) Runway 03 Simple Approach Lighting System (SALS)
(3) Precision Approach Path Indicators (PAPI)
(4) Runway Edge Lights (REDL)
(5) Runway Threshold Lights and ing Bar Lights (RTHL/WBAR)
(6) Runway End Lights (RENL)
(7) Stop way End Lights (Overrun End Lights) (STWL)
(8) Turning Pad Edge Lights (TPEL)
(9) Taxiway Edge Lights (TEDL)
(10) Taxiing Guidance Signs (TXGS)
(11) Wind Direction Indicator Lights (WDIL)
(12) Aerodrome Beacon (ABN)
(13) Apron Floodlighting (FLO)
(14) Cable Ducts and Manholes
(15) Control and Monitoring System

3.0 CODES AND STANDARDS

3.1 Characteristics of the aeronautical ground lighting shall, except when clearly indicated otherwise in the Specification, conform to the following ICAO Standards and Recommendations, Aerodrome Design Manual, Airport Services Manual, IEC International Standards and other related national or international regulations and agreements.

- Annex 14 Aerodromes (Third Edition – July 2009)
- Aerodrome Design Manual, Part 4 Visual Aids (Forth Edition –2004)
- Airport Service Manual, Part 9 Airport Maintenance Practices (First Edition – 1984)
- IEC International Standards (IEC-TC-97) regarding electrical installations for lighting and beaconing of aerodromes

3.2 Unless specified otherwise in this Specification, design, materials, manufacture, and testing of all works shall comply with the following Standards and recommendations;

ICAO Aerodrome Design Manual, Part 5 Electrical Systems (1st Edition – 1993)
ICAO Airport Services Manual Part 8 – Airport Operational Services
IEC - International Electrotechnical Commission Publications
ISO - International Organization for Standardization
CIE - Commission Internationale de l'Eclairage (International Commission on Illumination)
JIS - Japan Industrial Standard
JEC - Standards of Japanese Electrotechnical Committee
JEM - Standards of Japan Electrical Manufacturer's Association
PEC - Philippine Electrical Code (Part 1 and Part 2)
NSCP - National Structural Code of Philippines
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)
JCAB - General Specifications of Visual Aids and Electrical Facilities Works (4th Edition)

3.3 Materials, devices and small parts may comply with the national or international authorized Standard prevalent in the country of manufacture. However, adequate modification shall be made for the point of interface with the facilities provided in accordance with Standards and regulations of PEC.

4.0 DESIGN AND MANUFACTURE

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

Ambient temperature	Inside room 10ºC – 45ºC
	Outside 10ºC – 55ºC
Relative humidity	Inside room Max. 95%
	Outside Max. 100%

4.2 The Contractor shall submit the design documents to the Engineer for approval within one hundred and twenty (120) days from the Commencement Date. The Engineer shall be advised if any change in design is found necessary after original approval is granted. The Engineer may require re-approval if they involve changes in concept, approach, quantity, size or weight, power requirements, performance.

4.3 The design documents shall include structural calculations and drawings of proposed structures, CCR Capacity calculations, lamp wattage, number of lamp, intensity distribution diagrams and average intensity, cable size and voltage drop calculations.

4.4 Cubicles for electrical power distribution equipment shall be provided with proper ventilation grilles, and these ventilation grilles shall be designed to ensure rodents will not enter into the cubicles.

4.5 Not less than 60 days prior to the shipment of the related equipment or structures, two final draft copies of installation instructions, drawings and maintenance and operation manuals shall be submitted to the Engineer for approval.

5.0 SPARE PARTS

5.1 General

(1) The provisions of para. 18.0 of **Section 1165** are applicable and are to be referred to in connection with 9000 series of the Specification.

(2) The following provisions are additional to, and are to be read in conjunction with, para. 18.0 of Section 1165, and are particular to the 9000 series of the Specification.

(a) The Contractor shall supply spare parts sufficient for two (2) years normal operation of equipment. This two (2) year period commences after the end of the Maintenance and Repair Period as defined in **Section 1155**.

(b) The Contractor shall assure the availability of spare parts of the same type or substitutes of equal or better quality for at least ten (10) years after the issue of the Defects Liability Certificate.

(c) The spare parts shall be supplied before the issuance of the Taking-Over Certificate.

(d) The Contractor shall be responsible for the spare parts list as recommended. This list shall be prepared by the Contractor and submitted to the Engineer within one hundred and twenty (120) days from the Commencement Date. Thus, during the two (2) years period after the issuance of the Defects Liability Certificate, should any defect occurs which would require replacement of parts other than the spare parts recommended by the manufacturer, the Contractor shall supply as soon as possible the needed spare parts at his own expense.

(e) The quantity of spare parts shall be recommended by the manufacturer for the period as stated in para. 5.1(2)(a) above. The recommended quantity shall be approved by the Engineer who shall have the right to reject the quantity offered.

(f) All spares supplied shall be treated and packed for long 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. Also, containers and other packages shall be suitably marked and numbered for purposes of identification.

(g) All such cases, containers, cable drums or other packages are liable to be opened for such examination as the Engineer may reasonably require, and all such opening and subsequent repacking shall be at the expense of the Contractor.

5.2 Minimum Requirements

The Contractor shall supply as a minimum requirement, the spare parts listed below.

(a) Elevated Lights
- Light fittings
- Lamps
- Lens, filters
- Breakable couplings

(b) Surface Lights
- Light fittings
- Lamps
- Lens, filters
- O-ring, packing
- Screws, nuts

(c) PAPI System
- Light units
- Lamps
- Lens, filters
- Breakable coupling

(d) Taxiing Guidance Signs
- Sign units (for 7 letters)
- Sign units (for 3 letters)
- Sign sheets
- Lamps
- Lamp holders
- Breakable coupling

(e) Aerodrome Beacon
- Lamps
- Lens, filters

(f) Wind Direction Indicator Lights
- Lamps
- Truncated cone

(g) Apron Floodlighting
- Floodlights
- Lamps
- Ballast

(h) Isolating Transformer for H.V series Circuits
- Isolating transformer

(i) CCR
- Printed-circuit boards
- Relays
- Indicator lamps
- Indicator lamp holders
- Power fuses

6.0 TOOLS AND APPLIANCES

6.1 General

(1) The provisions of para. 17.0 of **Section 1165** are applicable and are to be referred to in connection with 9000 series of the Specification.

(2) The following provisions are additional to, and are to be read in conjunction with, para. 17.0 of Section 1165, and are particular to the 9000 series of the Specification.

(a) Tools and appliances necessary for normal maintenance shall be supplied by the Contractor.

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

(c) The tools and appliances with appropriate boxes shall be handed over to the Engineer prior to the issuance of the Taking-over Certificate.

(d) The smaller items or the tools and appliances shall be suitably arranged in fitted boxes of mild steel, wood, or plastic, 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 two keys and 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.

(e) The tools and appliances supplied shall not be used for erection purposes.

(f) The Contractor shall supply effective and efficient tools and appliances to meet the recommendations for maintenance as set out in ICAO Airport Service Manual Part.9 (Airport Maintenance Practices).

(g) The scope of tools and devices for assembly and maintenance shall include all customary tools and all devices and tools which are specially made and/or required for complete assembling, dismantling, adjustment and maintenance of all equipment.

(h) The Contractor shall submit tool list with drawing for the approval by the Engineer within one hundred and twenty (120) days from the Commencement Date.

(i) Lifter, dummy resistor for CCR shall be supplied by the Contractor.

7.0 MEASURING EQUIPMENT

7.1 Measuring equipment shall be supplied necessary for normal maintenance but not limited to those specified in the relevant sections hereunder.

7.2 Measuring equipment shall be provided with all necessary accessories for measuring with adequate supply of spares and also including operation manuals.

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

7.4 Measuring equipment except for 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 carts with steerable rubber-tired wheels shall be supplied.

7.5 All measuring equipment to be used on AC shall be suitable for 60Hz, 230V, single-phase two-wire circuits and be capable of satisfactory operation within voltage variation of ±10%.

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

7.7 The Contractor shall supply effective and efficient measuring equipment to meet the recommendations for maintenance as set out in ICAO Airport Services Manual Part 9 – Airport Maintenance Practices, Preventive Maintenance of Illuminated Visual Aids.

7.8 The Contractor shall submit measuring equipment list with related technical data and drawings for approval by the Engineer within one hundred and twenty (120) days from the Commencement Date.

8.0 EQUIPMENT REQUIREMENTS

8.1 Screw Thread

All bolts, nuts and screws shall conform to the metric thread of ISO (International Organization for Standardization)

8.2 Cleaning and Painting

(1) 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.

(2) All metalwork 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 yellow paint before shipment.

(3) All parts which will ultimately be buried in concrete shall be cleaned and protected before leaving the factory by approved method. Before being built in they shall be thoroughly descaled and cleaned of all rust and adherent matter by the used of strong wire brush.

(4) Before erection at the Site all exposed steelwork, including bare pipe surface 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 high quality paint in colors approved by the Engineer.

(5) Exterior surface of metal-enclosed switchgear and control gear (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, as follows.

(a) Before prime coat, oil or grease shall be removed with benzine or other solvent and scale, rust and other foreign substance on the surface shall be thoroughly cleaned by sandblasting or bonderizing.

(b) For prime coat an anti-corrosive paint shall be used. The dry film thickness of coating shall be not less than 0.02mm and the coating weight shall be not less

than 0.14kg/m².

(c) The coating weight of oil putty shall be decided in accordance with the surface condition of the prime coat. The coating weight of filling shall be not less than 0.15kg/m² for each coat.

(d) The dry sanding with paper shall be applied after putty. The dry film thickness of under coat shall be not less than 0.02mm and the coating weight shall be not less than 0.14kg/m².

(e) The coating weight of finish coat shall be not less than 0.12kg/m² for each coat and the dry film thickness of finish coat shall be not less than 0.035mm.

(6) 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, as follows:

(a) Before prime coat, oil or grease shall be removed with benzine or other solvent and scale, rust and other foreign substance on the surface shall be thoroughly cleaned by sandblasting or bonderizing.

(b) For prime coat an anti-corrosive paint shall be used.

(c) The dry film thickness of coating shall be not less than 0.02mm and the coating weight shall be not less than 0.14kg/m².

(d) The coating weight of finish coat shall be not less than 0.12kg/m² for each coat and the dry film thickness of finish coat shall be not less than 0.025mm.

8.3 Locks

(1) Three (3) keys shall be supplied for each lock called for under this Section of the Specification. Locks and keys for all equipment under a particular group to be designated by the Engineer shall be interchangeable.

(2) All locks for outdoor equipment shall be weatherproof.

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

(4) A rack or cabinet of approved design shall be supplied for the accommodation of padlocks and/or keys supplied under this Contract while they are not in used. The padlocks and keys shall be engraved with a suitable identifying code or inscription and this shall be repeated on the racks or cabinets on engraved labels attached thereto.

8.4 Galvanized Work

(1) 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.

(2) 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.

(3) 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 gm/m² of area covered.

(4) Galvanized wire shall comply with the authorized Standard of the country of 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.

(5) All galvanized parts shall be protected from injury to the 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.

8.5 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 manufacture.

8.6 Rating Plates and Labels

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

(2) All equipment and cubicle doors shall be labeled in an approved manner to indicate the service provided.

(3) 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.

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

(5) The inscription of all nameplates, labels shall be in English and identification marks shall be in English and clearly designate the service or rating of the particular equipment. Such nameplates or labels shall be of non-hydroscopic material with engraved lettering or a contrasting color or, alternatively, in the case of indoor switchgear, etc., of transparent plastic material with suitably colored lettering engraved on the back.

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

(7) 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.

8.7 Electrical Power Equipment

(1) 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.

(2) 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.

(3) Adequate ventilation shall be provided to enable the equipment to operate continuously under the local ambient temperature designated hereinabove, and the same time care should be taken into account of rodents.

(4) Precautions shall be taken to prevent overheating through hysteresis and eddy current loss.

(5) All electrical equipment shall be provided with a suitable grounding terminal.

(6) All electrical instruments and meters to be mounted on electrical panels shall be accurate to within ±1.5%, flush-mounting type with dustproof cover measuring 80mm – 110mm square. Wherever necessary, instruments shall be provided with easily accessible zero adjuster.

(7) All control panel wiring and secondary control wiring in circuit breakers, control gear and the like shall be made in a neat and systematic manner, with cables supported clear of the panels and other surfaces at all points to obtain free circulation of air.

(a) Wiring shall be color-coded as follows:
Green : Grounding
Yellow : All wiring other than grounding circuit

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

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

(9) Equipment shall be provided with lamps that indicate the stage of operation and a lamp test circuit shall be provided on the panel accordingly. Light emitting diode shall be adopted rather than filament lamp.

8.8 Grounding Systems

(1) Generally

(a) The lightning protection for underground cables is specified in para. 13.11 herein after.

(b) The light fittings, secondary cables and secondary wires of isolating transformers, electroducts, and exterior lighting poles shall be grounded for lightning protection.

(c) The grounding system shall be provided properly for safeguard to the person, equipment, light unit, and fitting, etc.

(d) The grounding of equipment, lights, poles, and masts shall be made

mechanically and electrically to ensure the continuous system, and shall be conductive.

(e) The common grounding counterpoise wires of the grounding system and lightning system shall be used for light fitting and light units.

(2) Common Grounding Wires

The lightning protection wires shall be installed above underground cables and power cables for linked circuits.

(3) Grounding Wires

(a) The grounding wires to be used in this work shall be manufactured and tested in accordance with the appropriate standards authorized in the country of manufacture or equivalent thereto.

(b) The portion of flexible stainless pipe protecting cables shall be bonded by 5.5mm² bare copper stranded wire.

(4) Light Fittings

The 5.5mm² bare copper stranded wire 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 (counterpoise wires).

(5) Light Units

The grounding of the PAPI, Taxiing Guidance Signs, Aircraft Stand Identification Signs, Aerodrome Beacon, Illuminated Wind Direction Indicator and Apron Floodlight shall be made by connecting 8mm² 600 volts PVC insulated wire with the grounding terminal of each light unit to the main common grounding wires.

(6) Exterior Lighting Poles

(a) All exterior lighting poles shall be grounded in accordance with PEC regulations and JIS A 4201. (The protection of structures against lightning).

(b) Lightning rods shall be mounted on the top of each pole of the apron floodlighting, and shall be bonded thereto. Two grounding plates shall be placed close to each pole and connected at its bottom part with PVC insulated wires.

(7) Equipment

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

(b) The copper grounding plates and rods shall be installed underground to a depth of not less than 1.0m. Grounding resistance of the system as a whole shall not exceed 5 ohms.

9.0 CIVIL WORKS

9.1 General

(1) This work shall be applied for the installation of mounting light bases, handholes, manholes, foundations, concrete base for cubicle/panel and outdoor cable trench.

(2) Where not specifically referenced below items of Civil Works shall meet the requirements of 2000 series of this Specification.

(3) Foundations for equipment shall be sufficient size and thickness as recommended by the equipment manufacturer.

9.2 Excavation and Backfill Work

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

(2) Excavated material may be used for backfill provided it is free of stones and other objects that can cause cable damage. Backfilling shall be put in horizontal layers not to exceed every 250 mm in depth, and shall be compacted to the satisfaction of the Engineer.

(3) The backfill of the trenches shall be in accordance with the specifications of F.A.A. AC No. 150/5370-10 (Standard for specifying construction of airport) Division VI (Lighting Installation L-108, L -110).

(4) The cables in the trenches shall be carefully laid over 75mm of sand cushion, on top of the cables another 75mm of sand layer shall be added before backfilling. To secure proper spacing horizontally and vertically adequate jigs shall be used during cable laying.

9.3 Concrete

(1) Concrete and mortar shall meet the requirements specified in **Section 1400** of this Specification.

(2) Concrete shall be Class C2 in accordance with **Section 1400**.

(3) Steel reinforcement shall meet the requirements specified in **Section 1420**.

(4) Formwork and finishing concrete shall meet the requirements specified in **Section 1440.**

(5) Joints, waterstops and sealants shall meet the requirements specified in **Section 1460**.

10.0 TESTS AND INSPECTION

10.1 General

(1) The provisions of **Section 1145 – Tests and Inspections** are applicable and are to be referred to in connection with 9000 series of the Specification.

(2) The following provisions are additional to, and are to read in conjunction with, Section 1145, and are particular to 9000 series of the Specification.

10.2 Scope of Testing

(1) The Contractor shall perform all the test activities specified in this Sub-Section.

(2) The Contractor shall prepare and submit, at least fifty six (56) days prior to any test carried out by the Contractor, two sets of detailed test procedures and schedules to the Engineer for consideration and approval. Test procedures shall be comprehensive and shall demonstrate equipment hardware compliance with all the requirements of this Specification.

(3) The entire work to be executed by the Contractor is subject to inspection and test by the Engineer during manufacturing, installation and on completion at the Site, but the approval of the Engineer or the passing of any such inspection or test shall not, however, prejudice the right to reject the items of equipment if they do not comply with the Specification when installed.

(4) Test items are shown as follows:

(a) Tests at factory by the Contractor himself
(b) Witness test at factory
(c) Tests at the Site during construction
(d) Commissioning tests
(e) Reliability tests
(f) Flight tests
(g) Other tests

(5) The Contractor should carry out the tests according to the following Tables 9050.1 to 9050.4

Table 9050.1 Test Item for Airfield Light Fittings

Test Item / Detail	1	2	3	4	Standard
Composition Test (Quality)	●	●		●	Approved Shop Drawings
Appearance & Structure Test	●	●		●	- Ditto -
Dimensional Test	●	●			- Ditto -
Photometric Test	●	●			- Ditto -
Continuous Operation Test (Temperature Rise Test)	●	●			Relevant JCAB Specification
Waterproof Test	●	●			Relevant JIS
Insulation Resistance Test	●	●	●	●	Relevant JCAB Specification
Dielectric Test	●	●			- Ditto -
Alignment Test			●	●	Document for Test and Inspection
Operation Test			●	●	- Ditto -

Notes:
1) Test at factory by the Contractor himself.
2) Witness test at factory.
3) Test at the Site during construction.
4) Commissioning test.

Sample size for test shall be decided with agreement between the Employer and the Contractor before factory test.

Table 9050.2 Test Item for Apron Floodlight Fittings

Detail \ Test Item	1	2	3	4	Standard
Composition Test (Quality)	●	●		●	Approved Shop Drawings
Appearance & Structure Test	●	●		●	- Ditto -
Dimensional Test	●	●			- Ditto -
Photometric Test	●	●			- Ditto -
Continuous Operation Test (Temperature Rise Test)	●	●			Relevant JCAB Specification
Waterproof Test	●	●			Relevant JIS
Insulation Resistance Test	●	●	●	●	Relevant JCAB Specification
Dielectric Test	●	●			- Ditto -
Alignment Test			●	●	Document for Test and Inspection
Operation Test			●	●	- Ditto -

Notes:
1) Test at factory by the Contractor himself.
2) Witness test at factory.
3) Test at the Site during construction.
4) Commissioning test.

Sample size for test shall be decided with agreement between the Engineer and the Contractor before factory test.

Table 9050.3 Test Item for Constant Current Regulator

Detail \ Test Item		1	2	3	4	Standard
Composition Test (Quality)		●	●		●	Approved Shop Drawings
Appearance & Structure Test		●	●	●	●	- Ditto -
Dimensional Test		●	●			- Ditto -
Photometric Test		●	●			- Ditto -
Operation Test	1) Transitional Response Test	●	●			- Ditto -
	2) Soft-starting Test	●	●			- Ditto -
	3) Brilliancy Tap Changing-over Test	●	●	●	●	- Ditto -
	4) Protective Device Test	●	●	●	●	- Ditto -
	5) Overall Operational Test	●	●	●	●	- Ditto -
Insulation Resistance Test		●	●	●	●	JCAB Specification
Dielectric Test		●	●			JCAB Specification
Temperature Test		●	●			JCAB Specification

Notes:
1) Test at factory by the Contractor himself.
2) Witness test at factory.
3) Test at the Site during construction.
4) Commissioning test.

Sample size for test shall be decided with agreement between the Engineer and the Contractor before factory test.

Table 9050.4 Test Item for Control Equipment

Test Item / Detail	1	2	3	4	Standard
Composition Test (Quality)	●	●			Approved Shop Drawings
Appearance & Structure Test	●	●	●	●	- Ditto -
Dimensional Test	●	●			- Ditto -
Insulation Resistance Test	●	●	●	●	- Ditto -
Operation Test	●	●	●	●	Relevant JCAB Specification or JIS
Dielectric Test	●	●			- Ditto -

Notes:
1) Test at factory by the Contractor himself.
2) Witness test at factory.
3) Test at the Site during construction.
4) Commissioning test.

Sample size for test shall be decided with agreement between the Engineer and the Contractor before factory test.

10.3 Documents for Tests and Inspection

(1) 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 procedure of tests at the factory.
(b) Complete description in writing about procedure of tests at the Site.
(c) Complete description in writing about procedure of commissioning tests at the Site.

(2) Certified readings and data of all tests to be carried out by the Contractor shall be submitted to the Engineer from time upon completion of each test and the Contractor shall prepare additional four (4) copies of complete set of these test data bound in book form for submission at the time of the commissioning test.

10.4 Factory Tests

(1) Factory tests shall be made by the Contractor on specific items of equipment to demonstrate that the equipment complies with applicable specifications and, additionally, any test called for by the Engineer to ensure that the equipment to be supplied meets the requirements of the Specification. The methods of testing of equipment not covered by any specification or applicable Standards shall be agreed with the Engineer.

(2) The Engineer shall be given the option of witnessing all tests. When the equipment is ready for inspection or test, the Contractor shall give notice to the Engineer together with the data of tests done by himself.

(3) The results of factory tests shall be recorded for submission to the Engineer, copy furnished to the Employer, prior to the shipment of the equipment item.

(4) The test report shall contain the information specified below:

(a) Indicate the performance of each equipment under the test and whether it meets the system limits.
(b) A record of any engineering changes necessary to correct design deficiencies.

(5) The suitability of diagnostics and technical manuals provided by the Contractor and their capability of off-line failure isolation and its repair shall be proved by the Contractor.

(6) The Contractor shall include all the costs required for such factory test mentioned below :

(a) Number of person to be dispatched from the Employer/Engineer : Four (4) persons (maximum).

(b) Round trip air ticket between Manila and supplier's country.

(c) Accommodation.

(d) Local transportation fee and subsistence allowance.

(e) Test period : Total 20 working days.

10.5 Tests at Site during Construction

During the course of installation, the Engineer shall have full right for making tests and inspection for the work, as he may deem necessary always with the participation of the Employer's personnel in all tests at Site if so requested by the MIAA for the purpose of on-the-job training. In this case, the Contractor may have part of the tests conducted by such personnel but shall assume final responsibilities for test results.

10.6 Commissioning Tests

(1) Commissioning tests of the system shall be carried out after it has been installed and tested. No commissioning test shall be commenced without prior approval of the Engineer to the schedule and procedure which are to be followed. At least ten (10) working days' notice of the Contractor's readiness to start each site test shall be given to the Engineer.

(2) The Contractor shall conduct the commissioning tests which, however, shall be carried out under the direction of the Engineer.

10.7 Reliability Tests

(1) When the Contractor considers that the installations 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 will be

required to operate under the working conditions, either continuously or intermittently as may be convenient, without failure or interruption of any kind for a period of not less than fifteen (15) days.

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

10.8 Flight Tests

(1) Within sixty (60) calendar days after the 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.

(2) 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.

(3) The Employer shall make arrangement of an aircraft and personnel necessary for the flight test, and shall notify the Contractor the date of the commencement of the test within thirty (30) days after the date of completion of the reliability test.

(4) 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 check smoothly and satisfactorily.

(5) The Contractor at his own expense, shall be responsible for and make good such defects as found by the flight tests. In the event of retesting by flight 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.

(6) The cost of flight test shall be borne by the Employer, however, should the said flight time and period of flight test be exceeded for any reason of the Contractor, the additional cost of any further flight test shall be borne by the Contractor.

10.9 Other Test

(1) The Contractor shall carry out any test other than specified hereinabove wherever so required by the Engineer. All tests shall be carried out in the presence of the Engineer and the personnel of MIAA and to their complete satisfaction.

(2) The Contractor may use for this at the Site the measuring equipment supplied by him under the Contract with permission of the Engineer, provided that such equipment be restored to its original condition at the time of commissioning tests.

10.11 Retest

Should the systems or any portion thereof fail under test 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.

10.12 Rejection

If any item fails to comply with the requirements specified in the Specification in any respect whatsoever at any stage of manufacture, test, erection 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 Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer.

11.0 TRAINING OF PERSONNEL

11.1 General

(1) The provisions of **Section 1150** are applicable and are to be referred to in connection with 9000 series of the Specification.

(2) The following provisions are additional to, and are to be read in conjunction with, Section 1150, and are particular to 9000 series of the Specification.

11.2 Phases of Training

(1) The Contractor shall conduct training for technical personnel who will operate and maintain the system equipment supplied under this Contract.

(2) Training for equipment operation and the maintenance of the equipment and systems shall be provided as specified herein in phases as follows:

(a) Factory training.
(b) Local training.
(c) On the job training.

(3) All training shall be conducted in English language and be suitable for trainees with the appropriate level of education. A detailed program for all training shall be submitted to the Engineer not later than fifty-six (56) days before any training is started.

(4) The Contractor shall update, if deemed necessary by the Engineer, the detailed program under the Contract not later than twenty-eight (28) calendar days before the date when the Contractor intends to start the program.

(5) The Employer 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 deemed disqualified and to request the Employer to nominate other candidates.

(6) The Employer shall have the trainees qualified by the Contractor be ready and available for the training in accordance with the said program.

11.3 Factory Training

(1) Factory training of the Employer’s trainees shall be conducted in the manufacturer’s country before shipment.

(2) The Contractor shall include all the costs required for such training mentioned below:

(a) Maximum number or persons to be dispatched from the Employer four (4) persons in the field of Aeronautical Ground Light.
(b) Round trip air ticket between Manila and supplier's country.
(c) Accommodation
(d) Local transportation fee and subsistence allowance.
(e) Training Period: Total 2 weeks.
(f) Training subjects shall include the following:
Inset lights, PAPI, TXGS, ASIS, CCR, Remote control and Monitoring System.

11.4 Local Training

(1) Training facilities shall be provided by the Contractor.

(2) Maximum number of trainees to attend the course for theoretical and practical training shall be twelve (6) persons per course

(3) The duration of the course both for theoretical and practical shall be at least the duration mentioned below:

	Course	Theoretical	Practical
(i)	Lighting	1 week	1 week
(ii)	Cables	3 days	3 days
(iii)	Isolating Transformer	3 days	3 days
(iv)	CCR	1 week	1 week
(v)	Control and Monitoring System	1 week	1 week

(4) The Contractor shall include the cost of instruction for the above mentioned courses and training manuals and material to be used in the courses, in his unit rates or lump sum prices, unless identified separately in the Bills of Quantities.

11.5 On the Job Training

(1) OJT shall be rendered by the Contractor (utilizing the manufacturer's engineers) to the Employer's trainees for the duration of installation and testing.

(2) The Contractor shall include the cost for such OJT in his unit rates or lump sum prices, unless identified separately in the Bills of Quantities.

12.0 OPERATION AND MAINTENANCE MANUALS

12.1 General

(1) The provisions of para. 16.0 of **Section 1165** are to be referred to in connection with 9000 series of the Specification.

(2) The following provisions are additional to, and are to be read in conjunction with, para. 16.0 of Section 1165, and are particular to 9000 series of the Specification.

12.2 Draft Manuals

The draft manuals to be submitted shall include, as a minimum, the following:

(a) Introductory material stating the model or type designation, the equipment purpose, and any appropriate general descriptive information.

(b) Preparation for use – any special unpacking and assembling requirements shall be explained. Essential installation instructions, such as foundation requirements, plumbing or electrical connections, power requirements and initial lubrication, servicing and inspection instructions shall also be explained.

(c) Operating Instructions – as applicable to the equipment, operating instructions shall include but not be limited to: preliminary adjustment and control settings, starting and stopping the equipment, operation, etc.

(d) Cleaning and lubricating.

(e) Trouble-shooting.

(f) Preventive maintenance.

(g) Test equipment.

(h) Parts list, (including component and parts layout)

(i) Maintenance record log forms and check lists for daily, weekly, monthly, semiannually and annually.

(j) Service life (year or hours) of equipment and main parts and devices.

13.0 CABLE WORKS

13.1 General

(1) Airfield lighting power and control cables shall be installed in ducts, conduits, and pits and on cable racks. Counterpoise wire and underground cable marker sheet shall be installed in the trench of cable ducts.

(2) The cable conductor size in the Specification and on the Drawings are given in mm or mm^2.

(3) The following information shall be marked repeatedly on suitable part of the cable.

Manufacturer's Name and/or Trademark
Size of Stranded Conductor Cross Section (for 5kV, 3kV only)
Voltage rating (for 5kV, 3kV only)
Year of Manufacture

(4) Cable length per cable drum shall be less than 1000 meter, and total weight of cable and drum shall be less than 5 tons, for easy transportation. The Contractor shall submit AGL power cable length list to the Engineer for approval before manufacturing.

(5) Where cable end projects from a drum they shall be adequately protected to prevent damage during handling and transportation, and a thick PVC wrapper (cap) shall be placed over the cable to prevent the ingress of dirt, dust and grit, etc.

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

(7) Particulars of the cable, i.e. type of cable, rated voltage, length, conductor size, number of cores, gross and net weights, as well as position of cable end, manufacturer's name and year and month of manufacture shall be clearly shown on the drum. The direction of rolling shall be indicated by an arrow.

13.2 Underground Series Circuit Cable (5kV and 3kV-single core)

(1) Aeronautical Ground light power cable shall be manufactured in accordance with PEC.

(2) High voltage series circuit cables to be used in the Works shall be 8mm² single conduct, ethylene-polypropylene rubber insulated, polychloroprene sheathed cables as follows:

Table 9050.5 Cable Details (1)

Voltage Rating		kV	5	3
No. of Conductor		-	1	1
Conductor	Nominal area	mm²	8	8
	No. and dia. of wires	No./mm	7/1.2	7/1.2
	Outside dia.	mm	3.6	3.6
EP Rubber Insulation Thickness		mm	4.0	2.5
Polychloroprene Sheath Thickness		mm	1.8	1.7
Outside Dia. of Sheath		mm	15.2	12.0
AC Test Voltage (for 10 Minutes)		kV	17	9
Insulation Resistance for 1000 m (20ºC) min.		meg ohm	900	600
Conductor Resistance per 1000 m (20ºC) max.		ohm	2.41	2.41

(3) The cable conductor will be tin or lead-alloy coated annealed stranded copper wires.

(4) The average thickness of the insulation and sheath shall not be less than 90% of the value given in Table 9050.5. The minimum thickness of the insulation and sheath at any point shall be not less than 80% of the specified value.

(5) The average thickness of the polychloroprene sheath (which will be black in color) shall be not less than 90% of the value given in Table 9050.5. The minimum thickness at any point shall be not less than 80% of the specified value.

(6) The primary cables shall be provided either with a factory molded receptacle or factory molded plug, depending upon their location.

13.3 Extension Cables - Secondary (600V, 2 PNCT Cable) and Wires to the Light Fitting

(1) The extension cable between the isolating transformer and light fitting shall be 3.5 mm² double-conductor, ethylene-polypropylene rubber insulated, polychloroprene sheathed portable cable. 2 PNCT Cable shall be manufactured in accordance with JIS-C 3327.

Table 9050.6 Cable Details (2)

Voltage Rating		V	600
No. of Cores		-	2
Conductor	Nominal cross-sectional area	mm²	3.5
	Composition and No. of wires	mm	45/0.32
	Outside diameter	mm	2.5
Thickness of Separator		mm	0.05
Thickness of Insulation		mm	0.8
Cabling Dia., approx.		mm	8.4
Thickness of Sheath		mm	1.9
Overall Dia. of Cable, approx.		mm	12.5
Weight of Cable per 1000 m, approx.		kg	245
Conductor Resistance per 1000 m (20ºC) max.		Ohm	5.54
AC Withstand Voltage for 1 Minute		kV	3.0
Insulation Resistance for 1000 m (20ºC) min.		meg ohm	400

(2) The secondary cables shall be provided either with a factory moulded receptacle or factory molded plug, depending upon their location.

13.4 Plugs and Receptacles

(1) Plugs and receptacles for the 5kV and 3kV single-conductor cables shall be designed for 25A current, and for the 600V, two-conductor cables for 20A.

(2) The plug and receptacle shall be water tight and will withstand continuous use under the designed ambient temperature range. The connector plug and receptacle shall resist a pulling force equal to a static weight of 5 kg without becoming disconnected. All plugs and receptacles shall be identical and of uniform manufacture.

13.5 Isolating Transformer

(1) The types and characteristics of the isolating transformer to be supplied shall be as shown in Table 9050.7.

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

Table 9050.7 Isolating Transformers

Characteristics	60 watt	100 watt	200 watt	300 watt	Remarks
Primary Current (A)	6.6	6.6	6.6	6.6	100% load
Secondary Current (A)	6.53-6.67	6.53-6.67	6.53-6.67	6.53-6.67	100% load
Secondary Current (A)	6.6-7.1	6.6-7.1	6.6-7.1	6.6-7.1	Short circuit
Primary Power Factor (%)	Min. 95	Min. 95	Min. 95	Min. 95	100% load
Efficiency (%)	Min. 85	Min. 85	Min. 90	Min. 91	100% load

Primary Voltage Regulation (%)	Max. 90	Max. 80	Max. 80	Max. 80	Open circuit
Frequency	60Hz	60Hz	60Hz	60Hz	
Rated Voltage	3000V	5000V	5000V	5000V	

(3) All isolating transformers shall be completely waterproof, shall withstand continuous use under the designated ambient temperatures and shall be suitable for burying in the ground or setting in transformer boxes, as required. Each transformer shall be completely sealed together with the lead cable joints, in black vulcanized rubber with polychloroprene sheathing of 7 mm or more in thickness to ensure water tightness.

(4) Two primary lead cables and one secondary lead cable shall be attached to the isolating transformer.

(5) The primary lead cables shall be 340 mm ± 30 mm in length, single-cored, 8 mm² PN cables, the one with a receptacle and the other with a plug. The receptacle and the plug shall be factory molded.

(6) The secondary lead cable shall be of 600V 2 x 3.5 mm² 2 PNCT, 1100 mm ± 50 mm in length in principle, and provided with a factory-molded receptacle. Isolating transformers shall show rating information. The Contractor shall examine necessary length of the secondary lead cable in consideration of the overall height of light.

13.6 Power and Control Cables

(1) All power cables of parallel circuit, as well as all control cables to be used in the Works shall be manufactured and tested in accordance with the following Standards:

IEC - International Electrotechnical Commission
JIS - Japan Industrial Standard
JCS - Japanese Cable Makers Association Standards
ICEA - Insulated Cable Engineers Association, U.S.A.

(2) All power cables, except where otherwise specified, shall be cross-linked polyethylene insulated and polyvinyl-chloride sheathed cables.

(3) All control cables, except where otherwise specified, shall be polyvinyl-chloride insulated, polyvinyl-chloride sheathed control cables.

13.7 Bare Copper Wire (Counterpoise wire)

(1) Bare copper wires for counterpoise installations shall be stranded or PVC insulated wire with a minimum size of 14 mm². Preference will be given to 600V polyvinyl-chloride insulated wires for long service life.

(2) The grounding wires to be used in this work shall be manufactured and tested in accordance with the appropriate Standards authorized in the country of manufacture, or equivalent.

13.8 Series Circuit Cable Joint

(1) All joints of the series circuit cables including their extensions, as well as joints with lead cables of the isolating transformer shall be made by means of the plug and the

receptacle factory-molded on cable ends.

(2) Prior to joining, the plug and the receptacle shall be thoroughly cleaned to be free from greases, dust, etc.

(3) Unless otherwise specified, all plug joints shall be protected by 4 layers of self-bonding tape, topped by 3 layers of PVC tape, with the exception of all connections with the secondary lead cable of the isolating transformer, whose receptacle shall be joined to the plug of the light fittings by means of a cable clamp.

13.9 Power and Control Cable Joint

(1) Joints and terminations of the power cable and control cables shall be executed in a manner to be approved by the Engineer. For the sake of easy access for maintenance, in principle all joints shall be made in the manholes or handholes.

(2) The Contractor submit jointing point location plan for the Engineer's approval within one hundred and twenty (120) days from the Commencement Date.

(3) Full details of jointing materials shall be submitted to the Engineer for written approval, before shipment.

13.10 Installation

(1) Power cable installation shall be executed in accordance with ICAO Aerodrome Design Manual Part 5 – Electrical Systems, - 4.5 Installation of underground cables.

(2) The approximate routes of the cables are shown on the Drawings. Actual laying positions of the cable ducts and of cable supports shall be determined with due regard to any obstacles that might exist as well as to accessibility of all such routes, subject to the approval of the Engineer prior to the installation.

(3) Galvanized steel pipe ducts shall be used where cables are installed under the pavement area. Where crossing runways, taxiways, roads or aprons those underground cables shall be protected with galvanized steel pipes.

(4) The series circuit cables, power cables, control cables and cables of radio navigational aids and communications shall be allocated separate duct pipes.

(5) When the supply and return circuits of a series circuit are routed together, the cables for both directions shall be laid in the same duct pipe. However, when one lighting system receives its power supply though 2 circuits, the cables for each circuit shall be laid in separate pipes.

(6) All cables shall be buried at least 600 mm below finished graded except for transformer secondary cable.

(7) Minimum spacing between underground cables to be maintained:

Between same voltage cables	60 mm
Between 6 kV cables and 600V cables	150 mm
Between 6 kV cables and light-current cables	300 mm
Between 5 kV cables and 600V cables	150 mm
Between 5 kV cables and light-current cables	300 mm
Between 600V cables and light-current cables	300 mm

(8) Each underground cable shall bear cable identification circuit markers for a non-corrodible materials, as directed by the Engineer. Cable installation shall be in accordance with the specification of FAA AC No. 150/5370-10 (Standard for specifying construction of airport) Division VI (Lighting installation, Item L-108 Installation of Underground cable for airports)

13.11 Grounding Systems

(1) A stranded bare copper wire 14 mm² minimum size shall be installed for lightning protection of the underground cables in trenches.

(2) The copper wire shall be installed in the same trench for the entire length of the insulated cables; it shall be placed at a depth of approximately 300 mm above the insulated cables. Where the cables are installed in parallel and their width exceeds 300 mm, the bare copper wire shall be installed each 300 mm width.

(3) The grounding rods shall be installed not more than 200 m apart around the entire cable length. The grounding rods shall be made of copper clad steel, coupled type, 1.5 m in length 10 or 14 mm in diameter. The grounding resistance as a whole shall be less than 10 ohms. The grounding resistance of each electrode shall be not more than 20 ohms.

(4) The grounding rod shall be installed not more than 750 mm in depth at the upper portion of the rod.

13.12 Secondary Cable Installation

(1) The extension wire to be used between the isolating transformer and light fittings shall be installed inside galvanized steel pipe on the lowest base of the piping pit.

(2) After the piping has been installed on dry condition, the backup materials shall be provided on the pipes. Backup materials such as cement mortar shall be provided full around these pipes in the pits. The backup materials shall be approved by the Engineer, before installations.

14.0 MEASUREMENT AND RATES

14.1 Measurement

Work under this Sub-Section shall be measured according to the item classification and units contained in the Bills of Quantities (BOQ).

14.2 Rates

(1) The rates and lump sums shall be full compensation for all plant, materials, labour, equipment, transport, temporary works, establishment charges, overheads, profits and taxes required to complete the work contained in this Section of the Specification and/or shown on the Drawings.

(2) The rates for cabling shall further include for:

(a) Trenches excavated by hand or machine, and in all types of ground including backfilling, disposal of surplus material, supports, protection and maintenance of sides, dewatering, etc.

(b) Rigid steel pipe, SGP or FEP (where not measured separately)

(c) Terminations, including gland assemblies, lugs, ferrules, seals, earth tags, shrouds, markers and connections

(d) Cable supports and protection, including raceways, rigid or flexible conduits, cable trays, trunking, ladders (unless separate pay items have been specifically included in the Bills of Quantities) and for all fittings, supports, brackets thereto

(e) maintaining earth continuity

(f) cable sleeves for casting into the structure and caulking between cables and plugging sleeves with fire resistant material

(g) all necessary marker post, marker tape, plates and tiles

(h) fixing to and embedding in any surface the foregoing items including providing all clips and fixings, cutting out holes, notices and chases, finishing over and all making good

(3) The rates for underground ducts (where measured separately) shall include for:

(a) Trenches excavated by hand or machine, and in all types of ground including backfilling, disposal of surplus material, supports, protection and maintenance of sides, dewatering, etc.

(b) bedding

(c) concrete encasement

(d) all short lengths and joints in the running lengths, including the provision of all loose collars, coupling and similar items where required and all jointing and sealing materials including gaskets, bolts and nuts

(e) Any assemblies (Rigid steel, FEP or SGP ducts)

(f) providing all necessary fittings including joints, marker-plates or posts, plugs, draw-cords and the like

(4) The rates for electrical manholes and Handholes shall include for:

(a) excavating by hand or machine, and in all types of ground, including all backfilling, disposal of surplus material, supports, protection and maintenance of sides, dewatering, etc.

(b) concrete, reinforcement and formwork

(c) covers and frames and cable support

(d) forming holes for building in ducts

(e) forming rebates for and building in frames

(5) The rates and lump sums shall further include, if not itemized separately in the BOQ

for the following Sections:

(a) Contractor’s design (where applicable)

(b) Training for equipment and systems

(c) Spare parts

(d) Testing and commissioning

(e) Maintenance tools, appliances and special tools

(f) Measuring equipment

(e) Protection

SECTION 9100

APPROACH LIGHTING SYSTEMS

1.0 RUNWAY 21 PRECISION APPROACH LIGHTING SYSTEM (PALS)

1.1 Scope

This work includes the supply and installation of the Precision Approach Category I Lighting System for Runway 21.

1.2 Lighting System

(1) The Approach Lighting System shall be high intensity system with Barrette Center Line.

(2) The Approach Lighting System shall consist of:

(a) A row of white lights, on the extended center line of the runway extending a distance of 900 m from the runway threshold.

(b) Barrettes which consists of five (5) light sources spaced 1 m apart at least 4 m in length, to be placed at longitudinal intervals of 30 m.

(c) The width of the crossbar and the number of fittings excluding center line fittings shall be:

Location	Width	No. of Fittings
300 m	30.0 m	16

(d) The Precision Approach Lighting System shall comprise elevated type unidirectional light fittings and surface type unidirectional light fittings within the overrun pavement.

(3) All lights shall be cleared (white) for an approaching aircraft.

1.3 Light Fittings

(1) Each high intensity light fitting shall be of the unidirectional type with light distribution of an intensity of Category I as shown in Appendix 2, Figure 2.1. of ICAO Annex-14. Elevated light fittings shall employ a single tungsten halogen lamp 6.6 amperes 200 watt and surface light fittings shall employ a single tungsten halogen lamp 6.6 amperes 275 watt.

(2) Elevated light fittings shall be subjected to thermal shock test in accordance with ICAO aerodrome design manual.

(3) Each fitting and supporting pole if necessary shall be of lightweight frangible construction suitable for concrete mounting base and shall be of sufficient strength to withstand aircraft engine blast.

(4) Exterior finished color of elevated light fittings shall be red or yellow.

(5) Surface type light fitting outer ring and space ring shall withstand (without damage) the mechanical stresses specified in FAA AC No. 150/5345-46B Specification for Runway and Taxiway Light Fixtures (Sept. 1998).

1.4 Installation

(1) Elevated type lighting fittings shall be installed on the top of the breakable coupling which is to be fitted to the conduit pipe (referred to as normal-bend on the Drawings) housed in the concrete base with transformer box.

(2) Where necessary, elevated type light fittings shall be installed on the top of the aluminum pipe which is to be fitted to concrete base with transformer box. The overall height of elevated light will not exceed approximately 1.8 m above ground level.

(3) Five (5) surface type light fittings in the overrun shall be installed on the outer ring and spacer ring which is to be fitted to the base box housed in the concrete base. This base box shall be connected to the galvanized steel pipe of 32 mm buried in the overrun pavement area.

(4) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, mounting base, and hand hole the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

(5) In azimuth the axis of the beams of the high intensity approach center line lights and crossbar lights shall be parallel with the extended center line of the runway.

(6) In elevation the axis of the beams of the high intensity approach lights shall be set as follows:

Center Line Lights and Cross Bar Lights

Threshold to 300 m	5.5 degrees
330 to 450 m	6.0 degrees
480 to 630 m	7.0 degrees
660 to 900 m	8.0 degrees

These lights shall be installed as accurately as practicable, but in no case shall the error be greater than ± 2% gradient.

1.5 Concrete Mounting Base

(1) The Contractor shall be submitted to the Engineer for approval structural calculation and drawings of proposed base box with concrete base in pavement.

(2) Concrete for the mounting based, and the base in blast pad pavement area shall be as specified in **Section 9050**.

(3) The concrete mounting base shall contain a transformer box and shall be so erected as to be capable of supporting the light fitting horizontally balanced within a tolerance of ±2 % gradient.

(4) Base box for surface type light shall be made of aluminum alloy castings or stainless steel plates.

(5) Base box of surface type light shall be connected to the concrete transformer box (Handhole) by 32mm inside diameter hot dipped galvanized steel pipe and flexible stainless steel joints where necessary.

1.6 Isolating Transformers

A rubber molded isolating transformer shall be installed in each transformer box of the concrete mounting base.

1.7 Power Supply System

The approach lights shall be supplied with power from the Power Substation by means of interleaved two circuits system operating on a constant current, high voltage series loop circuit of 6.6 amperes at 100% brilliance.

1.8 Brilliancy Control

The Approach Lighting System shall be controlled in five (5) brilliancy steps of 100%, 25%, 5%, 1%, and 0.2% of the full brilliance by means of Logical Control System automatically and ATC Controller at the Control Tower manually.

2.0 RUNWAY 02 SIMPLE APPROACH LIGHTING SYSTEM (SALS)

2.1 Scope

This work includes the supply and installation of the Simple Approach Lighting System for Runway 03.

2.2 Lighting System

(1) The approach lighting to be installed on Runway 03 shall be the Simple Approach Lighting System consisting of center line bars of lights placed along the extended center line of the runway over a distance of 420 m from the runway threshold, plus a bar of lights forming a crossbar 30 m in length placed at a distance of 300 m from the runway threshold.

(2) Each center line bar comprises five (5) high intensity lights. The crossbar shall comprise sixteen (16) high intensity lights.

(3) The lights forming the center line shall be placed at longitudinal intervals of 60 m.

(4) All of the lights shall be cleared (white) for an approaching aircraft.

2.3 Light Fittings

(1) High intensity light fitting shall be of unidirectional elevated type with light distribution of an intensity of Category I as shown in Appendix 2, Figure 2.1 of ICAO Annex – 14 and light fittings shall employ a single tungsten halogen lamp, 6.6A 200W.

(2) Each fitting and supporting pole if necessary shall be of lightweight frangible

construction suitable for concrete mounting base and shall be of sufficient strength to withstand aircraft engine blast.

(3) Exterior finished color of light fitting shall be red or yellow.

2.4 Installation

(1) High intensity light fittings shall be installed on the top of the breakable coupling which is to be fitted to the conduit pipe (referred to as normal-bend on the Drawings) housed in the concrete base with transformer box.

(2) Where necessary, high intensity light fittings shall be installed on top of the aluminum steel pipe which is to be fitted to concrete base with transformer box. The overall height of light shall not exceed 1.8 m above ground level.

(3) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

(4) In azimuth the axis of beam of the high intensity approach center line lights and cross bar lights shall be parallel with the extended center line of the runway.

(5) In elevation the axis of the beams of the high intensity approach lights shall be set as follows:

Center Line Lights and Crossbar Lights

Threshold to 300 m	5.5 degrees
300 to 420 m	6.0 degrees

These lights shall be installed as accurately as practicable but in no case shall the error be greater than ± 0.25 degree.

(6) The Contractor shall construct an embankment at and around the 300m crossbar.

2.5 Concrete Mounting Base

(1) Concrete for the mounting base shall be as specified in **Section 9050**.

(2) The mounting concrete base shall contain a transformer box. The mounting base shall be so erected as to be capable of supporting the light fitting horizontally balanced within a tolerance of ±2% gradient.

2.6 Isolating Transformer

A rubber molded transformer for the light fitting shall be installed in each transformer box of the concrete mounting base.

2.7 Power Supply System

The approach lights shall be supplied with power from the Power Substation, by means of interleaved two-circuit system operating on a constant current, high voltage series loop circuit of 6.6 amperes at 100 % brilliance.

2.8 Brilliancy Control

The high intensity Approach Lighting System shall be controlled in five (5) brilliancy steps of 100%, 25%, 5%, 1% and 0.2% of the full brilliance, by means of Logical Control System automatically and by ATC Controller at the Control Tower manually.

SECTION 9200

PRECISION APPROACH PATH INDICATOR (PAPI)

1.0 SCOPE

This work includes the supply and installation of the Precision Approach Path Indicator System.

2.0 LIGHTING SYSTEM

2.1 Precision Approach Path Indicator System for both Runway 21 and Runway 03 shall comprise a total of four (4) each light units placed at left side of the runway and right angles to the runway center line.

2.2 Each light beam angle of elevation setting for 3 degree PAPI approach slope shall be 2º30', 2º50', 3º10' and 3º30' respectively for Runway 03.

2.3 Each light beam angle of elevation setting for 3 degree PAPI and ILS/GS approach slope shall be 2º25', 2º45', 3º15' and 3º35' respectively for Runway 21.

3.0 LIGHT UNITS

3.1 Each unit shall contain three (3) high intensity tungsten halogen lamps 6.6A 200W and shall comprise a glass fiber or aluminum plate housing containing the optical projectors, filters, lamps, lead cables, etc., with an adjustable positioning frame and mounting legs to give an adjustment in lateral, transversal, horizontal and elevation angle.

3.2 The color transition from red to white in the vertical plane shall be such as to appear to an observer at a distance to occur up to a vertical angle of not more than 3 minutes.

3.3 The light distribution of each unit shall be in accordance with the specification of Appendix 2, Figure 2, 23 of ICAO Annex -14.

3.4 The intensity of the completely red beam immediately below the transition sector shall not be less than 15% of the intensity of the completely white beam immediately above the transition sector.

3.5 The light unit housing shall be guaranteed against distortion due to sun or other climatic conditions prevailing on the Site.

3.6 Each light unit and supporting pipe shall be of lightweight, frangible construction suitable for concrete mounting base and shall be of sufficient strength to withstand aircraft engine blast.

3.7 Exterior finished color of light units shall be red or yellow.

4.0 INSTALLATION

4.1 Each light unit shall be installed on top of the flat steel structures which are to be fitted on a concrete mounting base using a breakable coupling, frangible pipe or steel pipes.

4.2 Four (4) light units shall be in the level when checked by precision level meter and electronic survey equipment.

4.3 The lower edges of all the slots of light units shall be within 150 mm of average level of the nearest point of both runway edge lines.

4.4 Exact position of light units to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light units determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

4.5 In azimuth the axis of the beams of all light units shall be parallel with the center line of the runway.

5.0 CONCRETE MOUNTING BASE

Concrete for the mounting base shall be as specified in **Section 9050**.

6.0 TRANSFORMER BOX (Handhole type)

Concrete Transformer boxes shall be erected beside the concrete mounting base. Each transformer box shall be connected to the mounting base with FEP pipe.

7.0 ISOLATING TRANSFORMER

A rubber molded isolating transformer for the Precision Approach Path Indicator shall be installed in the transformer box.

8.0 POWER SUPPLY SYSTEM

The Precision Approach Path Indicator System to be installed on Runway 03 and Runway 21 shall be supplied with power from the Power Substation respectively, by means of constant current high voltage series loop circuit of 6.6 amperes at 100% brilliance.

9.0 BRILLIANCY CONTROL

The Precision Approach Path Indicator System shall be controlled in three (3) brilliancy steps of 100%, 30% and 10% of the full brilliance, by means of Logical Control System automatically and ATC Controller at the Control Tower manually.

SECTION 9300

RUNWAY LIGHTING SYSTEMS

1.0 RUNWAY EDGE LIGHTS (REDL)

1.1 Scope

This work includes the supply and installation of the Runway Edge Lighting System.

1.2 Lighting System

The Runway Edge Lighting System shall comprise elevated high intensity bi-directional light fittings placed along both edges of the runway over the entire length of 2500 m at approximately 60 m intervals. Fittings for a section of 600 m from both ends of the runway shall be equipped with aviation yellow filters to show the yellow only at the remote end of the runway from the end at which the take-off run is started. All other fittings shall show clear (white) when viewed from the approaching aircraft.

1.3 Light Fittings

(1) Each high intensity light fitting shall be of the bi-directional high intensity type with light distribution of an intensity of Category I as shown in Appendix 2, Figure 2.9 of ICAO Annex-14. The elevated light fitting shall employ a single tungsten halogen lamp, 6.6A 150W and the surface type light fitting shall employ two (2) tungsten halogen lamps, 6.6A 100W.

(2) Each fitting shall be of lightweight frangible construction suitable for the concrete mounting base, and shall be of sufficient strength to withstand aircraft engine blast.

(4) Exterior finished color of elevated light fittings shall be red or yellow.

(5) Surface type light fitting outer ring and space ring shall withstand (without damage) the mechanical stresses specified in FAA AC No. 150/5345-46B.

1.4 Installation

(1) Elevated type light fitting shall be installed on the mounting concrete base using breakable coupling at a distance of 3 m from the runway edge.

(2) Surface type light fittings in the exit taxiway and turning pad shall be installed on the outer ring and space ring which is to be fitted on the base box housed in the concrete base.

(3) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the base box, the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

(4) The overall height of elevated light shall not exceed 600mm above ground level.

1.5 Concrete Mounting Base

(1) The Contractor shall submit to the Engineer for approval structural calculations and drawings of proposed base box with concrete base in pavement.

(2) Concrete for the mounting base and the base in the pavement shall be as specified in **Section 9050**.

(3) The mounting base shall be so erected as to be capable of supporting the light fitting horizontally balanced within a tolerance of ±2% gradient.

(4) Base box for surface light shall be made of aluminum alloy castings or stainless steel plates.

1.6 Transformer Box (Handhole type)

(1) Concrete transformer boxes shall be erected as shown on the Drawings appropriately equidistant from the edge of both runway shoulders.

(2) Each transformer box shall be connected to the mounting base of the corresponding light unit by FEP pipe.

(3) Base box of surface type light shall be connected to the Handhole by RSC pipe.

1.7 Isolating Transformer

A rubber molded isolating transformer for the light fittings shall be installed in each transformer box specified above.

1.8 Power Supply System

The Runway Edge Lighting shall be supplied with power from the Power Substation respectively by means of interleaved two circuits system operating on a constant current high voltage series loop circuit of 6.6 amperes at 100% brilliance.

1.9 Brilliancy Control

The Runway Edge Lighting System shall be controlled in five (5) brilliancy steps of 100%, 25%, 5%, 1% and 0.2% of the full brilliance, by means of Logical Control System automatically, and ATC Controller at the Control Tower manually.

2.0 RUNWAY THRESHOLD LIGHTS (RTHL) AND WING BAR LIGHTS (WBAR)

2.1 Scope

This work includes the supply and installation of the Runway Threshold Lighting System, including Wing Bar lights for Runway 21.

2.2 Lighting System

(1) Runway threshold lights for both Runway 21 and Runway 03 shall comprise high intensity unidirectional elevated type fittings for threshold lights and high intensity unidirectional elevated type fittings with wing bar lights for Runway 21.

(2) Light fittings shall be placed in line at right angles to the runway axis as near to the

end of the runway at not more than 3 m intervals.

(3) At Runway 21 threshold, the additional ten (10) threshold wing bar lights shall be symmetrically disposed on each side of the runway each bar shall be formed by a line of lights extending at least ten (10) meters outward from the outermost threshold lights and right angle to the line of runway center line.

(4) All fittings shall be equipped with aviation green filters to show green in the direction of the approach to the runway.

2.3 Light Fittings

(1) Each high intensity light fitting shall be of the unidirectional type with light distribution of an intensity of Category I as shown in Appendix 2, Figure 2.3 and Figure 2.4 of ICAO Annex -14, and each light fitting shall employ a tungsten halogen lamp, 6.6A 200W.

(2) Each fitting shall be of lightweight frangible construction suitable for concrete mounting base and shall be of sufficient strength to withstand aircraft engine blast.

(3) Exterior finished color of elevated light fittings shall be red or yellow.

2.4 Installation

(1) Threshold elevated type lights fittings shall be installed on the breakable coupling which is to be fitted to the base box housed in the concrete bases with transformer box in overrun pavement.

(2) Each base box shall be connected by RSC pipe.

(3) Ten (10) wing bar light fittings shall be installed on the top of the breakable coupling which is to be fitted to the base box housed in the concrete base with transformer box.

(4) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

(5) In azimuth the axis of the beams of the threshold lights shall be parallel with the extended center line of the runway.

2.5 Concrete Mounting Base

(1) The Contractor shall submit structural calculation and drawings of reinforced concrete base to the Engineer for approval within 120 days from the Commencement Date.

(2) Concrete for the base for threshold lights in the overrun area and mounting base for wing bar lights outside shoulder shall be as specified in **Section 9050**.

(3) Base box shall be made of suitable steel plate, aluminum alloy castings or stainless steel plate and the Contractor shall minimize size of diameter and height of base box together with concrete base size.

(5) The elevated light base plate, base box and concrete base shall withstand (without damage) the mechanical stresses specified in FAA AC No. 150/5345-46B.

2.6 Transformer Box (Handhole Type)

(1) Concrete transformer boxes shall be constructed as shown on the Drawings appropriately equidistant from the edge of both runway shoulders.

(2) Each transformer box shall be connected to the mounting base box of the corresponding light unit by RSC or FEP pipe.

2.7 Isolating Transformer

A rubber molded isolating transformer for the light fittings shall be installed in the transformer box of the mounting base.

2.8 Power Supply System

The runway threshold lights and wing bar lights shall be interleaved into the Runway Edge Light's series circuits together with the Runway End Lights, Stop way End Lights and Turning Pad Edge Lights.

2.9 Brilliancy Control

The runway threshold lights and wing bar lights shall be controlled in five (5) brilliancy steps of 100%, 25%, 5%, 1% and 0.2% of the full brilliance which are controlled simultaneously with Runway Edge Lights, Runway End Lights, Stop way End Lights and Turning Pad Edge Lights.

3.0 RUNWAY END LIGHTS (RENL)

3.1 Scope

This work includes the supply and installation of the Runway End Lighting System.

3.2 Lighting System

(1) Runway end lights for both Runway 21 and Runway 03 shall comprise high intensity unidirectional elevated type fitting.

(2) Light fittings shall be placed in line at right angles to the runway axis as near to the end of the runway at not more than 3 m intervals. All light fittings shall be equipped with aviation red filters to show red in the direction of the runway.

3.3 Light Fitting

(1) Each high intensity light fitting shall be of the unidirectional elevated type with light distribution of an intensity of Category I as shown in Appendix 2, Figure 2.8 of ICAO Annex -14 and each light fitting shall employ a single tungsten halogen lamp, 6.6A 100W.

(2) Each fitting shall be of lightweight construction suitable for concrete mounting base and shall be of sufficient strength to withstand aircraft engine blast.

(4) Exterior finished color of elevated light fittings shall be red or yellow.

3.4 Installation

(1) Each light fitting shall be installed on the breakable coupling which is to be fitted to the base box housed in the concrete base in the overrun pavement.

(2) Each base box shall be connected by RSC pipe.

(3) Base box in concrete base shall be connected to transformer box (Handhole) by RSC pipe.

(4) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

(5) In the azimuth the axis of the beams of the runway end lights shall be parallel with the runway center line.

3.5 Concrete Base

(1) The Contractor shall submit structural calculation and drawings of reinforced concrete base to the Engineer for approval within 120 days from the Commencement Date.

(2) Concrete for the base for end lights in overrun pavement shall be as specified in **Section 9050**.

(3) Base box shall be made of suitable steel plate, aluminum alloy castings or stainless steel plate and the Contractor shall examine to minimize size of diameter and height of base box together with concrete base size.

(4) The elevated light base plate, base box and concrete base shall withstand (without damage) the mechanical stresses specified in FAA AC No. 150/5345-46B.

3.6 Transformer Box (Hand hole Type)

(1) Concrete transformer boxes shall be constructed as shown on the Drawings appropriately equidistant from the edge of both runway shoulders.

(2) Each transformer box shall be connected to the mounting base box of the corresponding light unit by RSC pipe.

3.7 Isolating Transformer

A rubber molded isolating transformer for the runway end lights shall be installed in transformer box of the mounting base.

3.8 Power Supply System

The runway end lights shall be interleaved into associated Runway Edge Light’s series circuits.

3.9 Brilliancy Control

The runway end lights shall be controlled in five brilliancy steps of 100%, 25%, 5%, 1% and 0.2% of the full brilliance which are controlled simultaneously with Runway Edge Lights, Runway Threshold Lights, Stop way End Lights and Turning Pad Edge Lights.

4.0 STOPWAY END LIGHTS (STWL)

4.1 Scope

This work includes the supply and installation of the Stop way End Lighting System.

4.2 Lighting System

(1) Stop way end lights for both Runway 21 and Runway 03 overrun shall comprise high intensity unidirectional elevated fittings.

(2) Five (5) light fittings each shall be placed across the blast pad end and at right angles to and symmetrically about the extended runway center line as shown on the Drawings.

(3) Two (2) light fittings each shall be placed on the extended line of runway edge lights.

(4) One (1) light fitting each shall be placed on the extended center line of runway and two (2) light fittings each symmetrically at a distance 1.5.m both sides of the extended center line of runway.

(5) All light fittings shall be equipped with aviation red filters to show red in the direction of the runway.

4.3 Light Fittings

(1) Stop way end lights shall be of the unidirectional elevated type light with light distribution for runway end light of an intensity of Category I as shown in Appendix 2, figure 2.8 Table 5-1 Runway End Light of ICAO Annex -14 and each light fitting shall employ a single tungsten halogen lamp, 6.6 A 200W, 150 W or 100W.

(2) Each fitting shall be of lightweight construction suitable for concrete mounting base and shall be of sufficient strength to withstand aircraft engine blast.

(3) Exterior color of elevated light fittings shall be red or yellow.

4.4 Installation

(1) Ten (10) light fittings shall be installed on the breakable coupling which is to be fitted to the conduit pipe (referred to as normal-bend on the Drawings) housed in the concrete base with transformer box along the edge of the overrun pavement.

(2) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

(3) In the azimuth the axis of the beams of the runway end lights shall be parallel with the runway center line.

4.5 Concrete Mounting Base

(1) Concrete mounting base shall be as specified in **Section 9050**.

(2) The mounting base shall be so erected as to be capable of supporting the light fitting horizontally balanced within a tolerance of ±2% gradient.

4.6 Isolating Transformer

A rubber molded isolating transformer shall be installed in transformer box of the mounting base.

4.7 Power Supply System

The Stop way end lights shall be interleaved into the associated Runway Edge Light's series circuits.

4.8 Brilliancy Control

The Stop way End Lights shall be controlled in five brilliancy steps of 100%, 25%, 5%, 1% and 0.2% of the full brilliance which are controlled simultaneously with Runway Edge Lights, Runway Threshold Lights, Runway End Lights and Turning Pad Lights.

5.0 TURNING PAD EDGE LIGHTS (TPEL)

5.1 Scope

This work includes the supply and installation of the Turning Pad Edge Lighting System.

5.2 Lighting System

(1) Turning pad edge lights for both Runway 21 and Runway 03 turning pads shall comprise high intensity unidirectional elevated fittings and shall be provided along the edge of turning pads.

(2) Turning pad edge light fittings shall show blue.

5.3 Light Fittings

(1) Each turning pad edge light fitting shall be of the unidirectional elevated type with light distribution for runway end light of an intensity of Category I in accordance with JCAB standard specification L-275. (Dec. 2000) and each light fitting shall employ a single tungsten halogen lamp, 6.6A 200W.

(2) Each fitting shall be of lightweight construction suitable for concrete mounting base and shall be sufficient strength to withstand aircraft engine blast.

(3) Exterior color of elevated light fittings shall be red or yellow.

5.4 Installation

(1) Elevated light fittings shall be installed on the breakable coupling which is to be fitted to the conduit pipe (referred to as normal-bend on the Drawings) housed in the concrete base at a distance of 3 meter from the edge of the turning pad.

(2) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

5.5 Concrete Mounting Base

(1) Concrete for the mounting base shall be made as specified in **Section 9050**.

(2) The mounting base shall be so erected as to be capable of supporting the light fitting horizontally balanced within a tolerance of $\pm$ 2 % gradient.

5.6 Transformer Box (Handhole type)

(1) Concrete transformer box shall be constructed as shown on the Drawings appropriately equidistant from the edge of the shoulder.

(2) Each transformer box shall be connected to the mounting base of the corresponding light unit by the pipe.

5.7 Isolating Transformer

A rubber molded isolating transformer shall be installed in each transformer box.

5.8 Power Supply System

The turning pad edge lights shall be interleaved into the associated Runway Edge Light's series circuits.

5.9 Brilliancy Control

The Turning Pad Edge Lights shall be controlled in five brilliancy steps of 100%, 25%, 5%, 1% and 0.2% of the full brilliance which are controlled simultaneously with Runway Edge Lights, Runway Threshold Lights, Runway End Lights and Stop way End Lights.

SECTION 9400

TAXIWAY LIGHTING SYSTEMS

1.0 TAXIWAY EDGE LIGHTS (TEDL)

1.1 Scope

This work includes the supply and installation of the Taxiway Edge Lighting System.

1.2 Lighting System

(1) Taxiway edge lighting system shall comprise the elevated type taxiway edge light fittings and shall be provided along the edges of all taxiway and of certain parts of the aprons as required as shown on the Drawings, so as to delineate the taxiway effectively.

(2) Taxiway edge light fittings at runway shoulder of exit positions shall be placed at one (1) meter distance from the line of runway edge lights.

(3) Taxiway edge light fittings shall show blue.

1.3 Light Fittings

(1) Each taxiway edge light fitting shall be of the elevated type with an omni-directional light distribution of an intensity of not less than 4 candelas over a beam width of 6 degrees in the vertical plane and 5 candelas at an elevation of 3 degrees in blue.

(2) Each light fitting shall employ a LED Type, 6.6A 7.5W and shall be of lightweight frangible construction suitable for concrete mounting base. The electronic components are encapsulated in waterproof polyurethane for protection to harsh environment. There shall be built-in overvoltage & lightning protection and has integrated fail open technology where in CCR can detect any failure in the LED or Electronic parts.

(3) Exterior finished color of elevated light fittings shall be red or yellow.

1.4 Installation

(1) Elevated type light unit shall be fitted on the base box using a breakable coupling as shown on the Drawing at a distance of 3 m from the taxiway and apron pavement edge.

(2) Exact position of light fittings to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light fittings determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

(3) The overall height of elevated light shall not exceed 600mm above ground level.

1.5 Concrete mounting Base

(1) Concrete for the mounting base shall be as specified in **Section 9050**.

(2) The mounting concrete base shall be so erected as to be capable of supporting the light fitting horizontally balanced within a tolerance of ±2% gradient.

1.6 Transformer Box (Handhole)

(1) Concrete transformer boxes shall be constructed as shown on the Drawings appropriately equidistant from the edge of taxiway shoulders.

(2) Each transformer box shall be connected to the mounting base of the corresponding light unit by the pipe, where necessary.

1.7 Isolating Transformer

A rubber molded isolating transformer for the light fittings shall be installed in each transformer box specified above.

1.8 Power Supply System

The taxiway edge lights shall be supplied with power from the Power Substation by means of constant current high voltage series loop circuit of 6.6A at 100% brilliance.

1.9 Brilliancy Control

The Taxiway Edge Lights shall be controlled in five (5) brilliancy steps of 100%, 25%, 5%, 1% and 0.2% of the full brilliance, by means of Logical Control System automatically and ATC Controller at the Control Tower manually.

2.0 TAXIING GUIDANCE SIGNS (TXGS)

2.1 Scope

This work includes the supply and installation of the Illuminated Taxiing Guidance Signs.

2.2 Guidance System

(1) Taxiing Guidance System shall be provided to convey a mandatory instruction and taxiing information signs to provide information to the pilots.

(2) Mandatory instruction signs shall be provided to identify a location beyond which an aircraft taxiing or vehicle shall not proceed.

(3) Mandatory instruction signs for runway designation signs, and Category I holding position signs shall be provided at the taxiway and runway intersections.

(4) Information signs shall be provided to indicate, by a sign, a specific location or destination on a movement area, or to provide other information.

2.3 Light Unit (Illuminated Signs)

(1) An information sign shall consist of black inscription on a yellow background and the signs shall be illuminated internally.

(2) A mandatory instruction sign shall consist of an inscription in white on red background, and the signs shall be illuminated internally.

(3) Letter, arrow and/or figure for each sign shall be subject to the approval of the Engineer before manufacturing.

(4) The inscription on the signs and their illumination shall be in accordance with the provisions of Appendix 4, of ICAO Annex 14.

(5) The light units shall be specifically designed and type tested to ensure adequate structural strength and rigidity which may cause only superficial damage to an aircraft in the event of an aircraft strike.

(6) Each light unit shall be of lightweight frangible construction suitable for concrete mounting base, and be of sufficient strength to withstand aircraft engine blast.

(7) The light unit shall be in the form of a fiberglass reinforced plastics (FRP) plate and/or stainless steel plate and each light unit shall employ a LED Type, 6.6A 54W to 84W.

(8) Exterior finished color of light units shall be red or yellow.

2.4 Installation

(1) Each light unit shall be fitted on the concrete base using a breakable coupling which is to be fitted to the conduit pipe (referred to as normal-bend on the Drawings) housed in the concrete base.

(2) The installed height of the sign shall not exceed 1.1 m, to preserve clearance for propellers and engine pods of jet aircraft. Signs shall be located at a distance 20 m from the edge of the runway and taxiway to near side of sign. An information sign on a taxiway indicating a location shall, wherever practicable, be installed on the left-hand side of the taxiway. At an intersection of a taxiway with another taxiway, the sign shall be installed prior to the intersection.

(3) A sign indicating a destination shall be installed on the same side of the taxiway as the direction to the location to be indicated.

(4) Exact position of light unit to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light units determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

2.5 Concrete Mounting Base

(1) Concrete for the mounting base shall be as specified in **Section 9050**.

(2) The mounting base shall be erected as to be capable of supporting the light unit horizontal balanced within a tolerance ±2% gradient.

2.6 Transformer Box (Handhole)

(1) Concrete transformer boxes shall be erected as shown on the Drawing beside the mounting base.

(2) Each transformer box shall be connected to the mounting base with the pipe.

2.7 Isolating Transformer

A rubber molded isolating transformer for the Taxiing Guidance Signs shall be installed in each transformer box.

2.8 Power Supply System

The Taxing Guidance System shall be supplied from the Power Substation by means of constant current high voltage series of loop circuit by the same circuit with the taxiway edge lights.

2.9 Brilliancy Control

The Taxiing guidance Signs shall be controlled in two (2) brilliancy steps in accordance with Appendix 4 of provisions of Annex-14.

SECTION 9500

OTHER AERONAUTICAL LIGHTING

1.0 WIND DIRECTION INDICATORS LIGHTS (WDIL)

1.1 Scope

This work includes the supply and installation of the Wind Direction Indicator Lights.

1.2 Lighting System

Two Wind Direction Indicators Lights shall be provided one at each end of the runway, at a location 150 meters from the runway ends, at the right angles to the runway center line, with sufficient separation.

1.3 Indicating Equipment

(1) The Wind Direction Indicator shall be in the form of a truncated cone made of nylon fabric resistant to mildew, mold and fungus attack.

(2) The cone shall be aviation orange and white in a combination of two colors and designated to give indication of the wind direction of the surface wind and a general indication of the wind speed when viewed from the a height of not less than 300 meters.

(3) The wind cone shall be illuminated by four light fittings of LED Type 60W or maximum of total 240watts, deep bowl, aluminum weatherproof type and complete with an aviation red obstacle light of LED Type 10W. An obstacle light shall be mounted on top of the indicator.

(4) The wind cone shall have a length of not less than 3.6 m and a diameter, at larger end, of not less than 0.9 m. The support pole for the indicator shall cause minimum damage to the aircraft in the event of the aircraft strike.

(5) Exterior finished color of light unit including pole shall be red or yellow.

1.4 Installation

(1) The support poles of the indicators shall be erected on the concrete base by using the breakable coupling.

(2) The Contractor shall submit drawings of proposed supporting structure and structural calculations to the Engineer for approval within 120 days from Commencement Date.

(3) Exact position of indicator lights to be installed shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation position of lights determined by him through detailed site survey against the corresponding positions indicating on the Drawings and shall notify the Engineer accordingly.

1.5 Circular Band

(1) The indicator shall be marked by a circular band 15 meters in a diameter and 1.5

meters wide, centered around the supporting structure and colored white.

(2) Both inside and outside of the circular band as described above shall be paved by asphalt concrete as shown on the Drawings.

1.6 Power Supply System

The indicator lights shall be supplied with power from the Power Substation respectively, by means of 460V single phase, via step-down transformer to 230 volts.

2.0 AERODROME BEACON (ABN)

2.1 Scope

This work includes the supply and installation of the Aerodrome Beacon.

2.2 Lighting System

(1) The Aerodrome Beacon shall show aviation green flashes alternating with white flashes with the light distribution of an intensity as specified in 5.3.3.6 and 5.3.3.7 of ICAO Annex-14. The frequency of total flashes shall be from 20 to 30 per minute.

(2) The effective intensity of the flash of the main beam shall be not less than 2,000 candelas.

(3) The Aerodrome Beacon shall not give glare to pilots of aircraft in flight, and to aerodrome controllers in the VFR room of the control tower. If necessary, adequate louver, shield, cover and screens in significant directions shall be provided to prevent glare.

2.3 Light Fitting

(1) The Aerodrome Beacon shall have two ordinary 230V, 300W or 500W or 1000W lamps, one regular and the other standby which shall be automatically exchanged when regular lamp fails.

(2) A 10 watts LED obstacle light shall be installed and be lighted when the regular lamp fails.

(3) The lantern housing shall be made of aluminum alloy and shall contain the optical system, color filter mounting assembly, aviation green filter, double lamp holder and changing mechanism.

(4) The base cabinet of the beacon shall be rigid cast iron or aluminum alloy construction, completely weatherproof, including slip rings, induction motor, reduction gear box assembly, and incoming cable terminal board incorporating main switch, motor fuse, etc.

2.4 Installation

(1) The beacon shall be mounted on the supporting structure on the concrete base located on the roof of the Control Tower which is included in the scope of work of the Building Works.

(2) The Contractor shall install this supporting structure in accordance with approved Shop Drawings.

(3) A power cable shall be laid vertically along cable ladder and cable rack inside of Control Tower Building.

(4) Exact position of beacons to be installed shall be subject to the approval of the Engineer.

2.5 Power Supply System

The beacon shall be supplied with power from the Substation by means of single phase 3-wire, 230 volt.

SECTION 9600

APRON FLOODLIGHTING

1.0 SCOPE

This work includes the supply and installation of Apron Floodlighting System.

2.0 LIGHTING SYSTEM

2.1 The Apron Floodlights shall be provided to give sufficient illumination for all the apron service areas intended to be used at night with a minimum of glare to pilots of aircraft in flight and on the ground.

2.2 The Apron Floodlights shall be mounted on poles and floodlight fixtures shall comprise a mixture of high pressure sodium lamps and metal halide lamps with an obstacle light mounted on top if necessary.

2.3 ON-OFF control of flood lighting shall be possible from own Control and Monitor Panel and switch box in the ballast box.

3.0 FLOODLIGHT FITTINGS

3.1 All floodlight fittings shall be specifically designed for apron floodlighting to provide sufficient illumination on the surface of the apron as stated in Chapter 13 of Aerodome Design Manual Part 4. Visual Aids of ICAO (4^{th} Edition – 2004)

(a) Aircraft stand for 20 lux (horizontal illuminance) with uniformity ratio (average to minimum) for not more than 4 to 1.

(b) Other apron area for 50 percent to average illuminance on the aircraft stand with the same uniformity ratio above.

3.2 The housing shall be made of steel, or sheet aluminum with a front lens of tempered glass, and the reflector made of electrolytically polished aluminum sheet.

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

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

3.5 All fittings shall be specifically designed for apron floodlighting and in particular to minimize the glare to the pilots of taxiing aircraft.

3.6 The high pressure sodium lamp shall employ a 230V 660W and the metal halide lamp shall employ a 230V 1000W in accordance with Table 9600.1 as below.

3.7 Floodlight fittings shall be a square wide type and compatible for both types of lamps.

3.8 The Contractor shall submit illuminance calculation report, including isolux curves with illustrated aiming direction of floodlights for horizontal illuminance on condition of

maintenance factor seventy (70) percent, to the Engineer for review and approval before commencing manufacture.

Table 9600.1
Optical Performance for Floodlight (Square Wide Angle Type)

Main Beam Coverage	Metal Halide Lamp (M 1000W)	High Pressure Sodium Lamp (NH 660W)
Main beam axis peak intensity	No less than 1200 cd/1000 lumens	Not less than 1300 cd/1000 lumens
40º angle from the beam axis (right and left side)	Not less than 120 cd/1000 lumens	Not less than 130 cd/1000 lumens
10º angle from the beam axis (upper side)	Not more than 150 cd/1000 lumens	Not more than 150 cd/1000 lumens
35º angle from the beam axis (lower side)	Not less than 120 cd/1000 lumens	Not less than 130 cd/1000 lumens

(1) The high pressure sodium lamp shall have a rated life of not less than 12,000 hours operation and shall take not more than 5 minutes from switching on to achieve full brightness. In the event of loss of supply for a period of 30 seconds or less, the lamp shall re-strike within 1 minute of supply resumption and rapidly regain full light output.

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

4.0 BALLAST

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

5.0 BALLAST BOX

5.1 Ballast box shall comprise a weatherproof outdoor type housing made of steel sheet, main and branch molded case circuit breakers (MCCB), ballast, and terminal board, etc. It shall be self standing type and provided with the following main items of equipment.

(a) Main MCCB
(b) MCCB's for supply power to apron floodlights
(c) Indoor lighting (Fluorescent lamp)
(d) Receptacle for maintenance device
(e) Control unit for lowering gear

5.2 This ballast box shall be installed on the concrete base of adequate size to support the weight of the box.

5.3 The ballast box shall be waterproof and vermin proof, and shall have necessary control device inside cubicle so arranged as to be accessible by means of suitable doors with handles and keys.

5.4 In the ballast box proper ventilation grilles shall be provided, and these ventilation grilles shall be properly made to prevent rodents entering the cubicles.

5.5 Only high pressure sodium lamps for general lighting shall be supplied with power by the engine generating set automatically when main power fails. The high pressure sodium lamps and metal halide lamp for spot lighting shall be supplied with power by the engine generating set even if in case of the supervisor switch-on at Control and Monitor panel manually.

6.0 POLES

6.1 The poles for apron floodlighting shall be approximately 25m high and suitable for mounting base. Each pole shall be equipped lowering gear for the maintenance.

6.2 All poles and accessories shall be hot dipped galvanized uniformly. A lightning rod shall be provided at the top of pole and grounded. All poles shall be finished with two (2) undercoats and two (2) topcoats of paint before erection or installation on the Site. The painting color of pole will be as directed by the Engineer.

7.0 INSTALLATION

7.1 The lights shall be fixed on poles to be set on to concrete bases.

7.2 Exact position of pole shall be subject to the approval of the Engineer. Prior to erecting the concrete base, the Contractor shall place temporary markings to identify the actual installation positions of the light poles determined by him through detailed site survey, against the corresponding positions indicated on the Drawings, and shall notify the Engineer accordingly.

7.3 Each weatherproof-type ballast box which is to be fitted on the pole bottom part shall include MCCB's for controlling "ON-OFF" each circuit.

7.4 The Contractor shall submit the drawings of the pole structure and footing foundation and its structural calculations to the Engineer for approval within 120 days from Commencement Date.

7.5 Aiming angle of each floodlight fittings installation shall be submitted to the Engineer for approval before manufacturing and shipment.

8.0 LIGHTING POLE FOUNDATION

The concrete foundation, as indicated on the Drawings, shall be sufficient dimensions to support the weight of the pole, light fixture, ballast, ballast box, etc. Civil works shall be as specified in **Section 9050**.

9.0 POWER SUPPLY SYSTEM

9.1 The apron floodlights shall be supplied with the power from the Power Substation by means of three phases, three wires, 230 volts circuits, to each ballast box at the pole and then supplied to each floodlights phase to phase single 230 volts.

9.2 ON-OFF control of light circuits from the own control and monitor panel should be performed in the Apron Panel N/E-N panel included in the scope of work for AGL Works – AGL Supply.

9.3 600 volts grade cross-link polyethylene insulated polyvinyl chloride sheathed power cable shall be used between the TR/LV panel and ballast, and floodlight fittings.

SECTION 9700

UNDERGROUND CABLE DUCTS

1.0 SCOPE OF WORK

This item shall consist of the installation of underground ducts and manholes, handholes in runway strip including where installed under the taxiway and paved road and shall also include cutting, trenching of any paved areas, installation of pull wires and capping and other necessary works.

2.0 MATERIALS

2.1 Cable Ducts

(1) The flame retardant corrugated rigid synthetic pipe (hereinafter referred FEP) and accessories shall meet the JIS-C 3653 (Installation methods of Power cables buried underground) and JIS-K 6922-1 (Plastic Polyethylene (PE) molding and extrusion materials Part-1).

(2) The galvanized steel pipe and accessories shall meet the requirements in accordance with JIS-G 3442 (Galvanized steel pipes for ordinary piping)

2.2 Concrete, etc

(1) The concrete, mortar and reinforcement to be used shall meet the requirements as specified in **Section 9050**.

(2) The Contractor shall, before the work on cable ducts and manholes is started, secure the Engineer's approval on the materials to be used and on the method of the work execution.

2.3 Crushed Stone or Rubble

The size of the crushed stone or rubble shall not be less than 100mm but no more than 200mm, and the quality of the crushed stone shall be approved by Civil engineer.

2.4 Granular Material for Backfill (Sand)

The gradation of granular material (sand) shall be in accordance with the requirements of Table 9700.1. The granular material (sand) shall be free from any foreign substances.

Table 9700.1 Gradation of Granular Materials

Sieve Designation (Square Openings)	Percentage by Weight Passing Sieves	Notes
10mm	100	
No. 4	95 – 100	
No. 16	45 – 80	
No. 30	25 – 55	
No. 50	10 – 30	
No. 100	2 – 10	

2.5 Metalware for Manholes

The steps, ladder bars, cable hangers or hook bolts shall be gray or malleable cast iron, galvanized wrought iron, or galvanized steel. The zinc coating shall weigh not less than 350 gm/m² of area covered. (JIS H 8641) The steps shall be of the size, length and shape as directed by the Engineer on the Drawings.

3.0 CONSTRUCTION METHODS OF CABLE DUCT

3.1 General

(1) The Contractor shall place the electrical cable ducts at the locations approved by the Engineer.

(2) The Contractor shall provide each duct with a core-wire.

(3) All ducts installed shall be provided with draw wires of galvanized iron or steel of not less than 1.6 mm diameter for the drawing of the permanent cabling/wiring. A part of the draw wire shall be left in the manhole or handhole in the length enough to be bent so that the wire will not slide back in the duct.

(4) When a spare duct is provided as designated on the Drawings, the terminal end of duct opening shall be closed with the detachable taper plug designed by the pipe manufacturer or with hard wood plug which shall accurately fit to the duct in shape and having the plug end at least 6mm larger than the size of the duct.

(5) All ducts shall be firmly located and embedded throughout construction and shall be plugged to prevent grout, storm water or mud from entering. Any duct section with defective connection shall not be installed.

3.2 Excavation

(1) The excavation shall be performed true to the line, conforming to the width, depth and dimension shown on the Drawings. The Engineer is authorized to change the dimension and elevation involved in the excavations to ensure the stability of the ground.

(2) The trench bottoms shall be compacted to not less than 90% of the maximum dry density.

(3) Any surplus excavated material shall be removed or disposed of as directed by the Engineer.

3.3 Duct Signs

All terminating points of ducts shall be indicated with a stake (50mm x 50mm x 500mm) approximately 350mm above the ground. The signs shall be inscribed with the letter “DUCT” and placed at the terminating points or ends of all ducts except where the duct terminates at a handhole or manhole. The Contractor shall inscribe, on the sign slabs, the number and size of ducts buried under the signs.

3.4 Backfilling

(a) Backfilling of granular material (sand)

The backfilling of granular material (sand) shall be performed in accordance with the design. The backfilling shall be compacted to not less than 90% of the maximum dry density.

(b) Backfilling with excavated soil

After the backfilling of granular material (sand) is finished, the backfilling with the excavated soil shall be performed to the elevations shown on the Drawings. The backfilling shall be compacted to not less than 90% of the maximum dry density.

3.5 Clearing and Restoration of Site

After the backfilling is completed, the Contractor shall dispose of all surplus materials, dirt and rubbish from the site. The Contractor shall remove all tools and equipment from the site and restore all disturbed areas to their original conditions.

3.6 Quality Standards

The quality shall satisfy the standard values shown on Table 9700.2.

3.7 Tolerance Standards

The tolerance of the work shall be controlled in the manner shown on Table 9700.3.

Table 9700.2 Quality Standards

Work Item	Test Item	Test Method	Frequency	Standard Value	Notes
Electrical cable ducts	Steel duct and accessories	As approved by the Engineer	At every receiving of materials	Federal Specification WW-C-581	Manufacturer's test data may substitutes as directed by the Engineer
	Granular material (Sand) Graduation	AASHTO T-27	Once for every 500m³	To meet the requirements of Table 9700.1	
	Granular material (Sand) Moisture density relations of sand	AASHTO T-180	- ditto -	---	
	Density in place of sand and trench bottom	AASHTO T-191	Once for every 50m at points designated by the Engineer	Not less than 90% of maximum dry density as determined by AASHTO T-180	

Table 9700.3 Tolerance

Work Item	Test Item	Test Method	Frequency	Standard Value	Notes
Electrical cable ducts	Finish elevation (Grade)	By surveying	At points designated by the Engineer	±50mm	
	Width	By the Engineer's Instruction	- ditto -	±20mm	
	Length	- ditto -	- ditto -	±20mm	
	Depth	- ditto -	- ditto -	±50mm	

4.0 CONSTRUCTION METHODS OF MANHOLE AND HANDHOLE

4.1 Excavation

(1) The excavation for structures or for the foundation of structures shall be performed in conformity to the requirements of location, grade and elevation designated on the Drawings. The Engineer shall authorize change to the construction methods in the foundations including the elevation in consideration of the stability or the ground.

(2) The Contractor shall provide all safety and maintenance materials for excavations so as to meet the requirements of excavation as specified on the Drawings.

(3) Unless otherwise specified, the Contractor shall remove the timbers, covers, and supports upon completion of the structures. The removal operation shall be performed in a manner that neither will the ground surface be disturbed nor the completed structures be damaged.

(4) The foundation bed for structures shall be compacted properly with compaction equipment approved by the Engineer. After the excavation is completed, the Contractor shall inform its completion to the Engineer. Concreting operations may only commence after the Engineer has approved the depth of the excavation and the condition of the foundation.

4.2 Installation of Steps or Ladder, Cable Hangers, hook bolts

(1) The steps, cable hangers and hook bolts shall be installed as designated on the Drawings. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is poured.

(2) In case prefabricated ladders made of aluminum alloy may be installed instead of the steps, the ladder shall be held in place by embedding the supports in drilled holes.

4.3 Backfilling

(1) After the structures are completed, the spaces adjacent to the structures shall be backfilled with approved material, in a finished thickness of not exceeding 200mm in a layer, and compacted properly with compaction equipment approved by the Engineer. Each layer shall be compacted to the elevations designated on the Drawings.

(2) The backfilling shall not be made until 7 days after the concrete has been placed or the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfilling, or by vibrations of the compaction equipments.

4.4 Clearing and Restoration of Site

After the backfilling is completed, the Contractor shall dispose of all the remaining materials, dirt and rubbish from the Site. The Contractor shall remove all tools and equipment from the site and restore all disturbed areas to their original conditions.

4.5 Quality Standards

The quality shall satisfy the standard values shown on Table 9700.4.

4.6 Tolerance Standards

The tolerance of the work shall be controlled in the manner shown on Table 9700.5.

Table 9700.4 Quality Standards

Work Item	Test Item		Test Method	Frequency	Standard Value	Notes
Manholes and handholes	Concrete		As specified in Section 1400 of this Specification			
	Reinforcing bars (Frame)		As approved by the Engineer	At every receiving of materials	AASHTO M-31 AASHTO M-42 Tensile strength at yielding point: 2,400 kg/cm²	Manufacturer's test data may substitute as directed by the Engineer.
	Mortar	Cement	- ditto -	- ditto -	AASHTO M-85	
		Sand	AASHTO T-27	Once for every 500m³	AASHTO M-45	
	Crushed aggregate		As specified in Section 1400 of this Specification			
	Frames and covers		As approved by the Engineer	At every receiving of materials	AASHTO M-150 AASHO M-106 AASHTO M-103 AASHO M-94	Manufacturer's test data may substitute as directed by the Engineer.
	Steps		- ditto -	- ditto -	AASHO M-106 AASHO M-100	

Table 9700.5 Tolerance

Work Item	Test Item	Test Method	Frequency	Standard Value	Notes
Manholes and handholes	Finish elevation	By surveying	At points designated by the Engineer	±10mm	
	Width	By the Engineer's Instruction	- ditto -	±20mm	
	Depth	- ditto -	- ditto -	±10mm	
	Thickness	- ditto -	- ditto -	±20mm ±10mm	

SECTION 9800

CONTROL AND MONITORING SYSTEM

1.0 SCOPE OF WORK

This work includes the supply and the installation of the Remote Control and Monitoring System for the airfield lighting system.

2.0 SYSTEM REQUIREMENTS

2.1 Remote operation of the airfield lighting system shall be carried out from the Remote Control Console at the VFR room and from the Local Control and Monitor Panel at the monitor room in the Power Substation. Changeover switch of operating position between Remote Control Console and Local Control and Monitor Panel shall be furnished at the Local Control and Monitor Panel.

2.2 The control functions shall include ON-OFF switching, intensity control, directional switchover of the approach lighting system (ALS) and PAPI according to the landing direction.

2.3 In order to receive and/or transfer the control and monitoring signal between consoles and facilities, Relay Panel (Interface equipment) shall be installed in the Power Substation.

2.4 Control and Monitoring System and Aeronautical ground light (AGL) shall comply with the following:

(a) ICAO Aerodrome Design Manual Part 4 – Visual Aids (Third Edition), Chapter 5, Light Intensity Settings.

(b) ICAO Aerodrome Design Manual Part 5 – Electrical Systems (First Edition), Chapter 3, 3.4 Control of aerodrome lighting systems and 3.7 Monitoring of aerodrome lighting circuits.

(c) ICAO Annex 14 Aerodromes (Fourth Edition), Attachment A, 15 Intensity Control of Approach and Runway Lights.

(d) ICAO Airport Services Manual Part 9 - Airport Maintenance Practices.

2.6 The Contractor shall submit to the Engineer for approval Equipment Layout plan and cable pit layout after review of the dimension size, weight and necessary cabling plan including control/communication cabling plan together with heat generation data of equipment.

3.0 DESIGN REQUIREMENTS (LOGICAL CONTROL SYSTEM)

3.1 System Function

(1) For light operation system the following functions shall be provided.

(a) Input of logical control condition according to Table 9800.1 at remote control console.

(b) To be able to undo previous status from the above (a) condition.

(c) To make input signal of above items (a) and (b) carry out information processing at logical control units.

(d) To monitor light operating condition and to make alarm with one flickering indicator for fault condition at remote control console and local control.

(2) For preventive maintenance operation system the following function shall be provided:

(a) To be provided with the same function as the above (1) (a) (b) and (c) at local control console. Operation selecting between remote control console and local control console shall be provided by means of changeover switch installed at local control console.

(b) To be able to operate manually.

(c) To indicate fault condition for power supply equipment such as CCR and so on at local control console.

3.2 Input Signal for Logical Control

The following input signal for logical control shall be provided at remote control console and local control console:

(a) Background brightness condition:

"DAY" "TWILIGHT" "NIGHT"

(b) Ceiling condition:

"LESS THAN 300M" "MORE THAN 300M"

(c) Runway visual range condition:

"LESS THAN 550M" "550 to 1,500M"
"1,600M to 4,900" "MORE THAN 5,000M"

(d) Active runway condition for example:

"02" "20"

3.3 Input Signal for Direct Control

(a) Direct control operation per load circuit group

Opposite condition of logical control should be selected with first direct control operation provided at remote control console and local control console as shown in Table 9800.1 and by next direct control operation control condition shall be back to logical control from direct control.

(b) Up-down operation

In respect of brightness changeover for the load circuit supplied by CCR, up-down operation shall be carried out with a pair of switches per load circuit group as shown in upper column of Table 9800.1 based on ICAO Aerodrome Design Manual Part 4

Visual Aids, Chapter 5 Light Intensity settings.

(c) Reset operation

By one “Reset” operation all of operation condition shall be back to logical control.

3.4 Reliability and Redundancy

(1) The system shall comprise high reliability parts.

(2) If the operation at remote control console becomes impossible, all airfield lighting control shall be done at local control console.

(3) If light operation system has some problems, the operation for airfield lighting shall be possible by means of maintenance operation system.

(4) To enable easy changing of logical control contents in the future, microcomputer shall be provided.

Table 9800.1 Brightness Level and Switching Control (Reference)

Background Brightness	Ceiling Height (m)	Runway Visual Range (m)	ALS	RWY	PAPI	ABN	WDIL	TWY
Day	Less than 300	< 550	5	5	5	ON	ON	0
		550 – 1500	5	5	5	ON	ON	0
		1600 – 4900	5	5	5	ON	ON	0
		> 5000	5	5	5	ON	ON	0
	More than 300	< 550	5	5	5	ON	ON	5
		550 – 1500	5	5	5	ON	ON	0
		1600 – 4900	4	4	5	ON	ON	0
		> 5000	0	0	5	OFF	OFF	0
Twilight	Less than 300	< 550	5	5	4	ON	ON	5
		550 – 1500	4	5	4	ON	ON	5
		1600 – 4900	3	4	4	ON	ON	5
		> 5000	2	3	4	ON	ON	5
	More than 300	< 550	5	5	4	ON	ON	5
		550 – 1500	4	5	4	ON	ON	5
		1600 – 4900	3	4	4	ON	ON	5
		> 5000	2	3	4	ON	ON	5
Night	Less than 300	< 550	4	4	3	ON	ON	5
		550 – 1500	3	4	3	ON	ON	5
		1600 – 4900	2	3	3	ON	ON	5
		> 5000	1	2	3	ON	ON	5
	More than 300	< 550	4	4	3	ON	ON	5
		550 – 1500	3	4	3	ON	ON	5
		1600 – 4900	2	3	3	ON	ON	5
		> 5000	1	2	3	ON	ON	5

3.5 Remote Control Console

This console installed at VFR room shall be free standing and constructed of steel frame and panels. This console shall majorly comprise operation parts for light operation and mimic diagrams.

(a) Operation Part for Light Operation

(i) Major Components shall be as follows:

11	-	Self illuminated push-button switches for “Logical control”
18	-	Ditto but for “Direct control”
1	-	Ditto but for “Reset”
4	-	Seven segment indicators for brightness tap for CCR
1	-	Pus-button switch for lamp check
1	-	Dimmer and the rheostat for indicators
1 set	-	Power Supply equipment for control and other

(ii) Operation parts shall be maintained and checked from front surface.

(iii) Indication for operation parts such as logical control switches shall be answered back from output signal of logical control parts inside the local control console.

(b) Mimic Diagrams (Facsimile diagrams)

(i) Indication of airfield lighting supplied by CCR shall be done via auxiliary relay by using output current detector inside CCR, etc.

(ii) In case of Aeronautical Ground light not be supplied by CCR, indications of mimic diagrams shall be done via auxiliary relays by means of contact operation of magnetic contactor switching each load circuit ON or OFF.

(c) Dimmer for Indicator on Remote Control Console

Dimmer shall be controlled by selecting “DAY”, “TWILIGHT” and “NIGHT” switch so as to keep adequate intensity.

3.6 Local Control and Monitor Panel

This panel installed at monitoring room shall be free standing and constructed of steel frame and panels.

(a) Operation part

Major components shall be as follows:

1 set	-	The same components with operation parts for light operation of remote control console.
16	-	Self illuminated push-button switches for changeover for remote control console-local control and monitor panel.
12	-	Self illuminated push-button switches for changeover for operation position between “Logical control” and “Manual”.
19	-	Ditto but for ON-OFF operation at manual condition.
8	-	Ditto but for UP-DOWN operation for CCR at manual condition.
2	-	Ditto but for active runway at manual condition.
20	-	Ditto but for changeover between common-use and standby CCR.
1	-	Push-button switch for “alarm stop”
1	-	Ditto but for “alarm reset”
2	-	Indications for receiving power.

(b) Monitor Part

(i) To be provided with monitor panel one of which corresponds to one CCR and has as many indications as CCR.

(ii) To be provided with the same indication with mimic diagrams of remote control console.

(iii) To be provided with grouped fault indicators such as heavy and slight fault of CCR's.

(c) Control Circuit Part

(i) To be provided with programmable logic method by means of more safety and reliability computerized programmable control equipment such as micro processor.

(ii) Control circuit parts shall be designed to be unit-composition per function and in case of fault it shall be due consideration to be able to check and exchange easily.

4.0 RELAY PANEL (INTERFACE EQUIPMENT)

The panel shall be constructed of steel plate and frame, accessible both from the front and back for maintenance and shall majorly comprise as follows:

(a) Relays to be plug-in type voltage relay, coil rating of DC 100V to be capable of operating in the voltage range of 85 to 110VDC.

(b) Molded case circuit breakers (MCCB's).

(c) Relay checker to check whether there is trouble or not in coil and concrete.

(d) Electrical/electronic interface units between data processing terminal equipment and data communication equipment should be provided, not relay units.

5.0 CONSTANT CURRENT REGULATORS (CCR)

5.1 General

The CCR's shall provide stepped brilliances with a stable current to the respective lighting system under the specific conditions. All CCR's should be able to change from 5 steps to 7 steps of brilliancy control in the near future.

5.2 Design Requirements

(a) Type of CCR
Thyrister type regulator with interstage firing CCR or equivalent to be used.

(b) Total Efficiency

The total efficiency of the regulator shall be not less than 90% at the rated output where 100% of the power factor of the load.

(c) Protective Devices

The adequate protective devices shall be provided for the load opened, the load grounded, over current and the load circuit problem.

(d) Standby CCR

In each substation the efficient and effective standby CCR having the maximum and minimum capability in the substation shall be provided.

(e) Output Terminals

Power cables should be easily removable from the output terminals for checking the field insulation resistances, i.e. plug-in type.

5.3 Technical Characteristics

Input Voltage : AC 230V
Input Phase : Single phase or three phase
Output Current : from 2.8A to 6.6A

Brilliancy control and the output currents:

No. of TAP	Brilliancy (%)	Output Current (A)
5	0.2 1 5 25 100	2.8 3.4 4.1 5.2 6.6
4	1 2 30 100	3.4 4.1 5.5 6.6
3	10 30 100	4.8 5.5 6.6
5 (Alternate)	1 3 10 30 100	3.4 3.8 4.8 5.5 6.6
ut Current Tolerance : The output current shall be tolerated within 2% of rated output under the condition of optional load from a quarter to full load and 10% lamp open circuit (fusing) or rated load capacity and 10% of input voltage variation.		

6.0 INSTALLATION

6.1 Cabling

The cable connecting between the remote control console in the VFR room and the local control and monitor panel in the Power substation shall be laid through the Underground piping and then along the vertical cable rack in the Control Tower through Operation Building.

6.2 Consoles and Relay Panel

(1) The remote control console shall be installed in the VFR room of the Control Tower as shown on the Drawing.

(2) The local control and monitor panel shall also be installed in the Monitor Room of Power house as shown on the Drawings.

(3) Relay panel (interface equipment) shall be installed in the Power house.

6.3 Constant Current Regulator (CCR)

Constant current regulator shall be installed at the position as shown on the Drawings. All constant current regulators shall be fixed on the horizontal balanced base of channel steel anchor-bolted to the floor, in such a manner that the front side of all CCR's in one group shall be in one vertical plane.

7.0 DATA COMMUNICATION AND DATA LOGGING

(1) All data for remote control and monitoring of AGL, which are communicated by the control/communication cable, shall be provided at relay panels (interface equipment).

(2) Data for data logging shall be provided by the communication cables between relay panel (interface equipment) and data logger control panel.

(a) Current detective devices shall be provided on each CCR circuit.

(b) The output of current detective device shall be provided. Data logging items of AGL shall be approved by the Engineer.

(3) The following items shall be recorded by typewriter and be indicated on CRT.

(a) Alternated operating status of CCR and the other lightings, such as ABN, WDIL and Apron floodlight, etc.

(i) Data of CCR shall be as follows:

ON-OFF	: 2 items/each
TAP 1 to 5	: 5 items/each
Switchgear of CCR common use/standby	: 2 items/each

(ii) Data of other lightings shall be as follows:

ON-OFF	: 2 items/each

(b) Operation status of pattern control, with operating TAP of 3 groups of CCR's and ON-OFF status of the other lightings at the time of pattern change.

(i) Data of pattern control shall be as follows:

Direction	: 2 items
Day, Twilight, Night	: 3 items
Runway Visual range	: 4 items
Ceiling height	: 2 items

(ii) Data of 4 groups of CCRs (for each group)

ON-OFF	: 2 x 4 items
TAP 1 to 5	: 5 x 4 items

4 groups are PAPI, ALS, RWL and TWL.

(iii) Data of other lighting. (For each lighting)

ON-OFF	: 2 x 3 items

Other lightings are ABN, WDIL and ASIS

(c) Fault status of each CCR

Time of fault	: 1 item/each CCR
Over current	: 1 item/each CCR
Load opened	: 1 item/each CCR
Load grounded	: 1 item/each CCR
Load circuit trouble	: 1 item/each CCR

(4) The integrated operating time of CCR of each operational and other lightings shall be accumulated, and be recorded by typewriter and be indicated on CRT.

(a) Data of pattern shall be as follows:

Every day/each current Tap/each CCR
Every month/each current Tap/each CCR
Every year/each current Tap/each CCR
Optional/each current Tap/each CCR

(b) Data of pattern shall be as follows:

Each pattern (Direction, DAY/TWILIGHT/NIGHT, Runway Visual range, Ceiling height) Status (Direction, Tap, UP or DOWN or Normal)/each CCR group

(c) Data of other lightings shall be as follows:

Every day/each circuit Tap/each lighting
Every month/each circuit Tap/each lighting
Every year/each circuit Tap/each lighting
Optional/each circuit Tap/each lighting