BID BULLETIN NO. 08
12 September 2022

This Supplemental/Bid Bulletin is issued to modify, amend or clarify items in the Bidding Documents for the **Expansion of Passenger Terminal Building at Davao International Airport – Bid No. 22-003-06**

1. Attached in this bid bulletin are the Technical Specifications of the abovementioned project under Section VI of the bidding documents.

2. The new schedule for the submission and opening of bid will be on **22 September 2022 at 10:00 AM** at CAAP Conference Room (4th Floor), MIA Road, Ninoy Aquino Avenue, 1300 Pasay City, Metro Manila.

This Bid Bulletin should be included in the Technical Requirements and be marked accordingly. This serves as an integral part of the bidding documents of the project and non-inclusion of this Bid Bulletin in the Technical Requirements will constitute disqualification.

For the information and guidance of all concerned.

ATTY. ROBERTO MARTIN S. BUENAVENTURA
Vice-Chairman, Bids and Awards Committee

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

GENERAL and CIVIL WORKS SERIES 1000

TECHNICAL SPECIFICATIONS FOR GENERAL REQUIREMENTS AND CIVIL WORKS

SERIES 1000

SERIES 1000 – GENERAL REQUIREMENTS AND CIVIL WORKS

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DEFINITION OF TERMS

Whenever the following terms are used in these specifications, the intent and meaning shall be interpreted as follows:

AASHTO
The American Association of State Highway and Transportation Officials, the successor association to AASHTO.

ASTM
The American Society for Testing and Materials

BS
British Standard Institution.

BRS
Bureau of Research and Standard

DOST
Department of Science & Technology

DTI
Department of Trade & Industry

DIA
DAVAO INTERNATIONAL AIRPORT

CAAP
CIVIL AVIATION AUTHORITY OF THE PHILIPPINES

CONTRACT
The written agreement covering the works to be performed. The Contract shall include, but is not limited to: The Contract Agreement, the Conditions of Contract, the Contract Specifications, drawings, plans and other legal requirements as may be required.

CONTRACTOR
The party or parties on whose behalf the Bid was submitted including its or their respective permitted assignees and where the Contractor comprises more than one party and the context so requires, each and every such party.

PROJECT SITE
The project site refers to the aircraft pavement including related structures within the Subic Bay International Airport, Subic Bay Freeport Zone.

ENGINEER/PROJECT-IN-CHARGE
Any person, firm or company appointed by the owner, Davao International Airport to perform the duties set out in the Conditions of Contract.

LABORATORY
The official testing laboratories of the Contractor as required.

MATERIALS
Any substance specified or required for use in the construction of the Contract work.

PLANS
The official drawings or exact reproductions which show the location, character, dimensions and details of works to be done.

WORK
The furnishing of all labor, materials, tools, equipment and incidentals necessary or convenient to the Contractor's performance of all duties and obligations imposed by the Contract.

SPECIFICATIONS
The meaning as identified on the Contract conditions and requirements.

For additional Definition of Terms and interpretations, please refer to clauses applicable in the Conditions of Contract.

PART A. FACILITIES FOR THE ENGINEER

SERIES 1000- GENERAL AND CIVIL REQUIREMENTS

Section 1120 – Employers and Engineers Facilities

1.1 Provision of field office for the employer and engineers including laboratory and staff house with electric power and water supply, (minimum area of 250 sq.m.) on rental basis.
1.2 Provision of furnitures/fixtures, equipment & appliances for the field office of the Engineer.
1.3 Operation and maintenance of Field Office for the Engineer
1.4 Provide and Maintenance Communication Equipment for the Engineer
1.5 Service Vehicle for the Engineer, Provide (2 Unit) Brand new Pick-up 4x2 Diesel Powered including operation and Maintenance.
1.6 Progress Photograph

A. Description

1. The Contractor shall provide and maintain field offices and testing laboratories, including all the necessary electricity, water, drainage and telephone services for the use of the Engineer and his staff. The offices and laboratories shall have at least the floor area prescribed on the Plans and shall contain the equipment, supplies and furnishings specified in the Contract. Testing equipment supplied in accordance with the Special Provisions shall be located in testing laboratories as required by the Engineer. All offices and laboratories shall be ready for occupancy and use by the Engineer within two (2) months of the commencement of the Works. Their location and final plan shall require the approval of the Engineer prior to the start of construction. It is the intent of this Specification to locate the field offices and laboratories in government owned lots so that the use by the government of these facilities can be maximized even after the completion of the project. However, if no government lot is available, and these structures are to be erected on private property, it is the responsibility of the Contractor to make the necessary arrangements with the landowner(s) regarding the use of the lot for the Engineer"s office and laboratories and to remove and/or transfer, if so required under the Contract, the improvements thereon, including all appurtenances upon completion of the Works.

   All facilities provided by the Contractor shall be near the job site, where necessary and shall conform to the best standard for the required types. On completion of the Contract, the facilities provided by the Contractor including utilities and communication facilities shall revert to the Government including office equipment, apparatus, pieces of furniture, laboratory equipment, etc, unless otherwise specified in the Contract documents.

The Contractor shall be responsible for raising the ground (if necessary), grading and drainage in the vicinity of each facility with suitable access walkways, seeding and sodding of the ground around as directed and approved by the Engineer. Also, the Contractor shall construct a parking area for the compound near the buildings and a satisfactory access road to the parking areas.

The Contractor shall be responsible for the maintenance and protection of all facilities to be provided during the duration of the Contract, including providing adequate stock of all expendable items, such as light bulbs, light tubes, laboratory equipment and supplies at all times to ensure proper and continuous functioning of all the Engineer's facilities.

The whole area of the Engineer's compound shall be fenced with barbed wire (or equivalent) with necessary gates as directed by the Engineer.
The Contractor shall provide suitable utilities and services, such as potable water, electricity, sewerage and security on a 24-hour basis.

2. The Contractor shall provide qualified and experienced laboratory staff to carry out all the materials quality control and all the tests specified in the Contract and required by the Engineer. The person so appointed by the Contractor to manage the laboratory shall be well experienced in the type of work to be undertaken and shall be subject to the approval of the Engineer. He shall work full time and shall be responsible to the Engineer for all works carried out.

3. The telephone service, if required in the Contract shall have a separate connection direct to the telephone company's telephone exchange single line for the exclusive use of the Engineer and his staff.

4. The Contractor shall provide, if required in the Contract, a two-way radio communication service.

5. Any portable offices required in the Contract shall be dismantled, moved and erected from time to time as directed by the Engineer.

6. All offices, stores and testing laboratories shall be proficiently guarded at all times of the day and night, regularly and properly cleaned, adequately supplied and maintained for the duration of the Contract.

7. Vehicles for the Engineer

The Contractor shall provide within thirty (30) calendar days after notice to commence work, the vehicles listed in the Special Provisions for the exclusive use of the Engineer. The vehicles to be provided by the Contractor shall be to the satisfaction of the

Engineer. All vehicles shall comply in all respects with all relevant Philippine national or local laws statutes and regulations. All vehicles shall carry or be fitted with the accessories as may be prescribed by laws and have comprehensive insurance. The vehicles on delivery shall be new and shall be driven by a competent, qualified and experienced driver who shall be under the direct order of the Engineer.

The contractor shall maintain the vehicle in first class condition and shall be supplied with appropriate fuel and lubricants at all times
He shall provide equivalent substitute vehicles during any period when the specified vehicles are taken out of service for maintenance, repair or any other reason. Unless otherwise specified, the vehicle shall at the end of the Contract become the property of the Government.

8. Assistance to the Engineer

The Contractor shall at all times during the duration of the Contract provide for the use of the Engineer all equipment, instruments and apparatus, all information and records and qualified chainmen and laborers required by the Engineer for inspecting and measuring the Works. Such equipment, instruments and apparatus shall include those listed in the Special Provisions.

9. Photographs

The Contractor shall provide record photographs taken as, when and where directed by the Engineer at intervals of not more than one month. The photographs shall be sufficient in number and location to record the exact progress of the Works. The Contractor shall provide one proof print of each photograph taken, and the negative and ten copies, not less than 254 mm x 203 mm and printed on glossy paper, of any of the photographs by the Engineer. The photographs retained by the Engineer will become the property of the Government and the Contractor shall supply approved albums to accommodate them. Two copies are to be signed by the Contractor, one of which will be signed by the Engineer and returned to the Contractor.

B. Methods of Measurement

1. Lump-sum items shall be provided for the provision of:

- furnitures/fixtures, equipment & appliances for the field office of the Engineer.

2. Provision of field office for the employer and engineers including laboratory and staff house with electric power and water supply, (minimun area of 250 sq.m.) on rental basis. The unit of measure is “month”.
3. For operation and maintenance of Field Office for the Engineer, the unit of measure “month”

4. No separate payment shall be made in respect of consumable materials as this is

deemed to be included in the pay item for maintenance of the Engineer's facilities.

5. The quantities for the provision of vehicles for the Engineer shall be the number of each type of vehicle supplied. The unit of measure is "each".
6. The quantities for the operation of vehicle for the Engineer shall be for the time the Engineer is supplied with each vehicle. The unit of measure is "month".
7. The quantities for progress photographs shall be the number of photographs selected and provided as progress photographs. The unit of measure is "month".

C. Basis of Payment

The quantities determined as provided above shall be paid for at the appropriate contract unit price, for each of the particular pay items shown in the Bill of Quantities which price and payment shall constitute full compensation for furnishing and maintain

Surveying Instruments

A. Description

To carry out tasks related to Survey Works the Contractor shall provide at his own cost a minimum Surveying/levelling equipment with breakdown as follows;

Electronic Total Station -1 unit
Level Equipment with Tripod -1 unit
Prism with Range Pole - 3 each
Prism with Range Pole - 3 each
50 meter tape - 2 each

B. Method of Measurement

Provision of Surveying Instruments shall be measured by Lump-Sum.

C. Basis of Payment

The accepted quantities, measured as prescribe above, shall be paid for at the contract unit price, for the pay item listed below that is included in the Bill of Quantities, which price and payment shall constitute full compensation including all other incidentals necessary to complete this item.

A.1.5 (1) Provision of Communication Facility for the Engineer

A. Description

The Contractor shall provide for the exclusive use of the Engineer's team within seven (7) calendar days upon commencement of the works and maintain for the duration of the project the communication equipment as stated below.

Communication equipment shall be returned to the Contractor and become the properties of the Contractor after the completion of the Project.

B. Method of Measurement

Provision of Communication Facility/Equipment for the Engineer shall be measured by Each unit.

C. Basis of Payment

The accepted quantities, measured as prescribe above, shall be paid for at the contract unit price, for the pay item listed below that is included in the Bill of Quantities, which price and payment shall constitute full compensation including all other incidentals necessary to complete this item.

A.1.4 (1) Provision of Progress Photographs

A. Description

The Contractor shall provide progress photographs in approved photo album taken as, when and where directed by the Engineer at intervals of not more than one month. The photographs shall be sufficient in number and location to record the exact progress of the Works.

The Contractor shall provide proof print of each photograph taken, with *electronic file* and ten copies, size 5R, and printed on glossy paper, of any of the photographs selected as progress photographs by the Engineer. Photographs and prints must be of professional quality; clear, in focus, with high resolution and sharpness, and with minimum distortion.

Photographs must be of the same view position of the works to show continuous progress of the works until the works are completed or as directed by the Engineer.

A. Method of Measurement

Provision of Progress photographs shall be measured by Month.

C. Basis of Payment

The accepted quantities, measured as prescribe above, shall be paid for at the contract unit price, for the pay item listed below that is included in the Bill of Quantities, which

price and payment shall constitute full compensation including all other incidentals necessary to complete this item.

Project Sign Board

A. Description

This item shall consist of furnishing, installing and maintaining during the duration of the project, the project information signboard of the type specified in accordance with this Specifications and the details as shown in the drawings. Location for signboard shall be identified by the Project-in-Charge.

The Project Billboard/Signboard shall be a tarpaulin signboard that must be suitably framed for outdoor display at the project location, and shall be posted as soon as the award has been made.

B. Material Requirements

Sign Panel
The panel for the project informational signboard shall be the standard 8 ft. x 8 ft. white tarpaulin suitably framed. The design and format of the tarpaulin, as shown in the drawings, shall have the following specifications:

Resolution	:	70 dpi
Font	:	Helvetica
Font Size	:	Main Information – 3”
	:	Sub-Information – 1”
Font Color	:	Black

Posts and Frames
The post and frames shall be hard wood of the specie indicated on the drawings.

Hardwares
All hardwares shall be of the kind and size specified on the drawings or as approved by the Project-in-Charge for DIA

C. Construction Requirements

Location
The project information signs shall be installed at the area designated by the Project-in-Charge for DIA

Excavation and Backfilling
Holes shall be excavated to the required depths of the bottom of the posts as shown on the drawings.

Erection of Posts

The posts shall be erected vertically in position at the locations identified by the Project-in Charge for DIA

Installation of Sign Panel
The sign panel shall be erected in accordance with the details shown on the drawings. Any chipping or bending of the sign panel shall be considered as sufficient cause to require replacement of the panel at the expense of the Contractor.

D. Method of Measurement and Basis of Payment

The accepted quantity, the number of set of signboard provided, shall be paid for at the contract unit price for item Project Signboard which price and payment shall constitute full compensation for furnishing and placing all materials including all labor, utilization of tools and equipment and incidentals necessary to complete the work.

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
	SERIES-1000 Section 1120 Employers and Engineers Facilities	
1.1	Provision of field office for the employer and engineers including laboratory and staff house with electric power and water supply, (minimun area of 250 sq.m.) on rental basis.	Month
1.2	Provision of furnitures/fixtures, equipment & appliances for the field office of the Engineer.	Lump Sum
1.3	Operation and maintenance of Field Office for the Engineer	Month
1.4	Provide and Maintenance Communication Equipment for the Engineer	Month
1.5	Project Sign Board	each
	SERIES-1000 Section 1210 Project Equipment	
1.1	Service Vehicle for the Engineer, Provide (2 Unit) Brand new Pick-up 4x2 Diesel Powered including operation and Maintenance.	Month
1.2	Surveying Instruments	Month
	SERIES-1000 Section 1165	
1.1	Progress Photograph	Month

PART B. OTHER GENERAL REQUIREMENTS

B.2 Medical Room and First Aid Facilities

A. Description

The Contractor shall provide and maintain throughout the duration of the Contract, a medical room together with all necessary supplies to be sited in the Contractor's main area. The medical room shall be waterproof; it could be a building or room designated and used exclusively for the purpose and have a floor area of at least 15 square meters and a glazed window area of at least 2 square meters.

The Contractor shall employ permanently on the site a fully trained Medical Aide who shall be engaged solely from medical duties.

The location of the medical room and any other arrangements shall be made known to all employees by posting on prominent locations suitable notices in the Site. The Contractor's arrangement to comply with this Section shall be subject to the approval of the Engineer and also to the approval of any qualified Medical Officer designated by the Government to supervise medical arrangements on the Site.

B. Construction Safety and Health

The Contractor shall, at his own expense, furnish his workers with protective equipment for eyes, face, hands and feet, lifeline, safety belt/harness, protective shields and barriers whenever necessary by reason of the hazardous work process or environment, chemical or radiological or other mechanical irritants of hazards capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical agent.

All Personal Protective Equipment and Devices shall be in accordance with the requirement of the Occupational Safety and Health Standards (OSHA) and should pass the test conducted and/or standards set by the Occupational Safety and Health Center (OSHC).

C. Method of Measurement and Basis of Payment

When the Contract stipulated that payment will be made for occupational safety and health program on lump sum basis, the pay items will include all necessary personal protective equipment (PPE), safety and health personnel and all other materials & supplies construction of safety signage, barricades and all other safety measures necessary during the entire duration of construction.

The accepted quantity shall be paid for at the contract unit price for item Occupational Safety and Health Program which price and payment shall constitute full compensation for all the works and incidentals prescribed in this Item.

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
	Series 1000 Section 1130	
1.2	Safety and Health	Month

B.9 Mobilization / Demobilization

A. Description

Mobilization: When the Contractor has executed the transport and furnishing of all necessary manpower including equipment but not limited to as tabulated below as well as all necessary preparations and requirements for the execution of permanent works.
The Contractor shall begin mobilizing manpower and construction equipment as soon as the site has been formalized. Mobilized equipment required in the contract shall be duly listed by the Contractor for approval, and, shall not be removed from the site by the same without prior written approval from the Project-in-Charge.

All Contractor's initial mobilization costs such as planning and designing all temporary works and facilities and making submittals to the Project-in-Charg recruiting and transferring staff, obtaining all necessary government licenses, permits, clearances, etc., and any other costs involved in preparing to carry out the permanent works as stipulated in the contract and / or as required by the Project-in-Charge or Engineer shall not be paid separately but shall be included in the unit prices in general or specific overheads.

Demobilization: When the Contractor has moved out all its manpower and equipment that are no longer necessary, and when the area is cleaned and satisfactory to DIA

Upon completion of the Project, the Contractor shall clear all the areas under contract to the satisfaction of DIA including the dismantling of temporary facilities, hauling of salvaged materials to designated areas and clearing, transport and disposal of all construction debris. The contractor shall also pullout all existing manpower and equipment as duly approved by the Project-in-Charge for SBMA.

B. Method of Measurement and Basis of Payment

The accepted quantity shall be paid for at the contract unit price for item Mobilization and Demobilization which price and payment shall constitute full compensation for all the works and incidentals prescribed in this Item.

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
SPL-1	Mobilization / Demobilization	Lump Sum

B.14 Environmental Management and Monitoring

A. General Description

Waste Disposal:

1. The Contractor shall provide for its workers adequate and appropriate sanitary facilities, i.e. provision of portable toilet in accordance with guidelines to be provided by the Ecology Center, and ensure that all sewage is disposed of, if and as necessary, by an accredited sewage disposal company.

2. The Contractor shall ensure that oil and grease and other related hazardous wastes, such as paints, concrete epoxies admixtures, etc., which are generated during Contract implementation shall be properly contained, handled and disposed of outside the project in accordance with provisions of Chapter VII of DAO 29 (IRR of RA 6969, otherwise known as the Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990). Disposal shall be done by a DENR and an accredited hauler and transporter, who shall advise the disposal site.

3. The Contractor shall ensure that recyclable items such as metal scraps shall be stored in an appropriate manner and reused to the fullest extent feasible. All materials remaining after completion of the Project shall be either recycled or disposed of. The Contractor is prohibited from maintaining a garbage dump within its leased premises. Construction debris and spoils such as excess and/or broken concrete, hollow blocks, tiles, etc. shall be disposed of in an approved Landfill. All wastes shall be properly contained and disposed of in this landfill. The Contractor shall secure a dumping permit for each truckload of waste to be disposed of in an approved disposal site. Cost and requirements for disposal are the following:

4. The Contactor shall ensure that no fishing, hunting, or collection of wild plants and animals is undertaken by his staff or the staff of his Sub-Contractors on or adjacent to the site. The Contractor shall be fully penalized as provided for by law.

Environmental Quality:

1. The Contractor shall strictly adhere to DENR standards on dust and smoke emissions as provided for in Section 62 of DAO 14. The Contractor shall also follow noise standards as provided for in Section78 of PD 984.

2. The Contractor shall ensure that all trucks use tarpaulins (spill catchers) to cover their top loads in order to prevent construction debris from falling on the roads. In the event of falling debris, the Contractor must take all necessary actions to recover the same. He shall be responsible for keeping the roads within the Freeport used by the Contractor's construction vehicles free from dirt and debris. Failure to do so will result in the imposition of necessary fines and penalties.
3. The Contractor shall ensure cleanliness of his leased premises and construction site at all times. This means that all construction materials shall be properly stored. He shall also ensure regular maintenance of trucks, vehicles and equipment. Failure to do so shall result in the imposition of necessary fines and penalties.

4. The Contractor shall conduct his construction activities so that they shall not be a nuisance and/or safety hazard to the public. A Traffic Management Plan shall be prepared by the Contractor and approved by the Engineer.

5. Contractor shall provide its personnel appropriate personal protective equipment including, as deemed necessary, eye and face protective devices, hard hats, safety shoes, electrical protective devices, respirators, gloves, ear plugs/muffs, etc. The appropriate protective devices must be worn as necessary. Mandatory safety provisions in accordance with standard industry practice must be strictly observed. The Contractor shall prepare a Health and Safety plan for approval, and appoint/designate a Safety Officer to oversee the implementation of all safety requirements and guidelines.

6. The Contractor shall conduct monthly effluent monitoring of water bodies, potentially affected by the project including parameters such as color, temperatures, TSS, oil and grease and BOD as mandated with provisions of Section 5 of DAO 35.

7. Throughout the Contract period, the Contractor shall provide for adequate temporary drainage at all locations along the project to prevent damage from rainfall and flooding in the form of erosion, loss of strength, contamination, etc. to adjacent pavements, water bodies/streams, etc.

B.14 (1) Environmental Management and Monitoring (Provision of Four (4) Units Portable Toilet)

A. Description

This item shall consist of provision of four (4) units portable toilet on rental basis including cleaning and disposal services and all other incidentals necessary to complete the work in accordance with this Specification or as directed by the Engineer.

The Contractor must ensure that portable toilets are to be compliant with all applicable codes, regulations, and industry standards, including proper disposal.

The Contractor and service provider agreement shall be in satisfaction to the Engineer in accordance to the Environmental Management Program required for the duration of the project.

B. Basis of Payment

The accepted quantities, measured as Month, shall be paid for at the contract unit price, for the pay item listed below that is included in the Bill of Quantities, which price and payment shall constitute full compensation for the provision for Portable Toilet including all other incidentals necessary to complete this item.

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
B.14 (1)	Environmental Management and Monitoring (Provision of Four (4) Units Portable Toilet)	Month

PART C. EARTHWORKS

110	Clearing and Grubbing
101 (1) a	Removal of existing office building
101 (1)b	Removal of existing Concrete Pavement
101(5) c1	Removal of existing covered ditch
101(5)c2	Removal of existing sewer line
101(5)c3	Removal of existing storm drainage
102(1) b	Removal of existing fence
101(5) d1	Remove existing Potable water line
101(5) d2	Remove of existing fire protection water line
102(2)	Surplus Common Excavation
103(1)a	Structure Excavation (Common Soil)
104(1)	Embankment from Common Borrow
104(6)	Granular Back Fill (Incl. filter stone and weep hole)
104(7)	Backfill from Structure Excavation
105(1)a	Subgrade Preparation

A. Description

This item shall consist of clearing and grubbing, removal of existing structures, structural excavation, embankment from common borrow, granular backfill and subgrade preparation, including stockpiling/disposal of material in accordance with this Specification and in conformity with the lines, grades, and dimensions shown on the Plans or as established by the Engineer for the Project and in conjunction with the

drawings, Bill of Quantities and Technical Specifications as per DPWH Blue Book 2013 Edition and its Department Order.

B. Construction Requirements

When there is evidence of discrepancies on the actual elevations and that shown on the Plans, a pre-construction survey referred to the datum plane used in the approved Plan shall be undertaken by the Contractor under the control of the Engineer to serve as basis for the computation of the actual volume of the excavated materials.

All excavations shall be finished to reasonably smooth and uniform surfaces. No materials shall be wasted without authority of the Engineer. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed.

Suitable materials from excavation shall be stockpiled to the location designated or approved by the Engineer for future use or as an embankment material.

Unless otherwise specified, all materials below subgrade level in earth cuts to a depth 150 mm or other depth shown on the Plans or as directed by the Engineer shall be excavated. The material, if suitable, shall be set aside for future use or, if unsuitable, shall be disposed in accordance with the requirements and procedures of SBMA policies.

C. Method of Measurement and Basis of Payment

The accepted quantities, measured as prescribed, shall be paid for based on the contract unit price for each of the particular pay items that are listed in the Bill of Quantities which price and payment shall constitute full compensation for all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.

SECTION 1400 : EARTHWORKS FOR SITE DEVELOPMENT AND BUILDING WORKS		
110	Clearing and Grubbing	Has.
101 (1) a	Removal of existing office building	ls.
101 (1)b	Removal of existing Concrete Pavement	sq.m.
101(5) c1	Removal of existing covered ditch	l.m.
101(5)c2	Removal of existing sewer line	l.m
101(5)c3	Removal of existing storm drainage	l.m
102(1) b	Removal of existing fence	l.m
101(5) d1	Remove existing Potable water line	l.m
101(5) d2	Remove of existing fire protection water line	l.m.
102(2)	Surplus Common Excavation	cu.m.
103(1)a	Structure Excavation (Common Soil)	cu.m.
104(1)	Embankment from Common Borrow	cu.m.
104(6)	Granular Back Fill (Incl. filter stone and weep hole)	cu.m.
104(7)	Backfill from Structure Excavation	cu.m.
105(1)a	Subgrade Preparation	sq.m.

SECTION 1500 : PAVEMENT WORKS

210 Granular Subbase Course

280(2) Portland Cement Concrete Pavement, 250 mm thick

290 Reflectorized Pavement Marking

SECTION 1600 : DRAINAGE WORKS

310 (1) RCPC 460 mm

310 (6) Pipe Culvert and Drainage Excavation

320 (1) Curb Inlet Manhole

320 (2) Storm Drainage Manhole

500 (3)c Lined Canal , Stone Masonry Type V

SECTION 1700 : MISCELLANEOUS WORKS

410(1) Curb and Gutter

410(3) Walkways, 100 mm thick

SECTION 1800 : CONCRETE FOR STRUCTURES

Retaining Wall
220(1.1)Structural Concrete, 28 Mpa
220(2)a Reinforcing Bars, Grade 40

220(2)b Reinforcing Bars, Grade 60

Description

The above items shall consist of pavement works, drainage works, miscellaneous works and concrete structures shall be in conformity with the Specification and in conjunction with the drawings, Bill of Quantities and Technical Specifications as per DPWH Blue Book 2013 Edition and its Department Order.

Basis of Payment and Measurement as per table hereunder

SECTION 1500 : PAVEMENT WORKS		
210	Granular Subbase Course	cu.m.
280(2)	Portland Cement Concrete Pavement, 250 mm thick	sq.m.
290	Reflectorized Pavement Marking	sq.m.
SECTION 1600 : DRAINAGE WORKS		
310 (1)	RCPC 460 mm	l.m
310 (6)	Pipe Culvert and Drainage Excavation	cu.m.
320 (1)	Curb Inlet Manhole	each
320 (2)	Storm Drainage Manhole	each
500 (3)c	Lined Canal , Stone Masonry Type V	l.m.
SECTION 1700 : MISCELLANEOUS WORKS		
410(1)	Curb and Gutter	l.m
410(3)	Walkways, 100 mm thick	sq.m.
SECTION 1800 : CONCRETE FOR STRUCTURES		
	Retaining Wall	
220(1.1)	Structural Concrete, 28 Mpa	cu.m.
220(2)a	Reinforcing Bars, Grade 40	kg.
220(2)b	Reinforcing Bars, Grade 60	kg.

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

STRUCTURAL WORKS SERIES 2000

TECHNICAL SPECIFICATIONS FOR STRUCTURAL WORKS

SERIES 2000

SERIES 2000 – STRUCTURAL WORKS

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General Requirements:

This specification shall be read in conjunction with the Bill of Quantities and Drawings for Series 2000- Structural Works.

The contractor shall provide all necessary measures to protect the structures, adjacent properties, workmen and other persons during all phases of construction and shall immediately notify the owner and / or the engineer of any condition which in his opinion might endanger the stability of the structures or cause distress in the structures.

The construction materials shall not be stored on poured floors. It is the general contractor's responsibility to ensure that the sub-contractors are informed and do not violate this important requirement.

The contractor shall provide temporary erection bracings and shorings for all the structural members as required for structure stability during all phases of construction. The contractor shall take all steps necessary to ensure the proper alignment of the structures during and after the installation of all structural and finish materials.

References:

For the standards and references, the following shall govern the design, fabrication and construction of the project:

- American Concrete Institute (ACI);
    a. ACI 318-14 building code requirements for structural concrete
    b. ACI 315-99 manual of standard practice for details and detailing of concrete reinforcement
- American Institute of Steel Construction (AISC):
- Manual of Steel construction, thirteenth edition.
- American Welding Society (AWS) -"Allowable Stress Design" (ASD)
- American Society for Testing Materials (ASTM)
- National Structural Code of the Philippines (NSCP) vol. 1,
- 7th edition 2015 Association of Structural Engineers of the Philippines (ASEP)
- Handbook of Structural Steel Shapes and Sections,
- 1987 Uniform Building Code (UBC), vol. 2 1997 edition

Design Loads:

BASIC DESIGN LOADS:

DESIGN LOADS (DL):

CONCRETE	24.00 kN/m 3
STEEL	77.00 kN/m 3
SOIL	18.00 kN/m 3
FLOOR FINISH	1.10 kPa
100MM THK. CHB WALL	3.32 kPa
150MM THK. CHB WALL	3.45 kPa
CEILING/FIXTURES	0.25 kPa

MECHANICAL DUCT 0.25 kPa
STEEL DECK WITH 5" RC 2.70 kPa

LIVE LOADS (LL):
GENERAL AREA/OFFICE 4.80 kPa
CORRIDOR/OPEN AREA 4.80 kPa
ELECTRICAL/MECHANICAL ROOM 6.0 kPa
ROOF DECK 1.0 kPa

WIND LOAD (WL)

The wind load on structure and building shall be calculated, based on National Structural Code of the Philippines, considering basic wind speed (3 second gust speed) equals to 41.70 m/sec.
BASIC WIND SPEED, V = 300 km/hour
OCCUPANCY CATEGORY = I
EXPOSURE CATEGORY = B

SEISMIC LOAD, E (refer to the General Notes)

MATERIALS

NORMAL WEIGHT CONCRETE:

-Concrete used in this work shall be marine type class iv with a minimum compressive strength @ 28 days, f'c, as follows:

COLUMNS & BEAMS	fc' = 28MPa (4,000 PSI)
SHEAR WALLS (W01 & W02)	fc' = 28MPa (4,000 PSI)
SUSPENDED SLAB	fc' = 28MPa (4,000 PSI)
FOOTING & SLAB ON GRADE	fc' = 21MPa (3,000 PSI)

- All concrete shall be deposited, vibrated and cured in accordance with ACI STANDARD 318-95

Minimum concrete cover for reinforcing bars shall be as follows:
a. footings & bot. of footing tie beam = 75mm (cast against earth)
b. beams and columns = 50mm (to stirrups and ties)
c. slabs and walls = 20mm (cast against forms)
d. all concrete members exposed to weather = 50mm (cast against forms)

Before concrete is poured, check with all trades to ensure proper placement of all openings, sleeves, curb1s, conduits, etc. relative to the work.

When concrete will be exposed to external sources of chlorides in services, such as deicing salts, brackish water, seawater or spray from these sources, concrete must be proportioned to satisfy the special exposure requirements of aci 318-95.

All concrete shall be kept moist for a minimum of 7 consecutive days immediately after pouring by the use of wet burlap.

REINFORCING BARS:

Reinforcing Steel, Grade 40
Reinforcing Steel, Grade 60

A. Description

This Item shall consist of furnishing, bending, fabricating and placing of steel reinforcement of the type, size, shape and grade required in accordance with this Specification and in conformity with the requirements shown on the Plans or as directed by the Engineer.

Other requirements such as but not limited to; materials and construction requirements shall be in accordance whenever applicable, with DPWH: Standard Specifications for Highways, Bridges, and Airports and to the DPWH latest issuance of department order related in particular to this item.

B. Method of Measurement and Basis of Payment

The accepted quantities, measured as prescribed, shall be paid for based on the contract unit price for each of the particular pay items that are listed in the Bill of Quantities which price and payment shall constitute full compensation for all labor, quipment, tools and incidentals necessary to complete the work prescribed in this Item.
Unless otherwise specified on plans, all reinforcing bars shall be deformed with a minimum yield strength of

fy = 410 mpa for diameter 12 and above, and;
fy = 275 mpa for diameter 10 and below.

All reinforcing bars shall be cleaned of rust, grease or other materials which tend to impair bond.

All reinforcing bars shall be accurately and securely placed before pouring concrete or applying mortar or grout.

Lapped splices shall be staggered where possible, unless indicated otherwise, splicing of reinforcement shall be in accordance with ACI- 318-14.

Unless shown otherwise on plans, splices shall be as follows:

a. beams and footing tie beams: top and bottom bars shall not be spliced within the column or within a distance of twice the member depth from the face of the column; at least two extra stirrup - ties shall be provided at all splices. the splice length shall not be less than the length in item 4.2.9 below.

b. columns: splices when permitted shall be made within the center half of column height, and lap splice shall not be less than 40 bar diameters. the use of approved mechanical devices may be permitted provided that not more than alternate bars are spliced at any level and the minimum vertical distance between two adjacent bar splices shall be 600mm.

c. cmu walls: vertical bars shall be spliced at the top of wall footing or tie beam and at the bottom of rc lintel beam or beams. splice lengths shall be 600mm min.

Unless indicated otherwise all beams terminating at the column shall have top and bottom bars extending to the far face of the column, terminating in a standard 90° hook length of anchorage not less than 600mm.

Shop drawings for bending and cutting of reinforcement shall be submitted for approval to the engineer prior to fabrication.

Splice length of reinforcing bars shall be as shown in the table below.

- structural steel/anchor bolts/bolts/welds & weldments
- all structural steel shall have a minimum yield strength, fy = 248 mpa (36 ksi) and shall conform to ASTM A 36 specifications.

- all structural steel shall be fabricated and erected in accordance with the AISC specifications (9th edition)
- all cold formed steel shall have a minimum strength, fy = 230 mpa (33 ksi)
- no steel shall be fabricated or erected until shop drawings have been approved by the structural engineer.

- all shop and field welding shall be in accordance with AWS D.1.1-2000 and performed by qualified welders.

- unless otherwise indicated all anchor bolts shall conform to ASTM A 307 specifications.

- bolts for member connections shall be high strength bolts, conforming to ASTM A 325 friction type with washers.

CONCRETE MASONRY UNITS (CMU)

- CMU used in these works shall have a minimum ultimate compressive strength @ 28 days as follows:
    a. 100mm thick non-load bearing cmu, f'm = 2.4 mpa (350 psi)
    b. 150mm thick non-load bearing cmu, f'm = 2.4 mpa (350 psi)

- All cells shall be solidly filled with grout. concrete shall have a minimum compressive strength of 13.80 mpa (2000 psi) @ 28 days.

- Unless indicated otherwise, cmu reinforcement shall be 10mm Ø hor. bars @ 600 and 10mm Ø vert. bars @ 600.

- All walls shall be constructed in conventional running bond unless noted otherwise.

- Grout masonry in 2.4m maximum lifts. reinforcing shall be secured against displacement prior to grouting by wire positioners at intervals not exceeding 200 bar diameters nor 3m.

CONSTRUCTION JOINTS:

- Construction joints not indicated on plans shall be made so as to least impair the strength of the structure and shall be subject to approval of the engineer.

- Unless shown otherwise, slab on grade shall have control joints @ 6.00m maximum center to center.

STRUCTURAL SPECIFICATIONS

A. REINFORCED CONCRETE WORKS

- All columns, shear walls & suspended slabs shall be of 28-day concrete strength of 4000-psi.
- All footings and slab on grade shall be of 28-day concrete strength of 3000-psi.
- Reinforcing bars of 12mm & larger shall be of Grade 60 ASTM A- 615 (Fy = 420 Mpa).
- Reinforcing bars of 10mm & smaller shall be of Grade 40 ASTM A- 615 (Fy = 275Mpa).
- Refer to sheet no. S-2100-1 for complete notes on concreting and reinforcements.

B. STEEL DECK

- Cold form steel, 1.8 mm TCT, 50mm depth, Fy 40ksi, Coating Galfan or Galvalume (coating mass = 275 g/sqm).
- Area = 8,161 sqm

C. STANDING SEAM ROOF PANEL

- AZ 150 g/sqm or greater (Galvalume) or Galfan, Fy =55 ksi, Material thichness = 0.60 mm
- The Panel must be prepainted panel and the color as per Architect.
- The Roof Panel wind Uplift must withstand basic wind speed of Davao which is 300 kph.
- 20 years Warranty.
- Area = 1150 sqm

D. STRUCTURAL STEEL

- For Angles and H sections : Surface Preparation - Sand blasting (Sa 2). Apply Epoxy zinc rich primer for anti-corrosion by the structural manufacturer.

- Circular pipes and Rectangular pipes are galvanized. Note special surface preparation and cleaning is required for Galvanized before applying of Epoxy zinc rich Primer by the structural Manufacturer.

- At the Construction sites for all steel structures Painting: Clean and hand applied brush one coat of Micaceous iron oxide paint before applying Intumecent paint (fireproofing) than

apply Epoxy top coat.

- Note the paint Brands and Paints including the Primer Paint must be all compatible with the Intumescent paint (Fireproofing Paint).

All angles and H section steel are Fy=50 ksi except all pipes are Fy 36ksi.

E. PURLIN Z

- Z - 200x 45x 13x 1.9mm TCT (total coated Thickness) with base metal thickness of 1.85 mm. Galvanized coated both sides w/ 90 micron or greater and Fy 50 ksi

F. Insulations: Glasswool or Fiberglass, Thickness and Density is as per Architect.

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

ARCHITECTURAL WORKS SERIES 3000

TECHNICAL SPECIFICATIONS FOR ARCHITECTURAL WORKS

SERIES 3000

SERIES 3000 – ARCHITECTURAL WORKS

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SOIL POISONING (Soil Treatment)

GENERAL

Whenever the Scope of Work includes soil poisoning, the work shall include furnishing of labor, materials, and equipment to complete all poisoning works.

MATERIALS

Soil Poisons, Soil poisons shall be water-based emulsions. Any of the following may be used:
Chlordane - 1% Concentration
Benzene Hexachloride - 0.8% Gamma Isomer Concentration
Dieldrin - 0.5% Concentration
Aldrin - 0.5% Concentration
Heptachor - 0.5% Concentration

SAMPLE AND TEST
A sample of the concentrated toxicant shall be tested.

At least two samples of working solution shall be tested for every 10,000 square feet or 1,000 square meters of treated area.

Samples shall be submitted, analyzed and tested by an approved testing laboratory. Tests shall be paid for by the Contractor. The results shall be submitted to the Construction Officer.

DELIVERY, STORAGE, AND PROTECTION
Chemicals shall be delivered to the job site in factory sealed containers with the manufacturer's brand and name clearly marked.

Chemicals shall be stored, handled, and applied in accordance with the directions in the manufacturer's label.

WORKMANSHIP

SITE INSPECTION
A general survey and through examination of the entire premises shall be undertaken in order to fully understand all existing conditions and to determine
the location and existence of subterranean termite colonies.

APPLICATION
Soil poison working solution shall be applied by means of pressure spray, soil injector, or when specified by direct pouring.

Live termite mounds found within the premises shall be exterminated by destroying the mounds and/or introducing soil poison working solution into mounds.

Soil poisoning work shall not begin until all preparations for slab placement have been completed.

Soil poisons shall not be applied when soil of fill is excessively wet or immediately after heavy rains to avoid surface flow of soil poison solution from the application site.

After grading and leveling the soil in the ground, gravel bed shall be set preparatory to the pouring of concrete at every 10.76 sq.ft. (Square Meter) floor footing area shall be flooded or soaked with soil poison working solution.

Every 3.28 linear feet (linear meter) of excavation for footing retaining wall and other foundation work shall be thoroughly drenched and saturated with soil poison working solution before pouring of concrete.

The solution shall be applied to all areas immediately below expansion joints, control joints and all areas where slab will be penetrated by pipe and other construction features.

Masonry wall resting on grades shall have their voids treated with 1 gallon of soil poison working solution per 5 linear feet (1.52 linear meter) of wall. Poison shall be poured directly into below spaces.

Prior to landscaping of lawn, every linear meter of building perimeter and of three-meter width shall be saturated with soil poison working solution.

Earth fill shall be treated thoroughly. As soon as fill is compacted and leveled, every one square meter area shall be drenched with soil poison working solution.

GUARANTEE

Upon completion and acceptance of the work, the Owner shall be furnished with a written guarantee stating that termite control is guaranteed for a period of 10 years and that regular inspections are to be done by the guarantor to ensure the quality of their work.

WATER PROOFING

- Concrete deck on High Tensile Flexible Rubberized Asphalt Water Proofing Membrane with Concrete Topping finished
- Hot applied Asphalt with Polyvinyl Chloride Sheet Membrane
- Polyethylene waterproof membrane

RADIANT HEAT BARRIER

SCOPE OF WORK

The Contractor shall furnish and install all labor and material to complete the work.

MATERIAL

RADIANT BARRIER

Radiant Barrier shall be fire retardant aluminum foil for roof insulation. It shall have a 6 layer fire retardant double-sided aluminum foil laminate with superior radiant heat barrier properties. It shall be tearproof, waterproof and possesses the following properties.

Elongation	:	150% ASTM D882
Water Vapor Transmission	:	Greater than 5000 Mns/g ASTM E96-E
Water Vapor Permeance	:	Less than 0.20 ng/Ns Less than 0.004 (Perms) ASTM E96-E
Tensile Strength:		M.D. 6.6 KN/m D.D. 5.0 KN/m C.D. 4.7 KN/m ASTM 828
Puncture Resistance	:	1.0 Joules T.APPA T800
Reflectivity	:	86% ASTM E466-71
Emissivity	:	5%
Roll Size	:	1.25m x 60m = 75.00 sq.m.
Weight	:	200 g/m2
Thickness	:	0.190mm
Total R-Value (M2K/W)	:	1.72
Fire Retardant BS476	:	Part 6 Class 0 Part 7 Class 1

WORKMANSHIP

The product shall be delivered to the site in its original package or container bearing the manufacturers
name and brand designation.

All materials shall be installed by skilled and selected workmen familiar with the aforementioned product.

INSTALLATION

The installation shall have a joint overlap of 75mm. It shall be unrolled foil down length of roof from ridge.

For further information, see manufacturer's specifications.

ELASTOMERIC WATERPROOFING MEMBRANE

SCOPE OF WORK
The Contractor shall furnish and install all materials and labor required to provide waterproofing on designated locations.

MATERIAL

Elastomeric waterproofing membrane shall be liquid applied single component and made by a reputable manufacturer.

PREPARATION

All surfaces to be waterproofed should be clean, sound and dry. Concrete surfaces should have a light steel-trowel followed by a fine hair-broom or equivalent finish that is dry and free from dust, oil and other contaminants. Remove all high spots. Moss and lichen must be removed physically followed by treatment with fungal wash down through and allow to dry. Lattence should be removed from concrete by grit blasting, wire brushing or water jet blasting and allowing to dry.

For installation procedure and other information, see manufacturer's specification

ROOFING (Roofing, Cladding and Facades)

DESCRIPTION

The work includes installation of pre-painted Rib-type Long-span roofing complete with hardware and accessories.

GENERAL

The work includes furnishing all materials and requirements performing all operations to provide a long span corrugated twin ribbed roofing and miscellaneous roofing works as required to provide an acceptable installation. Surfaces to which metal formed roofing sheets are to be applied shall be thoroughly cleaned and prepared, free from any defects that may affect the application. Metal formed roofing shall be locked and lapped and installed as applicable. Specific installation details shall be in accordance with manufacturer's recommended installation practice.

Metal formed roofing and sheets and accessories shall be carefully handled at all times in strong and handling to prevent damage to the surfaces, edges and ends and shall be slightly elevated for drainage.

Metal formed roofing and sheets and accessories shall be delivered to the site in the original sealed container or packages bearing the manufacturer's name and brand designated where materials
are covered by a reference specification number, type and class as applicable.

INSTALLATION

Lay and install the first sheet with the turned down edge towards the outside of the area to be covered. Overlap the next sheet to the previous sheet in such a manner that the exposed edge is turned down and the covered edge is turned up. Side up fasteners should be done by rivets and washers spaced from 300 mm to 450 mm on centers.

Care should be exercised in the proper anchorage of all roof frames.

Ridge strips for ridge rolls and ridge flashings are attached to the roofing sheets by means of rivets. Other flashings are to be fabricated from plain sheets of the same materials as the roofing in accordance with details and/or site requirements. These are also attached to roofing sheets by means of rivet.

TEMPORARY PROTECTION
Metal formed roofing sheet surfaces requiring protection from stains, discoloration, surface abrasion and other construction abuses shall be suitably protected in accordance with the manufacturer's recommendations.

FINAL CLEARING

Upon completion, the Contractor shall clean the metal formed roofing sheets surfaces and drain line of burrs, leaves, stones and other foreign matter that may impair the flow of water. Surface shall be kept clean by periodic inspection.

Roofing System complete with necessary accessories/miscellaneous items

a. "(R1) .8MM THK STANDING SEAM DOUBLE FOLDED ALUMINIZED STEEL ROOFING WITH 100MM THK 10KG/M³ GLASS WOOL INSULATION WRAPPED IN POLYETHYLENE FILM

b. "(R2) 12MM THK LAMINATED SKYLIGHT GLASS (6MM THK CLEAR FLOAT GLASS - ANTI SHATTER INNER FILM - 6MM THK CLEAR FLOAT GLASS) ON STRUCTURAL STEEL FRAMING (SEE DETAIL)

Facade and Cladding Systemcomplete with necessary accessories/miscellaneous items

a. (W8) 4MM THK ALUMINUM COMPOSITE PANEL WITH PVDF COATING ON STEEL FRAMING , REFER TO MANUFACTURERS DETAIL, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE.
b. (W10) WALL CLADDING SOUND PROOF INSULATION
c. (W11) ALUMINUM VERTICAL BAFFLES

CEMENT FINISHES

SCOPE OF WORK
This work includes furnishing of all materials, equipment and labor, and other facilities necessary to complete all scored cement finish.

MATERIALS

Normal Portland Cement conforming to ASTM Standard C150.

Sand shall be hard, sharp, well washed, siliceous, clean and free from deleterious materials conforming to ASTM Specifications C40.

WORKMANSHIP

Thoroughly clean concrete surface of all dirt, dust, oil patches and other foreign matters. Apply the 1:2 mix cement mortar, trowelled and leveled in accordance with the required slope in the plane. After the mortar has hardened initially, apply scored finish in accordance with the approved sample.

CEMENT MORTAR

GENERAL

Plastering work shall be properly coordinated with the work of other trades. The work of other trades shall be adequate protected from damage during plastering operations. Finishing work shall be protected with a covering of heavy Kraft waterproof paper or other approved protective covering with lapped and sealed joints. Scaffolding shall be amply strong, well braced, tied, securely and inspected regularly. Overloading on scaffolding shall not be permitted.

DELIVERY, STORAGE AND HANDLING OF MATERIALS

Manufactured materials shall be delivered in the manufacturer's original unbroken packages or containers which are labeled plainly with the manufacturer's names and brands. Cementitious materials shall be kept dry until ready to be used. They shall be stored off ground under cover and away from seating walls and other damp surfaces.

MATERIALS

Portland cement shall conform to the Standard Specifications ASTM C-150, Type 1, latest edition.

Sand shall be hard, sharp, well-washed, siliceous, clean and free from deleterious materials, conforming with ASTM C-40.

Water shall be fresh, clean and free from organic matter, acids and alkalis.

MIXTURE

Plaster materials, specified on a volumetric basis, shall be measured accurately in approved containers that will insure the specified proportion. Measuring materials with shovels (shovel count) shall not be permitted. Mortar for plastering shall be mixed in the proportion by volume of one part Portland Cement, 3 parts sand and 25% part hydrated lime. Mortar for finish coat shall be of the same proportioning as specified for plastering expect that proportion of sand be increased to not more than 4 parts.

WORKMANSHIP

Plastering work shall be finished level, plumb, square and true with a tolerance of 0.30mm to 3.00mm, without waves, cracks, blisters, pits, crazings, discoloration's, projections, or

other imperfections. Plastering work shall be formed carefully around angles, contours, and well up to screeds. Special care shall be taken to prevent sagging and consequent dropping of applications. There shall be no visible junction marks in the finish coat where one day's work adjoining another.

APPLICATION

Surfaces to receive plaster shall be cleaned of all projections, dust, loose particles, grease bond breeders and other foreign matter. Plaster shall not be applied directly to (a) concrete masonry surfaces that have been coated with bituminous compound (b) surfaces that have painted materials or previously plastered. Before the plaster work is started, masonry surfaces shall be wetted thoroughly with fog spray of clean water to produce a uniformly moist condition. Metal grounds, corner beads, screed and other accessories shall be checked carefully for alignment before work is started.

Brown coat shall be applied with sufficient pressure to fill the grooves in hollow block of concrete to prevent air pockets and secure a good bond. Brown coat shall be lightly scratched and broomed. Each coat of cement plaster shall be kept moist for 48 hours after application and then allowed to dry.

Finished coat shall be applied until after brown coat has seasoned for 7 days. Just before application of the finished coat, brown coat shall again be evenly moistened with fog spray. Finished coat shall be floated first to a true and even surfaces then trowelled in a manner that will force the sand particles down into the plaster. Plastered surfaces shall be smooth and free from rough areas, trowel marks, checks and blemishes. Thickness of plaster shall be 3/8" on vertical concrete and on masonry.

PLAIN CEMENT WITH FLOOR HARDENER

SCOPE OF WORK

This work includes furnishing all labor, materials, equipment, and other facilities, and the satisfactory performance of all work necessary to complete all plain cement with floor hardener work specified herein.

MATERIALS

Floor hardener shall be non-rusting and on titanium base, to provide extreme hard and highly abrasion and impact resistant floors. It shall be monolithic bonded with base concrete, impact resistant, oil and grease resistant., dense and non-porous, free from rust-stain, easy to install and highly abrasion resistant. Verify color.

WORKMANSHIP

DELIVERY

Materials shall be delivered to the site in their original packages of containers bearing the manufacturers name and brand designation.

PREPARATION

Floor hardener shall be prepared and applied strictly in accordance with the

manufacturer's printed instruction. Flat troweling shall be done keeping the trowel flat and only after the surface has sufficiently set, a second and flat trowelling shall be done. Continue trowelling process until the desired surface finish is achieved.

CONSUMPTION
Heavy duty : 4 - 6 kg/sq.m. Floor Hardener
4 - 6 kg/sq.m. Cement

TILE WORKS

SCOPE OF WORK
Furnish materials and equipment and perform labor required to complete installation;

Floor Finishes complete with necessary accessories/miscellaneous items

1. (F1) 600MM X 600MM X 20MM POLISHED GRANITE TILES WITH ACCENT (SEE PATTERN DETAILS), TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE.
2. (F2) 600MM X 600MM X 20MM FLAMED GRANITE TILES, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE.
3. (F3) 600MM X 600MM X 8MM SLIP RESISTANT UNGLAZED HOMOGENEOUS TILES, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE.
4. (F4) 300MM X 300MM X 6MM SLIP RESISTANT UNGLAZED VITRIFIED TILES, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE.
5. (F5) 300MM X 300 X 3MM VINYL FLOOR TILES, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE.
6. (F6) 600MM X 600MM ANTI STATIC VINYL FLOOR TILES ON RAISED FLOOR SYSTEM, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE.
7. (F8) SMOOTH CONCRETE ON EPOXY PRIMER FINISHED, COLOR AS PER ARCHITECT / CLIENT'S APPROVAL.

Wall Finishes complete with necessary accessories/miscellaneous items

1. 19mm thk Plain Cement Plastering Class "A"
2. (W1) PLAIN CEMENT PLASTER IN SYNTHETIC RESIN EMULSION PAINT FINISHED (EXTERIOR), COLOR AS PER ARCHITECT / CLIENT'S APPROVAL
3. (W2) PLAIN CEMENT PLASTER IN ACRYLIC EMULSION PAINT FINISHED (INTERIOR), COLOR AS PER ARCHITECT / CLIENT'S APPROVAL
4. (W3) DRYWALL IN ACRYLIC EMULSION PAINT FINISHED (INTERIOR), COLOR AS PER ARCHITECT / CLIENT'S APPROVAL
5. (W4) 600MM X 600MM X 20MM MATTE GRANITE TILES, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE
6. (W5) 600MM X 600MM X 8MM HOMOGENEOUS TILES, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE
7. (W6) 300MM X 300MM X 6MM VITRIFIED TILES, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE
8. (W7) DECORATIVE WALL ACCENT ON LAMINATED WOOD FINISHED

9. 100mm thk Tinted Green Glass with aluminum frame for fixed bridge
10. 9mm thk Fiber Cement Board with 50mm thk insulation panel for fixed bride

SAMPLES
Submit samples of floor and wall tiles, and countertop marble slab including all required beads and moldings to the C.O. before purchase for approval as to quality and shade or color.

DELIVERY OF MATERIALS
Deliver all materials in original cartons and containers with labels intact and seals unbroken.

MEASUREMENT AND COORDINATION
The Contractor shall coordinate with other trades involved before starting finishing work. He shall protect works of other trades from damage while finishing works is in progress. Tile work shall not be started until roughing-ins for plumbing and electrical work have been completed and tested.

PROTECTION OF FINISHED WORK
Cover floors with heavy building paper before foot traffic is permitted over finished tile floors. Lay board walkways on floors to be used as passageways.

8.4.6.2 GROUT MATERIALS

Portland Cement Grout:

Scratch Coat : 1 part portland cement to 5 parts damp sand to 1/5 part hydrate lime.

Mortar Bed : 1 part portland cement to 5 parts sand to ½ part hydrated lime. Bond Coat : Neat portland Cement paste.

EXECUTION

APPLICATION OF SCRATCH COAT
Thoroughly dampen, but do not saturate surfaces of masonry or concrete walls before applying the scratch coat. Surface areas shall appear slightly damp.
Allow no free water on the surface. On masonry, first apply a thin coat with
great pressure then bring it out sufficiently to compensation for the major irregularities on the masonry surfaces to a thickness of not less than 6
millimeters (¼ inch) at any point. On surfaces not sufficiently rough to provide
good mechanical key, dash on the first coat with a whisk broom or fiber brush using a strong whipping motion. Do not trowel or otherwise disturb mortar applied by dashing until it has hardened. Evenly rake scratch coats, but not dash coats, to provide good mechanical key for one (1) subsequent coat before the mortar has fully hardened.

FLOOR TILE INSTALLATION ON MORTAR BED

Before spreading the setting bed, establish lines of borders and center the fieldwork in both directions to permit the pattern to be laid with a minimum of
cut tiles. Clean concrete sub-floor then moisten but not soak. Afterwards,
sprinkle dry cement over the surface and spread the mortar on the setting bed. Mix mortar 1 part Portland Cement to 3 parts sand. Tamp to assure good bond over the entire areas and screed to provide a smooth and level bed at proper height and slope. Pitch floor drain as required. After setting bed has been set sufficiently to be worked over, sprinkle dry cement over surface and lay tile. Keep tile joints parallel and straight and lay tile. Keep tile joints parallel and straight over the entire area by using straight edges. Tamp the tile solidly on to the bed, using wood blocks of size to endure solid bedding free from depressions. Lay tiles from center lines outward and make adjustments at walls.

WALL TILE INSTALLATION ON MORTAR BED

Before application of mortar bed, dampen the surface of scratch coat evenly to obtain uniform suction. Use temporary or spot grounds to control the thickness
of the mortar bed. Fill out the mortar bed even with the ground and rod it to a
true plane. Apply the mortar bed over an area no greater than what can be covered with tiles while the coat is still plastic. Allow no single application or
mortar to be 19 millimeters (3/4 inch) thick. Completely immerse glazed wall
tile in clean water and soak it at least 1/2 hour. After removal, stack tile on edge long enough to drain off excess water. Re-soak and drain individual tiles that dry along edges. Allow a bond coat 0.80 millimeters to 1.6 millimeters coats of paint over the shop prime coat. Touch up all exposed metal with anti- rust.

VINYL TILE INSTALLATION

The surface to which flooring is to be applied shall be thoroughly dried, cleaned and leveled. Brush apply primer at a rate of 0.40 liter/m2 to base surfaces and leave to dry for more than 24 hours. Lay tiles in accordance to approved layout drawings with tiles aligned to axis of the room and with proper border widths. All completion, tile surfaces shall be cleaned and thoroughly polished by applying two coats of wax in accordance with directions of the manufacturer of the tile employed.

MARBLE INSTALLATION

Bedding

Bedding mortar shall consists of one (1) part portland cement to three (3) parts sand mix thoroughly until required consistently is reached.

Horizontal

Bedding mortar setting bed is spread, thoroughly clean concrete or masonry surface, making sure that it is free from dust or dirt accumulation and thoroughly moisten it with clean, fresh water. Spread mortar until surface of mortar setting bed is absolutely true and even in place, either leveled or uniformly sloped for drainage, ad required. Place at one operation as large an area as can be covered with tiles before mortar reaches its initial setting.

Vertical
Where tiles are to be applied to masonry construction thoroughly clean and directly moisten surface before applying scratch coat. Properly moisten scratch
coat or plumb coat, when there is one, prior to placing of tiles. Spot scratch coat or plumb coat when there is one, with pieces of tiles mortared in place to
accurately indicate plane of tile when wall is finished. Butter each tile with setting mortar applied as butter coat, consisting of one (1) part portland cement, one half (½) to one (1) part lime putty and three (3) parts sand. Cover back of
each tile with setting mortar and bring to plumb and true surface flush with spot tiles previously mortared in place into scratch or plumb coat to indicate
plane of finished wall.

Polishing Surface
After all marble slabs had been laid it shall be wet ground with an electric grinding machine to a smooth, even surface. For vertical surfaces use an
electric sanding machine. Use No.24 grit abrasive stone for the initial rubbing
follow by No. 80 grit abrasive stone.

Finishing
Final rubbing shall be done by the use of abrasive stone no coarser than No.80 grit. and shall remove scratches and produce a true surface. The finish surface, after final grinding and rubbing shall not show a wave exceeding one thirty second (1/32) of an inch, when tested with steel straight edge, three (3) feet long. After final grinding, it shall be thoroughly cleaned and left in a finished polished condition using an electric buffing machine.

CLEANING
The contractor shall clean all paints, spots, daubs, oil and stain in their entirely from all similar items and leave the work in perfect condition upon completion,
satisfactory in every respect to the Owner and the Construction Officer.

GUARANTEE
The Contractor shall guarantee his work in strict accord with the requirements for "Guarantee" as set forth in the General Conditions of the Contract Documents.

DOORS AND WINDOWS AND ACCESSORIES

SCOPE OF WORK

Furnish and install all labor and materials to complete all vinyl doors and jambs (hinges included) as shown on the drawings and as specified herein.

GENERAL REQUIREMENT

Doors shall be of the quality and workmanship acceptable to the Officer. Doors shall be of the size and type indicated in the schedules and as specified herein guarantee finished doors against twisting, warping, cracking and such other defects due to construction and

installation for a period of three hundred sixty hundred sixty days after final acceptance of the building.

INSTALLATION

Hinged doors shall be hung plumbed and fitted accurately allowing 1.5 mm clearance at the jambs and heads and 3 mm over thresholds. Clearance at the bottom of doors having no threshold shall be 9 mm. Lock stiles of doors 35 mm thick and thicker shall be leveled 3 mm. Knob locks and latches shall be installed 964 mm from the finished floors to the center.

METAL / WOODEN FLUSH DOORS

SCOPE OF WORK

Furnish and install all labor and materials to complete all metal flush doors as shown on the drawings and as specified herein.

GENERAL REQUIREMENT

Doors shall be of the quality and workmanship acceptable to the Construction Officer. Doors shall be of the size and type indicated in the schedules and as specified herein. Guarantee finished doors against rust, twisting, and such other defects due to construction and installation for a period of three hundred sixty days after final acceptance of the building.

SHOP DRAWINGS AND INSPECTIONS

Shop drawings showing fabrication and installation details of doors shall be prepared prior to manufacture and submitted to the Architect for approval.

After shop fabrication and before painting of doors, the work shall be inspected under attendance of the Construction Officer and Inspection reports shall be submitted to him/her.

SCHEDULE OF FINISHES

Wood/ Metal Doors and Jambs complete with necessary accessories/miscellaneous items

1. "(D 1) 900mm x 2400mm SWING TYPE FHC METAL DOOR ON EPOXY POLYESTER BAKED PAINT FINISHED WITH 6.6mm THK WIRED GLASS FIXED WINDOW, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

2. "(D 2) 900mm x 2100mm SWING TYPE FHC METAL DOOR ON EPOXY POLYESTER BAKED PAINT FINISHED WITH 6.6mm THK WIRED GLASS FIXED WINDOW, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

3. (D 3) 2 - 900mm x 2100mm SWING TYPE FHC METAL DOOR ON EPOXY POLYESTER BAKED PAINT FINISHED WITH 6.6mm THK WIRED GLASS FIXED WINDOW, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

4. (D 4) 2 - 800mm x 2100mm SWING TYPE FHC METAL DOOR ON EPOXY POLYESTER BAKED PAINT FINISHED WITH 6.6mm THK WIRED GLASS FIXED WINDOW, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

5. (D 5) 900mm x 2400mm SWING TYPE FHC METAL DOOR ON EPOXY POLYESTER BAKED PAINT FINISHED WITH AIR LOUVERS, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

6. (D 6A) 900mm x 2100mm SWING TYPE INSULATED WOODEN FLUSH DOOR ON LAMINATED FINISHED WITH AIR LOUVERS, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

7. (D 6B) 800mm x 2100mm SWING TYPE INSULATED WOODEN FLUSH DOOR ON LAMINATED FINISHED WITH AIR LOUVERS, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

8. (D 7) 700mm x 2100mm SWING TYPE INSULATED WOODEN FLUSH DOOR ON LAMINATED FINISHED WITH AIR LOUVERS, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

9. (D 8) 600mm x 2100mm SWING TYPE INSULATED WOODEN FLUSH DOOR ON LAMINATED FINISHED WITH AIR LOUVERS, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

10. (D 9) 2 - 900mm x 2100mm SWING TYPE FHC METAL DOOR ON EPOXY POLYESTER BAKED PAINT FINISHED WITH AIR LOUVERS, PROVIDE STAINLESS STEEL PUSH AND KICK PLATE complete with necessary accessories/miscellaneous items.

11. (D 10) 2 - 900mm x 3000mm SWING TYPE STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.

Aluminum Doors complete with necessary accessories/miscellaneous items

1. "(AD 1) 2-1100mm X 2400mm COMBINATION DOUBLE ACTING SENSOR TYPE 12mm THK TEMPERED CLEAR GLASS DOOR ON POWDER COATED EXTRUDED ALUMINUM FRAMING WITH DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM

- 6mm CLEAR FLOAT GLASS) FIXED WINDOW (22.7 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

2. (AD 2) 2 - 1050mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (22.66 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

3. (AD 2-A) 2 - 1000mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (77.31 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

4. (AD 3) 3 - 1050mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (21 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

5. (AD 4) 2 - 1050mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS CORNER FIXED WINDOW (23.07 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

6. (AD 5) 2 - 1000mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS CORNER FIXED WINDOW (15.43 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

7. (AD 6-A) 900mm x 2100mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (12 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

8. (AD 6-B) 900mm x 2100mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (2.16 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

9. (AD 7A) 900mm x 2100mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (9.18 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

10. (AD 7B) 2 - 800mm x 2500mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (4.13 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

11. (AD 8) 2 - 1050mm x 2100mm COMBINATION DOUBLE ACTING SENSOR TYPE 12mm THK TEMPERED CLEAR GLASS DOOR ON POWDER COATED EXTRUDED ALUMINUM FRAMING WITH DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW (27.6 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

12. "(AD 9-A) 4 - 1000mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (70.81 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE complete with necessary accessories/miscellaneous items."

13. (AD 9-B) 2 - 800mm x 2400mm COMBINATION DOUBLE ACTING SENSOR TYPE 12mm THK TEMPERED CLEAR GLASS DOOR ON POWDER COATED EXTRUDED ALUMINUM FRAMING WITH DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW (4.68 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.
14. (AD 9-C) 2 - 800mm x 2400mm COMBINATION DOUBLE ACTING SENSOR TYPE 12mm THK TEMPERED CLEAR GLASS DOOR ON POWDER COATED EXTRUDED

ALUMINUM FRAMING WITH DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW (15.48 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

15. (AD 10) 2 - 1050mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (45.11 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.
16. (AD 11) 2 - 1000mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (9.14 SQ.M.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

17. (AD 12) 975mm x 2100mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (7.00 SQ.M.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

18. (AD 13) 2 - 800mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (4.56 SQ.M.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

19. (AD 14) 1050mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (2.70 SQ.M.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

20. (AD 15) 4 - 800mm x 2400mm COMBINATION DOUBLE ACTING SENSOR TYPE 12mm THK TEMPERED CLEAR GLASS DOOR ON POWDER COATED EXTRUDED ALUMINUM FRAMING WITH DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW (32.04 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

21. (AD 16) 2 - 1000mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (7.10 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

22. (AD 17) 2 - 975mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.
23. (AD 18) 2 - 928mm X 2800mm COMBINATION DOUBLE ACTING SWING METAL DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (11.80 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED. complete with necessary accessories/miscellaneous items.

24. (AD 19) 1150mm X 2700mm COMBINATION DOUBLE ACTING SWING METAL DOOR WITH 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW (6.00 sq.m.) ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED. complete with necessary accessories/miscellaneous items.

25. (GD 1) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

26. (GD 2) 2 - 800mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR, WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

27. (GD 3) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (6.24 sq.m.) WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

28. (GD 4) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (3.60 sq.m.), WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

29. (GD 5) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (5.40 sq.m.), WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

30. (GD 6) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (3.00 sq.m.), WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

31. (GD 7) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (4.86 sq.m.), WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

32. (GD 8) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (4.75 sq.m.), WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

33. (GD 9) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (3.00 sq.m.), WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

34. (GD 9A) 900mm x 2400mm COMBINATION DOUBLE ACTING SWING TYPE 12mm THK FRAMELESS TEMPERED CLEAR GLASS DOOR WITH 12mm THK FRAMELESS TEMPERED CLEAR FIXED WINDOW (2.34 sq.m.), WITH STAINLESS STEEL DOOR HANDLE IN BRUSH FINISHED complete with necessary accessories/miscellaneous items.

ALUMINUM WINDOWS/LOUVER WINDOWS

GENERAL REQUIREMENT

All aluminum windows shall be products of reputable and nationally known manufacturers approved by the Construction Officer. Unless otherwise indicated, all window frames shall be constructed to withstand a minimum 1225 N/sq.m., windload with the sashes in closed position. Windows shall be designed for glazing from outside with continuous glazing heads.

The Contractor shall submit to the Officer shop drawings for approval showing design, elevation of windows, full of size sections of sash, frames and mullion, hardware, construction and assembly details. Details of anchorage, erection, proposed location and method of jointing and splicing of the unit to be installed shall be clearly shown. Fabrication shall not commence until these shop drawings have been submitted and approved.

SCHEDULE OF FINISHES

Aluminum Windows complete with necessary accessories/miscellaneous items

1. (AW 1) 5000mm x 5600mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
2. (AW 3) 4600mm x 6000mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER

FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.

3. (AW 2-B) 17850mm x 4000mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
4. (AW 4) 4825mm x 6000mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
5. (AW 5) 9388mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
6. (AW 6) 4100mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
7. (AW 7) 5000mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
8. (AW 8) 3375mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
9. (AW 9) 9600mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
10. (AW 9A) 10550mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.

11. (AW 11) 3900mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
12. (AW 12) 4700mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
13. (AW 13) 10600mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
14. (AW 14) 9650mm x 2900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
15. (AW 15) 6750mm x 3400mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
16. (AW 16-A) 1500mm x 2700mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
17. (AW 16) 1700mm x 2700mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
18. (AW 17) 3540mm x 2700mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
19. (AW 18) 5129mm x 2700mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
20. (AW 19) 4800mm x 3400mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.

21. (AW 20) 3000mm x 3400mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
22. (AW 21) 2775mm x 3400mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
23. (AW 22) 5200mm x 3400mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
24. (AW 23) 2575mm x 3400mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
25. (AW 24) 10900mm x 3400mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
26. (AW 25) 3000mm x 900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
27. (AW 26) 5000mm x 900mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
28. (AW 27) 8750mm x 2400mm DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
29. (AW 28) 87.10 sq.m. TRAPEZOIDAL SHAPED DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) CLERESTORY FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
30. (AW 29) 67.80 sq.m.TRAPEZOIDAL SHAPED DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) CLERESTORY FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
31. (AW 30) 13.71 sq.m.TRAPEZOIDAL SHAPED DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) CLERESTORY

FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.

32. (AW 31) 19.21 sq.m. DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) CLERESTORY FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
33. (AW 32) 18.05 sq.m.DOUBLE GLAZED 14mm THK LAMINATED GLASS (8mm THICK HEAT ABSORBING TEMPERED GLASS - ANTI SHATTER INNER FILM - 6mm CLEAR FLOAT GLASS) CLERESTORY FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
34. (LW 1) 4525mm x 2900mm rectangular shaped 50mm X 150mm TUBULAR STEEL FRAMED WITH 50mm X 75mm STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.
35. (AW 33) 35660mm x 2700mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
36. (AW 34) 14728mm x 2700mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.
37. (AW 35) 5675mm x 2700mm 12mm THK TEMPERED CLEAR GLASS FIXED WINDOW ON POWDER COATED EXTRUDED ALUMINUM BACK MULLION FRAMING complete with necessary accessories/miscellaneous items.

LOUVER (STEEL) WINDOWS

38. (LW 1) 4525mm x 2900mm rectangular shaped 50mm X 150mm TUBULAR STEEL FRAMED WITH 50mm X 75mm STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.
39. (LW 2) 2625mm x 2900mm rectangular shaped 50mm X 150mm TUBULAR STEEL FRAMED WITH 50mm X 75mm STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.
40. (LW 3) 2325mm x 2900mm rectangular shaped 50mm X 150mm TUBULAR STEEL FRAMED WITH 50mm X 75mm STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.
41. (LW 4) 1725mm x 2900mm rectangular shaped 50mm X 150mm TUBULAR STEEL FRAMED WITH 50mm X 75mm STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.

42. (LW 5) 3475mm x 2900mm rectangular shaped 50mm X 150mm TUBULAR STEEL FRAMED WITH 50mm X 75mm STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.
43. (LW 6) 4450mm x 2900mm rectangular shaped 50mm X 150mm TUBULAR STEEL FRAMED WITH 50mm X 75mm STEEL LOUVERS ON EPOXY POLYESTER BAKED PAINT FINISHED complete with necessary accessories/miscellaneous items.

METAL WORKS

Metalworks complete with necessary accessories/miscellaneous items

1. (W9) 50MM Ø STAINLESS STEEL TROLLEY GUARD (GRADE 304)
2. STAINLESS STEEL RAILINGS FOR STAIRS 1 & 2 WITH BRACING/SUPPORTS
3. STAINLESS STEEL RAILINGS FOR GLASS RAILING WITH BRACING/SUPPORTS (with 12mm thk, Tempered Glass , area=93 sq.m.)

WOOD WORKS AND PARTITIONS

1. "(T5.1) PHENOLIC PARTITION, COMPLETE WITH DOOR, POWDER COATED BLACK ACCESSORIES / MISCELLANEOUS FOR TOILET"
2. "(T5.2) PHENOLIC PARTITION, COMPLETE WITH POWDER COATED BLACK ACCESSORIES / MISCELLANEOUS FOR URINAL"

CEILING FINISHES

Ceiling Finishes complete with necessary accessories/miscellaneous items

1. (C1) 12MM THK FR GYPSUM BOARD ON STANDARD DOUBLE METAL FURRING FRAMING
2. (C2) 12MM THK MR GYPSUM BOARD ON STANDARD DOUBLE METAL FURRING FRAMING
3. FLAT ACRYLIC EMULSION PAINT, COLOR AS PER ARCHITECT / CLIENT'S APPROVAL
4. "(C3) 600MM X 600MM X 15MM ACOUSTIC ROCKWOOL CEILING BOARD ON EXPOSED T-BAR SUSPENSION SYSTEM
5. (C4) 300MM WIDTH METAL LINEAR CEILING SYSTEM ON WOOD GRAIN FINISHED, REFER TO MANUFACTURERS DETAIL, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE
6. (C5) 200MMX300MM ALUMINUM TIMBER BAFFLE ON WOODGRAIN FINISHED, REFER TO MANUFACTURERS DETAIL, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE

7. (C6) 600MM X 600MM SUSPENDED METAL PANEL CEILING SYSTEM, REFER TO MANUFACTURERS DETAIL, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE
8. (C7) 25MM X 50MM ALUMINUM BAFFLE CEILING ON WHITE COLOR FINISHED, REFER TO MANUFACTURERS DETAIL, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE
9. (C8) 4MM THK ALUMINUM COMPOSITE PANEL WITH PVDF COATING ON STEEL FRAMING , REFER TO MANUFACTURERS DETAIL, TYPE AND COLOR AS PER ARCHITECT / CLIENT'S APPROVE SAMPLE
10. (C9)UNDER SLAB IN ELASTOMERIC PAINT FINISHED, COLOR AS PER ARCHITECT / CLIENT'S APPROVAL
11. 600MM X 600MM ACOUSTIC CEILING WITH T-BAR FOR FIXED BRIDGE

MISCELLANEOUS FITTINGS/FURNITURES

FIXTURES

1. (T14) STAINLESS STEEL TISSUE HOLDER complete with necessary accessories/miscellaneous items.
2. (T15) Wall Mounted Soap Dispenser, type and color as per Architect/ Owner's approval
3. FRAMELESS VANITY FACE MIRROR WITH LED STRIP COVE LIGHTING complete with necessary accessories/miscellaneous items.
4. "FULL LENGTH FACE MIRROR TO BE FLUSH ON WALL, PROVIDE 1/2"" THICK MARINE PLYWOOD BACKING complete with necessary accessories/miscellaneous items.
5. STAINLESS STEEL GRAB BAR complete with necessary accessories/miscellaneous items.
6. WALL MOUNTED BABY CHANGING STATION complete with necessary accessories/miscellaneous items.
7. (T10) 3/4" thk Polished Granite Maintenance Wall Cover, type and color as per Architect/ Owner's approval
8. (T11) 3/4" thk Polished Granite Countertop and Splashboard, type and color as per Architect/ Owner's approval

Furniture complete with necessary accessories/miscellaneous items

1. (IF-1) PUBLIC SEATS AT ARRIVAL, 5 SEATS, COMBINATION SEATS PER OF ROWS VARIES (VERIFY ON FURNITURE LAYOUT & SPECS)
2. (IF-2A) PUBLIC SEATS AT DEPARTURE, 5 SEATS, COMBINATION SEATS PER OF ROWS VARIES (VERIFY ON FURNITURE LAYOUT & SPECS)
3. (IF-2B) PUBLIC SEATS AT DEPARTURE, 10 SEATS, COMBINATION SEATS PER OF ROWS VARIES (VERIFY ON FURNITURE LAYOUT & SPECS)
4. (IF-3) CUSTOM DESK & CHAIR WITH MOVABLE SIDE TABLE FOR HEAD, CONFIGURATION VARIES (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
5. (IF-4) DESK AND CHAIR FOR OFFICE PERSONNEL (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)

6. "OFFICE FILE CABINET (VERIFY LOCATION ON FURNITURE LAYOUT)"
7. "(IF-8) SOFA SET (4 SETS & COFFEE TABLE AT PRIVATE LOUNGE (VERIFY LOCATION ON FURNITURE LAYOUT & QUANTITY ON SPECS)"
8. "(IF-9) ROUND TABLE CONFIGURATION WITH 4 CHAIRS (VERIFY LOCATION ON FURNITURE LAYOUT)"
9. (IF-10) CUSTOM TV RACK WITH BOOK SHELVES AT PRIVATE LOUNGE(VERIFY LOCATION ON FURNITURE LAYOUT)
10. TAPE BARRIER INCL. STAINLESS STEEL BOLLARD

COUNTER SET

1. (CO-1) OUTDOOR COUNTER WITH 2 SEATS (VERIFY LOCATION ON DRAWING)
2. (CO-2) INDOOR COUNTER WITH 2 SEATS (VERIFY LOCATION ON DRAWING)
3. (CO-3) CHECK-IN COUNTER (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
4. (CO-4) RECEPTION COUNTER WITH 1 SEAT AT PRIVATE LOUNGE (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
5. (CO-5) LOST & FOUND COUNTER (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
6. (CO-6) SECURITY COUNTER (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
7. (CO-7) FIDS COUNTER (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
8. (PAN-1) CONCESSIONAIRE PANTR (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
9. (PAN-2) VIP LOUNGE PANTRY (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)
10. (IB) IMMIGRATION BOOTH 1 SEAT (VERIFY LOCATION & QUANTITY ON FURNITURE LAYOUT)

SIGNAGES

Supply and install building signages with all accessories to complete the works

1. ARRIVAL SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
2. DEPARTURE SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
3. PASSENGER TERMINAL BUILDING SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
4. CHECK-IN complete with necessary accessories/miscellaneous items. See Signage schedule/details.
5. DECORATIVE SIGNAGE CUT-OUT complete with necessary accessories/miscellaneous items. See Signage schedule/details.
6. OUTDOOR DIRECTIONAL SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.

7. INDOOR DIRECTIONAL SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
8. STANDING DIRECTIONAL SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
9. BAY SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
10. INTERIOR BUS GATE SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
11. CONCESSIONAIRE SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
12. MALE TOILET DOOR SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
13. FEMALE TOILET DOOR SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
14. TYPICAL DOOR SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
15. TYPICAL GLASS DOOR SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
16. MALE TOILET SIGNAGE CUT-OUT complete with necessary accessories/miscellaneous items. See Signage schedule/details.
17. FEMALE TOILET SIGNAGE CUT-OUT complete with necessary accessories/miscellaneous items. See Signage schedule/details.
18. PWD TOILET SIGNAGE CUT-OUT complete with necessary accessories/miscellaneous items. See Signage schedule/details.
19. BAGGAGE SIGNAGE complete with necessary accessories/miscellaneous items. See Signage schedule/details.
20. LED WALL BILLBOARD complete with necessary accessories/miscellaneous items. See Signage schedule/details.

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

MECHANICAL and FIRE PROTECTION SERIES 4000

TECHNICAL SPECIFICATIONS FOR MECHANICAL WORKS and FIRE PROTECTION

SERIES 4000

SERIES 4000 – MECHANICAL WORKS AND FIRE PROTECTION

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MECHANICAL ENGINEERING SERVICES

1.0 PART 1- PREAMBLES

1.1 INTRODUCTION

Specification

1.1.1 Supply, install, set to work, test and commission the complete mechanical services installation as described in this specification and as shown on the tender drawings.

1.1.2 Read the specification in conjunction with the Preliminaries of the Main Contract.

Standards and Codes of Practice

1.1.3 References to Standards, Philippine Code of Practice, Regulations and the like do not give the year of issue or amendment. The published versions which will apply will be those current ten days before the date set for return of tenders.

Engineer

1.1.4 References to the Engineer shall mean the person nominated in the contract as Contract Administrator or his authorized representative.

Approvals

1.1.5 References to "approval of the Engineer" or similar terms shall mean the written acceptance in principle of the Engineer.

Tender Drawings

1.1.6 The specification lists all tender drawings hereby referred to as “working drawings” of the mechanical engineering services.

1.1.7 If required inspect the Architect’s and Structural Engineer’s drawings at their respective offices.

Read Together

1.1.8 Read the specification and working drawings together. Include work shown on working drawings but not described in the specification, and vice-versa. If it is considered there is a discrepancy between the specification and drawings or ambiguity in either of them, clarify the difference before Tendering.

1.1.9 If all of the information required cannot be obtained from the specification, working drawings or visiting the site, apply to the Engineer for the information.

Preferred Standard Equipment

1.1.10 The specification and working drawings contain references to products and equipment, and all such references quote by name, type, figure number or by detailed specification, particular products of specified manufacturers. The working drawings have been prepared using the dimensions and salient features of such preferred standard equipment.

1.1.11 Base the tender on the equipment specified.

1.1.12 If the Contractor desires to submit alternative equipment for the approval of the Engineer, do so after the Contract is let only one (1) alternative equipment will be evaluated. Provide calculations to demonstrate the sizing and selection of all mechanical services plant and equipment.

1.2 INFORMATION TO BE PROVIDED

General

1.2.1 Provide installation, builder's work information and drawings and other information as detailed in the specification.

1.2.2 Thoroughly check all Suppliers and Specialists drawings etc to ensure that the various works, installations and services do not conflict with each other or with other Sub-Contractors' drawings or with the building structure, fabric or finishes, either during construction or in the finished building.

1.2.3 Submit drawings in sufficient time to comply with the contract programme. Allow not less than two working weeks for the Engineer's comments. Make due allowance for re-submission of drawings, if necessary, in accordance with the Engineers comments.

1.2.4 Do not proceed with ordering, fabrication, erection or installation, until the Engineer has confirmed in writing he has no further comments.

1.2.5 Supply three copies of all drawings for comment and seven copies of the final version for use by the Employer.

1.2.6 The Engineer's comment on installation, shop or manufacturing drawings submitted by the Contractor shall not in any way relieve the Contractor of his responsibility in respect to the accuracy of all such drawings nor from his responsibility for providing equipment suitable in dimension, construction and finish for the location in which it is to be installed, provided that any discrepancies, errors or omissions are not due to inaccurate information of particulars furnished in writing to the Contractor by the Engineer. The Engineer will draw attention to any divergence from the specified requirements or errors which occur to him his comment shall not imply approval in terms of dimensional accuracy or completeness of detail.

Equipment Manufacturer's and Shop Drawings

1.2.7 Obtain manufacturers shop drawings etc for all items of plant, equipment, control panels etc for the purpose of explaining how components of the design are to be assembled, fabricated, connected and installed.

Builders Work Information

1.2.8 Prepare drawings and schedules to show the architectural and structural requirements for all builder's works and allow their integration into the project. Include on these drawings and schedules requirements for foundations, bases and supporting structures for plant and equipment.

1.2.9 Mark out all builders work and carry out minor builder's work (e.g. fixing of brackets to grounds and drilling of holes for screws).

Installation/Shop Drawings

1.2.10 Prepare drawings, based on the working drawings and/or co-ordination drawings showing proposals for the execution of the works. Prepare the drawings in such detail as to enable the works to be installed. Agree the precise location of the pipes and duct openings with the Engineer.

1.2.11 The contractor shall be responsible for producing the following installations/shop drawings:

- complete individual services drawings (ISD's)
- complete combined services drawings (CSD's)
- complete structural, electrical, mechanical drawings (SEM's)

These shall be based on the design working drawings. The contractor shall be responsible for ensuring his mechanical services are full coordinated with other services such as, electrical, plumbing and drainage, lift and fire protection services.

The contractor shall be responsible for ensuring all structural openings, etc. are reflected on his SEM drawings. All installation/hop drawings shall be submitted with enough time to ensure no clashes between services occur or incorrect structural openings take place.

The contractor shall rectify any clashes or non-coordinated electrical, P&D, FP services at his own cost.

1.2.12 Allow for attending co-ordination meetings with the Main Contractor, other sub-Contractors and Engineer as required to enable the installation/shop drawings to be co-ordinated with those of other trades. Subsequently set out work involved and tale all measurements and dimensions required for the installation on site.

1.2.13 Ascertain on site that the installation will not foul other permanent services or equipment. Notify the Engineer if it is necessary to make changes to take account of site conditions.

Working Drawings

1.2.14 Keep on site a complete set of prints of installation drawings. Mark all variations, deviations and amendments on these drawings as the installation work proceeds. Use these 'marked-up' drawings as the basis for the record drawings referred to later.

1.2.14 Keep working drawings on site and available at all times for inspection by the Engineer.

1.3 STATUTORY & GENERAL OBLIGATIONS

Statutory Obligations

1.3.1 In respect of the installation, materials, components, equipment and workmanship comply with statutory and other obligations, regulations of any Local Authority, Public Services or Statutory Undertaking relating to the execution of the works. In particular comply with the requirements of:-

(a) The Philippine Society of Mechanical Engineers.
(b) American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
(c) Philippine National Building Codes.
(d) Air Movement and Control Association, International (AMCA).
(e) American Refrigeration Institute (ARI).
(f) Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA).
(g) The Health and Safety at Work, ect Act.
(h) The Rules and Regulation of Local Authority.
(i) The Building Regulations.
(j) Construction (Design & Management) regulations 1994 (CDM).
(k) All other relevant British Standard Specifications and Philippine Code of Practice, whether mentioned in this Specification, or not.

Existing Services

1.3.2 Do not interfere with or disrupt in any way the operation of any existing services (including process services) without the written permission of the Engineer; and in the case of Statutory Authorities of Private Owners, without the permission, in writing, of such Authorities or Owners.

1.4 MANAGEMENT AND ADMINISTRATION PROCEDURES

Schedule of Rates

1.4.1 Within two working weeks of being awarded the contract submit for approval of the Engineer three copies of the Schedule of Rates upon which the tender has been based. Schedule detailed quantities and rates for all works, and fully price and total the schedule to equal the original tender figure.

Valuation of Instructions and Variations

1.4.2 Oral instructions have no effect unless confirmed in writing.

1.4.3 Submit to the Engineer, within fourteen days of the receipt of the written instruction, the price of each variation showing the quantities and rates applicable for all materials etc employed in accordance with the schedule of rates. No work will be certified for payment until this information is provided.

Programme

1.4.4 Prepare a programme for the works, and submit it for approval within two weeks of commencement of the contract. Take into account the Main Contractors programme, materials procurement and the needs for liaison with other services. Include all such relevant dates, and supply three copies to the Engineer.

1.4.5 Review the programme at least on a monthly basis and update the programme if any circumstances arise which affect the progress of the works. Submit three copies of all revisions to the Engineer.

Specialist Activities

1.4.6 Employ specialists to undertake installations, including:-

a) Testing and Balancing Contractor.

1.4.7 Employ specialists conversant with such work and ensure their attendance and advice on all aspects of installation, testing and commissioning.

Service Agreements

1.4.8 Obtain details and costs of all service agreements available and hand these to the Engineer four weeks prior to Practical Completion.

Site Procedures

1.4.9 Provide all necessary superintendence during the execution of the works and employ full time, on the site, a suitably qualified supervisor to be in charge of the site works from commencement of first fix activities to completion. Submit CV's of the site staff for approval of competence prior to field assignment. The Site Engineer shall be authorized to receive and execute efficiently instructions issued by the Engineer and the Main Contractor.

1.4.10 Do not remove or transfer key members of staff unless they prove unsatisfactory or cease to be employed by you. In such circumstances introduce their replacement in sufficient time for them to fully understand the status of the works prior to the original persons replacement.

1.4.11 Maintain on site during all such times as work is proceeding at least one copy of the under noted documents:-

(a) All contract documents other than priced tender documents.

(b) All installation/shop drawings and additional details and instructions issued to operatives in connection with the Contract.

Protection and Cleaning

1.4.12 Ensure that all materials held on site, whether installed or awaiting installation, are protected against site deterioration.

1.4.13 Inspect all equipment and material immediately on delivery to site and rectify any deficiencies without delay. Subsequently maintain them free from corrosion or deterioration.

1.4.14 Paint purpose made mild steel supports fabricated from unpainted stock with a suitable primer and two coats of approved protective paint immediately after fabrication but before erection.

1.4.15 All mild steel pipe sleeves to wire brushed clean and given a minimum of one coat of red oxide paint.

1.4.16 Properly protect non-ferrous, highly finished and specialty items at all times by approved coverings and packings to prevent deterioration.

1.4.17 Replace any defective, damaged or deteriorating equipment and/or material.

1.4.18 Maintain the site in a clean and sanitary condition to the satisfaction and remove surplus materials, packings, etc., as they accumulate.

1.4.19 Protect all equipment and/or material against ingress of dust, water and foreign bodies, and seal off all openings at each interruption of work, so as to eliminate all possibility of contamination and clogging.

Steelwork and Fixings

1.4.20 Provide all necessary supporting steelwork, brackets, clamps and fixings necessary for the complete installation.

1.4.21 Obtain the Engineer's permission before welding to structural steelwork.

1.4.22 Make fixings generally as follows to:

(a) Concrete brickwork, etc., by suitably sized plugs or expansion bolts in correctly drilled holes.

(b) Structural steelwork by means of beam clamps.

(c) Steelwork specially provided for the purpose of supporting services and by means of suitably sized bolts, nuts and washers or clamps as required.

1.5 WORK AT COMPLETION

Notices, Charts and Labels

1.5.1 Provide all necessary statutory and warning notices.

1.5.2 Submit sample copies of all notices, charts and the wording for all labels to the Engineer for approval before ordering them.

Inspection, Testing and Commissioning of the works

1.5.3 The contractor shall hire an independent specialist testing, balancing and commissioning contractor.

Attendance

1.5.4 Provide attendance during the testing and commissioning of all mechanical and electrical plant, equipment and apparatus connected under this contract.

Inspection and Testing of Installation

1.5.5 On completion of the works carry out tests on the Mechanical systems in accordance with the requirements of the documents listed in the Statutory and General Obligations clause of this specification.

1.5.6 Tabulate the results of all tests in an approved format. Note and record on the tabulated forms the date such tests were carried out. Hand these forms to the Engineer on completion of the works.

1.5.7 For specialist installations, complete the test certificates as prescribed in the relevant Statutory and General Obligations clause of this specification and hand to the Engineer on completion of the works.

1.5.8 Provide all necessary instruments and tools for the tests. Supply the Engineer with copies of recent test certificates confirming the accuracy of all test instruments.

1.5.9 On completion of the works, forward to the Engineer duplicate copies of all test certificates and the completion certificates and inspection certificate as prescribed in the Statutory and General Obligations clause of this Specification.

Record Drawings

1.5.10 Use 'marked-up' installation/shop drawings as the basis of the record drawings.

1.5.11 Record drawing shall be submitted by the Contractor showing all utilities with corresponding measurement of actual location duly signed by the Contractor's Authorized Representative prior to Covering/Close out of slab, wall and ceiling.

1.5.12 Incorporate plans, sections, elevations and other views as necessary to provide a complete record of the services as installed.

1.5.13 Include on the drawings the following items in sufficient detail to enable the building occupier to operate, maintain and adjust the plant and equipment.

(a) The location, level and sizes of all below ground services.

(b) The identification references of all plant and equipment.

1.5.14 Not later than two weeks prior to the completion of the works provide two copies of each record drawing to the Engineer for approval. Following approval, issue to the Engineer one copy of each drawing in AutoCad version 2007 format on CD and insert two print copies in the operating and maintenance manual.

Operating and Maintenance Instructions

1.5.15 No later than two weeks prior to the commencement of testing provide two draft copies of the manual for comment.

1.5.16 Issue the final version of the manuals on completion of the works.

1.5.17 Each manual to be A4 size, in plastic covered loose leaf four ring binders with hard covers, indexed, divided and appropriately titled.

1.5.18 Ensure each manual contains the following information:-

(a) Index

(b) A full technical description of each system written to ensure that the Employer's staff fully understand the scope and facilities provided.

(c) A description of the mode of operation of each system.

(d) A list of record drawings with a brief description of each.

(e) A legend for all color coded services.

(f) Schedules, system by system, of plant and equipment stating their locations, duties and performance figures.

(g) The manufacturers name, address and telephone number for each item of plant and equipment together with catalogue list numbers.

(h) Manufacturers technical literature for all items of plant and equipment.

(i) A copy of all test certificates.

(j) A copy of all manufacturers guarantees and warranties.

(k) Recommendations as to the preventative maintenance frequency and procedures to be carried out to ensure efficient operation especially on fuel storage tank.

(l) A list of normal consumables.

(m) A list of recommended spares.

(n) A copy of each record drawing.

(o) A list of emergency telephone numbers.

1.5.19 Edit manufacturers' standard operating and maintenance instructions to ensure only that information relevant and pertaining to the works is used.

Hand Over Procedure

1.5.20 On completion of testing the Engineer will make a preliminary hand over inspection and list all outstanding works and defects. Rectify these defects and subsequently offer the works for final hand-over. The Engineer will only recommend handover following receipt of the record drawings, operating and maintenance instructions, manual, written confirmation of the completion of outstanding works and satisfactory instruction of the Clients representative.

During the handover period, the contractor shall allow a period of 2 weeks to train and explain all the requirements and works in the operating and maintenance manual by all the specialist suppliers / contractors to the clients representatives to the satisfaction of the clients representatives.

Defects Liability Period

1.5.21 The defects liability period shall be 12 months following hand over, during the defects period attend to further/additional items that meet attention.

1.5.22 Approximately three weeks before the end of the defects period the Engineer will produce a final defects lists. Ensure that any items noted thereon are rectified prior to the end of the defects period. Write to the Engineer confirming such defects have been rectified and the work is complete.

Maintenance Contract

1.5.23 The Contractor is to include in his Tender a separate price for maintaining (not operating) the mechanical services for the duration of the defects liability period. Allow for twelve service visits and the cost of all consumables for carrying out the procedures listed in the operating and maintenance manual. This may be accepted or deleted by the owner. The cost proposal for preventive maintenance shall cover the next three years of operation of the building.

Warranty

1.5.24 The warranty of all equipment shall be a minimum of 12 months from the building practical completion date.

1.6 DRAWINGS

1.6.1 The drawings are to be read in conjunction with this specification:-

1.7 PUBLICATION COMPLIANCE

Where materials are specified to conform to industry and technical society publications or organizations such as Philippine National Standards (PNS) Japanese Industrial Standard (JIS), International Electro-technical Commission (IEC), British Standards (BS), American National Standards Institute (ANSI), American Society of Testing and Materials (ASTM), and Underwriters Laboratories Inc (UL), submit proof of such compliance. The label or listing by the specified organization will not be acceptable evidence of compliance. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority" having jurisdiction," or words of similar meaning, to means the Engineer. In lieu of the label or listing, submit a certificate from an approved independent testing organization, adequately equipped and competent to perform such services, stating that the item has been tested in accordance with the specified organization's publication.

1.8 DELIVERY AND STORAGE

Handle and store, and protect materials in accordance with the manufacturer's recommendation. Replace damaged or defective items with new items.

1.9 CATALOGUED / PRODUCTS / SERVICE AVAILABILITY

Materials shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of materials under similar circumstances and of similar size. The 2-year period shall be satisfactory completed by a product for sale on the commercial market through advertisements, manufacturer's catalogs or brochures.

1.10 CONTINGENCY AND PROVISIONAL SUMS

1.10.1 Refer to the main contract documents.

PART 2 - SCOPE OF WORKS

2.1 GENERAL

2.1.1 This part of the specification describes the scope of the mechanical services installation and should be read in conjunction with the remainder of this specification and the drawings. Together they cover the manufacture, supply, delivery to site, off loading and positioning, co-ordination, erection, testing, setting to work and commissioning of the Mechanical Services Installation.

2.2 THE BUILDING

2.2.1 The scheme is for the development of the Davao International Airport Expansion located in Davao City , Philippines.

2.3 SCOPE OF WORK

2.3.1 The work to be done under this division of the specifications consist of providing air conditioning and ventilation system at the subject project premises and all work and materials incidental to the proper completion of the installations, except those portions of the work which are expressly stated to be done by others. All work shall be in accordance with the governing codes and regulations and with specifications. The requirements in regard to materials and workmanship specify the required standards for the furnishing of the labor, materials and workmanship specify the required standards for the installation/operation of the work specified herein and indicated on the drawings. These specifications are intended to provide a broad outline of the required installation but are not intended to include all detail design and construction.

2.3.2 The contractor before submitting his proposal shall examine all tender documents specifications and drawings relating to his work and verify all governing conditions at site and shall become fully informed as to the extent and character of the work required.

No consideration will be granted for any alleged misunderstanding of the materials to be furnished or work to be done, it being understood that the submission of a proposal is an agreement to all items and conditions referred to herein or indicated on the accompanying drawings and actual site conditions. If specified materials are not locally available, contractor must immediately place an order as soon as project is awarded. Any exceptions, omission or substitutions shall be presented in writing with the contractor's bid.

2.3.3 The contractor, before commencing work, shall examine all adjoining areas on which this work is in any way dependent for perfect workmanship according to the intent of this specification and shall report to the Owner's representative any condition which will prevent this contractor from performing first class work. No waiver of responsibility for defective work will be considered unless notice has been filed at the time this contractor submits his proposals.

2.3.4 It is the intention of these specifications and drawings to call for furnish work tested and ready for operation. Whenever the word "provide" is used, it shall mean "furnish and install, complete and ready to use". Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified.

2.4 **WORK INCLUDED**

Under this division of the specifications, provide all materials and equipment and perform all the work necessary for the complete execution of the mechanical works as shown on the mechanical drawings as herein specified except as otherwise excluded and which without excluding the generality of the foregoing, shall include but not be limited to the following principal items of work:

2.4.1 Supply/installation of air conditioning and ventilating equipment, pipings, ductworks and accessories, supports and hangers, materials and other items necessary for complete installation/operation of the system.

2.4.2 Supply/installation of exhaust, fresh air, ductworks and accessories, supply/return, exhaust air grilles, registers, grilles, louvers motorized control dampers, relief dampers, hangers, materials and other items necessary for complete installation/operation of the system.

2.4.3 Supply and installation of smoke evacuation fan.

2.4.4 Supply/installation of air handling units, ducting, piping, fitting valves and insulation and all other accessories for terminal A/C units as shown on plans.

2.4.5 Supply and installation of ventilation system and its fresh air louver intake. Fresh air intake shall include the required acoustic louver.

2.4.6 Electrical power and control wiring system including motor starters, BMS interfacing devices, interlock and all necessary protection devices from the equipment to disconnect switch. (Coordinate work activity with electrical contractor).

2.4.7 Testing, balancing and commissioning of all equipment. Contractor to hire independent testing and balancing contractor to be approved by the owner's representative.

2.4.8 Furnishing and installation of all required consumable materials and other accessories for proper operation and all equipment and materials to be installed.

2.4.9 Coring works on non-structural walls, roof, floors and partitions to provide openings for ducts and sealing of openings between sleeves and ducts. This work shall be properly coordinated with the architect and structural engineer. When sealing of opening at the Fire Wall/slab, fire stopper sealant shall be provided on sleeves and cored areas and used as entry points for utilities.

2.4.10 Provision of all systems with access doors for all equipment and access opening for ductworks, hangers, anchors, etc. hereinafter specified or as directed.

2.4.11 Grouting openings in floors and walls after all ducts are in place and sealing of all such openings if not used. Supply and install mechanical equipment supports such as steel supports or concrete pad.

2.4.12 Full instruction after completing the job to the maintenance personnel regarding operation and maintenance of the entire installation. Provide complete printed/typed instruction booklets (hardbound) covering maintenance, operation and adjustment of each piece of equipment and list of spare parts for each piece of equipment.

2.4.13 Supply and installation of kitchen exhaust ductwork minimum gage 18 complete with fiber glass insulation 50mm thick, 48 kg/m³ density with design route as shown on plan.

2.4.14 Supply and installation of toilet exhaust ductworks complete with toilet exhaust fan, outlet grille with insect or bird screen installation. Toilet exhaust shall be of low noise criteria, NC 30 and suitable for ducted application.

2.4.15 Supply and installation Chillers, Chilled water Pumps, Expansion Tanks and other required accessories for a Central chilled water Systems including Controls.

2.4.16 Supply and installation of chilled water piping system including insulation and piping supports.

2.4.17 Supply and installation of condensate piping system including 25mm thick Aeroflex insulation or of equivalent material specifications.

2.4.18 Supply and installation of wires, cable, and conduits for power supply requirement of individual AHU, Fans, Pumps, Chillers. The mechanical shall be the one who will install their disconnect (CB-type) switch to the power panel of electrical system.

2.5 SHOP DRAWINGS, SAMPLES AND OTHER SUBMITTALS

2.5.1 The contractor shall submit to the Engineer, for approval, detailed shop drawings of all equipment and all material required to complete the project, and no material or equipment may be delivered to the jobsite or installed until the Contractor has in his position the approved shop drawings for the particular material or equipment. The shop drawings shall be complete as described therein.

The Contractor shall furnish five (5) copies of the submittals as required by the General and Special Conditions of the contract.

2.5.2 Prior to the delivery of any material to jobsite, hop drawings samples, catalogs shall be submitted sufficiently in advance of requirements to allow ample time for checking. Submit for approval detailed, dimensioned, operating clearances, performance characteristics and capacity. Each item of equipment proposed shall be standard catalog product of an established manufacturer and of equal quality, finish and durability to the specified.

2.5.3 Samples, drawings, specifications and catalogs submitted for approval, shall be properly labeled indicating specific service for which material or equipment is to be edited, section and article number of specifications governing, Contractor's name and name of job.

2.5.4 Catalogs, pamphlets, or other documents submitted to described items in which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly made in ink. Data of general nature will not be accepted. Approval rendered on shop drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings approved, said approval does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract drawings and specification.

2.5.5 All drawings, etc. shall be submitted sufficiently in advance of field requirements to allow ample time for checking. Failure of the Contractor to submit shop drawings in ample time for checking

shall not entitle him to an extension of contract time and no claim for extension by reason of such default will be allowed.

2.5.6 Contractor shall prepare and submit to Engineer for approval the following:

2.5.6.1 Manufacturer: Technical performance tables, curves or data, noise generation data of the new equipment to be furnished.

a. Exhaust air Fans/Toilet Exhaust Fans.

b. Supply air Fans, Smoke evacuation Fans

c. Water Chiller

d. Pumps

e. Air Handling Units

2.5.6.2 Basic Materials

a. Ductwork system, fire damper/smoke and volume dampers or balancing dampers and all other necessary consumable needed for complete and operable system.

b. Pipework system, valves, fitting and all other necessary consumable needed for complete and operable system.

2.5.6.3 Electrical system components to include wires, controller, conduits, etc.

2.5.6.4 Vibration isolators shall be provided for all equipment.

2.5.6.5 Complete control schematics and wiring diagrams for all equipment under Mechanical Works.

2.5.6.6 All shop drawings as indicated on the plans or as the Engineer shall be provided.

2.5.6.7 Dimensional and piping layout drawings of mechanical equipment, air distribution system which require close coordination with work of other trades.

2.5.7 All drawings should be signed and dry-sealed by the Contractor's Registered Professional Mechanical Engineer.

The Contractor shall assume unit responsibility and shall provide the service of a highly qualified Engineer to supervise the complete installation.

2.6 **WORKS NOT INCLUDED**

The following items of work will be done under other divisions or will be supplied and installed by others:

1. All source of electrical power wirings (by electrical contractor). Source of electrical power shall be as near as possible to the equipment.

2. Hacking of structural load bearing walls, roofs, floors and partitions to provide openings or passage for ductwork. The contractor shall coordinate, however with other trade contractors such passage requirements and shall provide the proper sleeves and sealing between sleeves and ducts. All making good shall be executed by general works contractor between outside of sleeves and openings.

2.7 **WORKMANSHIP**

The work throughout shall be executed in the best and most thorough manner to the satisfaction of the Architect and the Engineer, who will jointly interpret the meaning of the Drawings and Specifications and shall have power to reject any work and materials which, in their judgment, is not in full accordance therewith.

The Contractor shall assume unit responsibility and shall provide the service of a highly qualified Engineer to supervise the complete installation.

2.8 **WARRANTY**

2.8.1 Provide manufacturer's written warranties covering defects in materials and workmanship of products and equipment utilized for the project.

2.8.2 Warranties shall be for a period of 1 year from the date of the building practical completion certificate.

PART 3 - BASIC MECHANICAL MATERIALS AND METHODS

3.1 GENERAL

3.1.1 Summary

This part includes the following basic mechanical materials and methods to complement other parts of the specifications.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete equipment base construction requirements.
3. Equipment nameplate data requirements.
4. Labeling and identifying mechanical systems and equipment is specified in Part 6, "Mechanical Identification."
5. Non-shrink grout for equipment installations.
6. Field-fabricated metal wood equipment supports.
7. Installation requirements common to equipment specification Sections.
8. Mechanical demolition.
9. Cutting and patching.
10. Touchup painting and finishing.

3.1.2 Definitions

Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

3.1.3 Submittals

Product data for following piping specialties:

- Chilled water piping.
- Condensate piping.
- Mechanical sleeve seals.
- Identification materials and devices.

- Samples of color, lettering style, and other graphic representation required for each identification material and device.
- Shop drawings detailing fabrication and installation for metal supports and anchorage for mechanical materials and equipment.

- Coordination drawings for access panel and door locations.

- Prepare coordination drawings according to a 1:50 scale or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

    1. Proposed locations of piping, ductwork, equipment, and materials. Include the following:

        a. Planned piping layout, including valve and specialty locations and valve stem movement.
        b. Planned duct systems layout, including elbow radii and duct accessories.
        c. Clearances for installing and maintaining insulation.
        d. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
        e. Equipment service connections and support details.
        f. Exterior wall and foundation penetrations.
        g. Fire-rated wall and floor penetrations.
        h. Sizes and location of required concrete pads and bases.

    2. Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

    3. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

    4. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

    - Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

3.1.4 Quality Assurance

- Qualify welding processes and operators for structural steel according to AWS D1.1 “Structural Welding Code--Steel."

- Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

- Comply with provisions of ASME B31 Series "Code for Pressure Piping."
- Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

- ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

- Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment shall meet the design requirements and commissioning requirements.

3.1.5 **Delivery, Storage, and Handling**

- Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

- Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

- Protect flanges, fittings, and piping specialties from moisture and dirt.

- Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

3.1.6 **Sequencing and Scheduling**

- Coordinate mechanical equipment installation with other building components.

- Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

- Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

- Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

- Coordinate connection of electrical services.

- Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

- Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.

- Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

3.2 PRODUCTS

3.2.1 Pipe and Pipe Fittings

- Chilled water piping shall be steel conforming to ASTM,.

- Condensate drain pipes shall be PVC class II. All drain pipes shall not be less than 25mm diameter.

- Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

3.2.2 Joining Materials

- Solder Filler Metal: ASTM B 32.

- Brazing Filler Metals: AWS A5.8.

    1. BCuP Series: Copper-phosphorus alloys.
    2. BAg1: Silver alloy.

- Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

- Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end pressure pipes.

    1. Sleeve: ASTM A 126, Class B, gray iron.
    2. Followers: ASTM A 47 (ASTM A 47M), Grade 32510 or ASTM A 536 ductile iron.
    3. Gaskets: Rubber.
    4. Bolts and Nuts: AWWA C111.
    5. Finish: Enamel paint.

3.2.3 Piping Specialties

- Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.

- Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

    1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
    2. Insulating Material: Suitable for system fluid, pressure, and temperature.
    3. Dielectric Unions: Factory-fabricated, union assembly for 1725 kPa minimum working pressure at 82 deg C temperature.
    4. Dielectric Couplings: Galvanized-steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 2070 kPa minimum working pressure at 107 deg C temperature.

5. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 2070 kPa working pressure at 107 deg C temperature.

- Mechanical Sleeve Seals: Modular, watertight mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.
- Sleeves: The following materials are for wall, beam, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage (0.70 mm) or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets, and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.

    a. Penetrating Pipe Deflection: 5 percent without leakage.
    b. Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111, of housing and gasket size as required to fit penetrating pipe.
    c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
    d. Housing-to-Sleeve Gasket: Rubber or neoprene push-on type of manufacturer's design.

4. Cast-Iron Sleeve Fittings: Commercially made sleeve having an integral clamping flange, with clamping ring, bolts, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with set-screws.

3.2.4 Grout

3.2.4.1 Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, non-corrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.50 MPa), 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

3.3 EXECUTION

3.3.1 Piping Systems –Chilled water Pipes and Common Requirements

- General: Install piping as described below, except where system Sections specify otherwise.

- General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.

- Install piping at indicated slope.

- Install components having pressure rating equal to or greater than system operating pressure.

- Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

- Install piping free of sags and bends.

- Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

- Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

- Install piping to allow application of insulation plus 1-inch (25 mm) clearance around insulation.

- Locate groups of pipes parallel to each other, spaced to permit valve servicing.

- Install fittings for changes in direction and branch connections.

- Install couplings according to manufacturer's printed instructions.

- Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

    1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw, and polished chrome-plated finish. Use split-casting escutcheons, where required, for existing piping.
    2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
    3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
    4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge, spring clips, and chrome-plated finish.
    5. Piping in Utility Areas: Cast-brass or stamped-steel, with set-screw or spring clips.

- Sleeves are not required for core drilled holes.

- Install sleeves for pipes passing through concrete and masonry walls, concrete floor and
- roof slabs, and where indicated.

- Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, concrete floor and roof slabs, and where indicated.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.

2. Build sleeves into new walls and slabs as work progresses.

3. Install large enough sleeves to provide 1/4-inch (6 mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than 6 inches (150 mm).
    b. Steel Sheet-Metal Sleeves: For pipes 6 inches (150 mm) and larger that penetrate gypsum-board partitions.
    c. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Flashing is specified in Section 07620, "Sheet Metal Flashing and Trim".

        1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealant as specified in "Joint Sealants."

Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch (25 mm) annular clear space between pipe and sleeve for installation of mechanical seals.

a. Install steel pipe for sleeves smaller than 6 inches (150 mm).
b. Install cast-iron wall pipes for sleeves 6 inches (150 mm) and larger.
c. Assemble and install mechanical seals according to manufacturer's printed instructions.

Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch (25 mm) annular clear space between pipe and sleeve for installation of mechanical seals.

Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer's printed installation instructions.

Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant materials.

Piping that passes through seismic gap shall be designed properly with acceptable restraint. Contractor submit details of this requirement.

Refer to equipment specifications in other Sections for roughing-in requirements.

Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3. Soldered Joints: Construct joints according to AWS "Soldering Manual," Chapter 22 "The Soldering of Pipe and Tube."
4. Brazed Joints: Construct joints according to AWS "Brazing Manual" in the "Pipe and Tube" chapter.
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:

    a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
    c. Align threads at point of assembly.
    d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

6. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to the "Quality Assurance" Article.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
8. Plastic Pipe and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following standards:

    a. Comply with ASTM F 402 for safe handling of solvent-cement and primers.
    b. Acrylonitrile-Butadiene-Styrene (ABS): ASTM D 2235 and ASTM D 2661.
    c. Chlorinated Poly(Vinyl Chloride) (CPVC): ASTM D 2846 and ASTM F 493.
    d. Poly(Vinyl Chloride) (PVC) Pressure Application: ASTM D 2672.
    e. Poly(Vinyl Chloride) (PVC) Non-Pressure Application: ASTM D 2855.
    f. PVC to ABS (Non-Pressure) Transition: Procedure and solvent cement described in ASTM D 3138.

9. Plastic Pipe and Fitting Heat-Fusion Joints: Prepare pipe and fittings and join with heat-fusion equipment according to manufacturer's printed instructions.

    1.6 Plain-End Pipe and Fittings: Butt joining.
    1.7 Plain-End Pipe and Socket-Type Fittings: Socket joining.

Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches (50 mm) and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch (50 mm) or smaller threaded pipe connection.
2. Install grooved flanged couplings in piping 2-1/2 inches (65 mm) and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.3.2 Equipment Installation

- Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

- Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Engineer.

- Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

- Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

- Install equipment giving right-of-way to piping systems installed at a required slope.

3.3.3 Concrete Bases

- Construct concrete equipment bases of dimensions indicated, but not less than 4 inches (100 mm) larger than supported unit in both directions. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi (20.70 MPa), 28-day compressive strength concrete and reinforcement as specified in "Cast-in-Place Concrete."

- Concrete equipment bases shall be a minimum of 150 mm thick unless otherwise specified on the Design Drawings. Housekeeping pads shall be a minimum of 100 mm thick.

3.3.4 Erection of Metal Supports and Anchorage

- Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- Field Welding: Comply with AWS D1.1 "Structural Welding Code--Steel."

- Erection of Wood supports and Anchorage

- Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

- Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- Attach to substrates as required to support applied loads.

3.3.6 **Cutting and Patching**

- Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.

- Repair cut surfaces to match adjacent surfaces.

3.3.7 **Grouting**

- Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

- Clean surfaces that will come into contact with grout.

- Provide forms for placement of grout, as required.

- Avoid air entrapment when placing grout.

- Place grout to completely fill equipment bases.

- Place grout on concrete bases to provide a smooth bearing surface for equipment.

- Place grout around anchors.

- Cure placed grout according to manufacturer's printed instructions.

3.4 **Pipe Fixings**

Generally, hangers and supports shall be steel of adequate dimensions and designed to allow for expansion and contraction. All hangers and supports shall be primed and finished coated with black bituminous paint.

All pipeworks connected to Pumps and Air Handling Units, shall be isolated from the building structure by using flexible pipe hangers, anchors and pipe guides as specified. No direct connection between the building structure and any part of the pipework shall be allowed.

Generally, all horizontal steel pipes shall be supported on cradles or by clevis type hangers or clamp type hangers with steel rod hangers and support spacing in accordance with the table below :-

Nominal Pipe Dia. (mm)	Max. Span (metres)	Min. Rod Dia. (mm)
Up to and including 50	2.0	M10
63 to 89	3.0	M13
100 to 150	4.0	M20

200 to 300	3.0	M20
350 to 400	3.0	M22
450 to 600	2.0	M22

Pipe hangers shall be placed not more than 600mm from each change of direction where possible.

Vertical runs of pipe shall be supported by anchors.
Brass pipe clips or rings shall be used on all copper tube.

Samples of pipe hangers, supports and anchors shall be submitted to the Architect or Engineer for review.

Fixing of the pipes at the Main Plant Rooms and the main pipe risers shall be isolated from the structure by the use of special hangers as detailed hereunder unless otherwise stated in the Schedule and/or in the Specification Drawings:-

a. Within the Main Plant Rooms

   These shall be steel spring in series with neoprene hanger/supports for the first three pipe hangers on all pipes nearest to equipment. For horizontal pipework beyond the first three spring hangers, double deflection neoprene in shear isolator hangers/supports loaded to minimum 6mm static deflection shall be provided.

b. Outside the Main Plant Rooms

   These shall be of the double deflection neoprene in shear isolator hangers/supports loaded to minimum 6mm static deflection.

c. Main Pipe Risers
   These shall be supported by anchors as specified elsewhere.

PART 4 – AIR HANDLING UNITS (AHU)

4.1 GENERAL

4.1.1 Description

4.1.1.1 This Section specifies the factory assembled air handling units which shall form part of the works as shown on the enclosed schedules.

4.1.2 Manufacture

4.1.2.1 All air handling units and accessories shall be supplied by manufacturers experienced in the design and construction of similar equipment and who have made air handling units for similar duties for at least five years.

4.1.3 Submissions

4.1.3.1 The information listed in this Clause must be provided for each air handling unit at the times stated.

4.1.3.2 At the time of tendering, the Manufacturer shall provide all information in accordance with the Form of Tender.

4.1.3.3 Within two weeks of being notified of the owner's intent to award the Contract(or such other period as may be approved in writing by the engineer) and prior to ordering the equipment, the Manufacturer shall furnish the following information for each unit to the Engineer for approval:-

- Wiring and control diagram;
- manufacturer's shop drawings;
- complete manufacturer's printed catalogues;
- physical dimensions and operating weights;
- pipework connections and flange details;
- mounting and fixing details; including vibration isolators
- complete materials specification;
- characteristic curves;
- sound power ratings; and
- certified list of recommended spare parts.

4.1.3.4 Manufacturer's shop drawings shall clearly indicate the construction and assembly of all air handling unit components including accessories.

4.1.3.5 Mounting and fixing details shall include details and dimensions of air handling unit bases, fixing bolts, flexible connections, vibration isolators and any special builder's work requirements.

4.1.3.6 Fan characteristic curves and sound power rating curves shall be provided.

4.1.4 Selection

4.1.4.1 The Manufacturer shall select all air handling units and all components and accessories required.

4.1.4.2 All air handling units and accessories shall be of minimum vibration and noise level during operation; should these be excessive and not within normal acceptable standards, the Manufacturer shall be responsible for provision of adequate vibration isolation and sound attenuation as recommended and required by the Engineer.

4.1.4.3 The Manufacturer shall allow for the interchangeability of spare parts and accessories in the selection of each unit.

4.1.4.4 Each complete air handling unit with all components and accessories such as coils, eliminators, by-pass section drain pans, fans, motors, drives, etc., shall be supplied from a single manufacturer and all guarantees, test certificates, etc., shall be deemed to apply to the entire assembly.

4.1.4.5 Maximum air velocity through the cooling coils shall not exceed 2.5m/sec.

4.1.5 Standards

4.1.5.1 All air handling units and accessories shall be of the highest commercial standard and shall be designed, constructed, rated and tested in accordance with an approved authority.

4.1.5.2 Materials shall comply with the various American Standards, listed elsewhere in this Section or other approved international standards.

4.1.5.3 All factory applied acoustical and thermal insulation, including facing and adhesive, is to be fire-resistant and to conform to requirements of NFPA.

4.2 EQUIPMENT

4.2.1 General

4.2.1.1 Unless specifically stated otherwise, all units shall be of the packaged factory assembled type of imported origin, horizontally or vertically mounted as shown on the schedules.

4.2.1.2 Motors, eliminators, filters, cooling coils, and other components and accessories shall be arranged so that they are accessible for repair, maintenance and replacement.

4.2.1.3 Where corrosion can occur, appropriate corrosion resistant materials and assembly methods must be used including isolation of dissimilar metals against galvanic interaction.

4.2.1.4 Grease fittings shall be mounted directly on bearings unless the latter are not readily accessible. Where equipment bearings are not visible or are inaccessible, easily accessible extensions to bearing lubrication fittings shall be provided. Provide automatic grease manifold.

4.2.1.5 All components shall be arranged to permit expansion without strain on tubes, headers or casings and with all guides and supports necessary to ensure proper alignment and unimpaired drainage.

4.2.1.6 All components including the mixing section, the filter section and motor mounting frame shall be factory fabricated and manufactured by the air handling unit supplier.

4.2.1.7 All fan/motor pulley shall be of proprietary made and imported from Europe, USA or Japan, local made pulley will not be accepted.

4.2.1.8 Each component of the air handling unit shall have matching cross sectional dimensions as to ensure equal internal area for continuous and even airflow and to give a neat overall external appearance.

4.2.1.9 All rotating components shall be mounted on a chassis fully isolated on spring/neoprene anti-vibration mountings from the framework and casing.

4.2.1.10 Each complete air handling unit with all components and accessories such as coils, eliminators, drain pans, fans, motors, variable frequency drive, etc. shall be supplied from a single manufacturer and all guarantees, test certificates, etc. shall be deemed to apply to the entire assembly.

4.2.2 Fans

4.2.2.1 All air handling unit fans shall be of the centrifugal type and shall comply with the following requirements.

4.2.2.2 All fans shall comply with AMCA 99, performance rating / AMCA 210, sound ratings to AMCA 301 and tested correctly to AMCA 300.

4.2.2.3 All fans shall be double inlet, double width backward incline of airfoil blade mounted together with their motor on a base frame isolated from the main casing by means of 98% efficient spring/neoprene vibration isolators. The vibration isolators shall have a minimum deflection of 25mm and a maximum of 50mm.

4.2.2.4 Fans shall have non-overloading characteristics and shall be selected to have a minimum operating efficiency of *85%* at design duty. Maximum operating fan speed shall be 600rpm for units with air flow exceeding 5m³/s and 1200rpm for units with air flow below 5m³/s.

4.2.2.5 Variable volume fans shall be complete with variable frequency drive and shall be capable of maintaining *85%* overall efficiency at design duty. Applicable for pressurization system coupled with static pressure automatic device of controller

4.2.1.6 All variable volume fans shall be capable of operating down to a minimum of 25% of the designed fan speed.

4.2.2.7 Fan casings shall be constructed to a truly volute form with circular rigid inlet cones free from dents. Fan casings shall be constructed from mild steel plate with angle stiffeners and base stiffeners to ensure freedom from drumming and shall be suitable for operation at the maximum static pressure of the system.

4.2.2.8 Fan casings shall be constructed so the impellers can be easily withdrawn after installation. A drain plug shall be fitted at low point of fan casing and an airtight inspection door provided.

4.2.2.9 Impellers shall be constructed from heavy gauge mild steel and shall be keyed to a substantial precision ground, turned and polished high tensile solid steel shaft. Impeller and shaft shall be statically and dynamically balanced and tested for over speed.

4.2.2.10 Bearings shall be high quality self aligning ball or roller type supported on plumber blocks. Bearing shall be located either side of fan wheel and shall be rated for a minimum of 70,000 hours.

4.2.2.11 Fan impellers and casings shall be zinc sprayed after manufacture.

4.2.2.12 Main release panels shall be provided for fan sections to allow ease of access to the fan and motor and to enable the complete fan unit to be removed from the casing. All other panels shall be readily removable and pulley sections shall be located adjacent to the main release panels. Drives shall be complete with guards. Motors shall be located on slide rails for adjustment of belt tensioning.

4.2.2.13 Each fan shall be driven by a TEFC electric motor through V belt drive (comprising not less than 3 belts).

4.2.2.14 The Manufacturer shall note that all fan static pressures indicated on the schedules are external to the air handling unit and do not include allowances for pressure losses within the unit

4.2.2.15 Spring type vibration isolator shall be installed in the fan section at the manufacturer's factory

4.2.3 The Cooling Coils

4.2.3.1 The duties of all cooling coils are shown in the schedules.

4.2.3.2 Cooling coils shall be constructed with copper tubes, and aluminum fins for all primary air handling units/air handling units in entire building.

4.2.3.3 All tubes shall be arranged horizontally, and where there are more than one row, tubes shall be stiffened. Tubes shall have brazed copper return bends.

4.2.3.4 All batteries shall be encased in substantial mild steel framed casing "built-up" from rolled steel angles or channels of welded or bolted construction. These frames and all components of the cooling and heating coils, where not otherwise protected against corrosion by a method approved by the Engineer shall be galvanized after construction

4.2.3.5 Fins shall have smooth drawn collars of length equal to fin spacing and mechanically bonded to tubes. Fins shall be plate type, corrugated to ensure maximum air contact.

4.2.3.6 All cooling coil headers shall be provided with gunmetal flanges for connection to the pipework.

4.2.3.7 Cooling coils shall be of sufficient area to prevent suspended moisture from being carried over from the cooling coils into the air stream.

The coils shall be rated for a maximum face air velocity of 2.5m/s and a maximum air pressure drop of 60Pa. Under no circumstance the coils be chosen to have fin spacing exceeding 2.5mm for cooling coils.

4.2.3.8 Each cooling coil shall be supplied complete with eliminator and an extended insulated drain pan.

4.2.3.9 Coil connection shall be fitted with sealing rings and plates where penetration of the end sandwiched panel occurs. There shall be no contact between ferrous/non-ferrous parts of the cooling coil and/or casing

4.2.3.10 Coil sections shall be arranged so as to enable same side connections to the flow and return pipework.

4.2.3.11 All cooling coils must fit the air handling plant with no bypass of air around the coils; a neoprene gasket shall be provided around the perimeter of each coil.

4.2.3.12 Every coils shall be certified and tested at maker's works to at least 1 times of the rated working pressure. Test certificate for the coils shall be submitted to the Engineer for record purpose.

4.2.4 Drain Pans

4.2.4.1 The Manufacturer shall provide drain pans for all cooling coils and humidifiers in air handling units, ducts and casings. A suitable method of connection shall be provided to allow others to connect the drain pan to a floor drain through a trapped waste through a vented air break.

4.2.4.2 Each drain pan shall be painted internally and externally with two coats bitumastic paint and insulated with a minimum of 25mm foamed plastic or an approved equal.

4.2.4.3 Drain pans for cooling coils shall extend under the isolator and control valves and shall be of at least 18 gauge galvanized steel with watertight brazed joints and insulated to prevent condensation.

4.2.5 Casing Construction

4.2.5.1 The air handling units shall be of modular constructed by galvanised sheet, formed and reinforced to provide a rigid assembly. Formed panels shall be removable to provide easy access.

4.2.5.2 Framework shall be constructed from galvanized steel sections of thickness no thinner than 2mm, welded or bolted to form a rigid box structure. Framework and panels shall be properly insulated to prevent formation of condensation on the exterior and intermediate surfaces of the unit casing under the extremes of operation and ambient conditions. All fixing screws/bolts shall not bridge the unit construction.

4.2.5.3 Jointing and sections shall be waterproof and air tight, a gasket shall be installed between mating faces.

4.2.5.4 Infill panels of the air handling units shall be of insulated double skin construction, comprising of a sandwich of insulation between two galvanized steel sheets. The external casing shall be of a minimum thickness of 1.2mm and shall be lined internally with 50mm thick, or 48kg/m³ fibreglass faced with 0.8mm perforated sheet of 2.4mm diameter holes at 4.8mm staggered centres. All unit panels, including floor panels, shall be double skin and insulated. Internal flanges of the components shall be bolted together with cadmium plated, nuts, bolts and washers.

4.2.5.5 The panels shall fit within the framework and shall be sealed at the jointed edges with a waterproof and air tight gasket. All panels shall be removable. However, panels not nominated as quick access panels may be securely bolted to the framework. Quick access panels may be lift off type with handles where they are below 1.0m², larger sizes shall be hinged unless plant access is restricted. Quick access panels shall have a locking device which gives a secure seal between frame, gasket and panel.

4.2.5.6 Main access panels shall be provided for the fan sections, filter sections and mixing boxes and elsewhere as indicated. The entire unit shall be mounted on a channel iron base frame.

4.2.5.7 The infill insulation material shall be adequately supported to prevent collapse and to eliminate the formation of cavities. Thermal conductivity shall not exceed 0.02 W/mºC.

4.2.5.8 The overall sound reduction index for the complete unit shall be no less than the followings:-

Octave Band (Hz)	63	125	250	500	4000	2000	4000
S.R.I.	19	31	32	39	41	39	44

4.2.5.9 The Sound Reduction Index must be presented at the time of tender and must be certified by the air handling unit manufacturer.

4.2.5.10 The Manufacturer shall ensure that all holes for instruments (manometers etc.) or test purposes shall be carried out at the maker's works and shall be strengthened at the inner and outer skin and tapped or threaded as required.

4.2.5.11 The Manufacturer shall ensure that all air handling units are adequately packed and protected prior to shipment and in transit to site. Similarly on delivery to site all air handling units shall be properly protected from damage until work is completed and handed over to the Employer.

4.2.5.12 Any damage to finishes which may have occurred during transit, installation or otherwise shall be made good in the manner recommended by the manufacturer and to the satisfaction of the engineer.

4.2.5.13 At the maker's work prior to packing and shipment air handling units shall be painted externally with oven baked polyester powder min. 50 micron thick with color to the Engineer approval.

4.2.6 Mixing Boxes

4.2.6.1 Mixing boxes shall be fitted to air handling units and shall be of the same manufacturer of the air handling unit.

4.2.6.2 Mixing and by-pass boxes shall be of the high efficiency type with opposed blade double skin aerofoil dampers positioned across the short dimension of each air opening. The mixing box shall be specially designed to provide high efficiency mixing of two air streams at different temperatures. All dampers shall have extended shafts and shall be suitable for manual operation. The damper shall operate without undue noise regeneration.

4.2.6.3 Construction standards of the mixing and by-pass boxes shall be as for the unit casings.

4.2.7 Flexible Connection

4.2.7.1 Fan intakes and discharges are to be connected to ductwork and plenums by flexible connections.

4.2.8 Insulation

4.2.8.1 The infill insulation material shall be adequately supported to prevent collapse and to eliminate the formation of cavities. Thermal conductivity shall not exceed 0.02W/mºC.

4.2.8.2 Additional external treatment of casings shall be provided for acoustical purposes as specified elsewhere.

4.2.9 Filter Section

4.2.9.1 Filter banks shall be made up from the filter manufacturer's standard units rigidly braced within a galvanized sheet steel structure. The external and internal finish shall be the same as for the unit casing.

4.2.9.2 Filter boxes shall be provided, having airtight access panels for filter replacement complete with corrosion-resistant steel filter frame and clamps, gasketed and sealed to prevent air bypass.

4.2.9.3 Filters areas shall be selected on the basis of a face velocity of 2.5m/s maximum and the filter frames shall be supplied by the filter manufacturer and factory installed by the air handling unit manufacturer.

- Each filter bank in the air handling unit shall be complete with a differential manometer to indicate static pressure drop across each filter bank.

4.2.10 Filters

4.2.10.1 Each air handling unit shall include a filters as shown on the schedule and conforming to the following:

1. Filter – Expanded Aluminium Foil Filters Panel.

- Panels shall be constructed from multiple layers of expanded aluminium mesh with the layers being corrugated or plain and arranged alternately at right angles at one another. Filter media shall be supported on both sides with a rigid and thicker aluminium expanded metal mesh.

- Filters shall be 50mm thick with a rolled or extruded aluminium frame. The frame section is to be ribbed for stiffness and its inner edges treated to prevent sharpness and increase strength. Corners shall be mitred and where secured riveted.

- Folding handles shall be applied to the short side of all washable filter panels for ease of removal for cleaning.

- The filters shall be cleanable. The filter support frame shall be suitable for the installation of the type specified.

- At the design air volume flow rate the initial (clean) resistance shall not exceed 75 Pa.

4.2.10.2 Filter media shall be adequately stored and protected during shipping and construction and shall not be fitted into the filter frames until necessary for the commissioning of the filters.

4.2.10.3 During initial testing and cleaning of all air handling equipment, temporary filter media shall be provided to clean air entering fans and coils.

4.2.10.4 Towards the completion of commissioning, filter media of the correct type shall be installed in each unit/system. One spare set of media shall be provided for each unit and handed over to the Owner's operative staff.

4.2.10.5 Average efficiency using cottrell precipitate and lint test shall be 70%.

4.2.10.6 Filters and their enclosures shall be constructed from materials which conform to the firm property requirement of one of the following standards:-

- BS476 Part 4 –Non combustibility Test for Materials.
- BS476 Part 6 – Method of Test for Fire Propogation for Product with indices "I"
- 12 and "i" £6.
- UL900 – Test Performance of filter units, Class 1 or Class 2.
- DIN 54348: Part 3 – Response to ignition by a small flame, surface ignition, Class 1.

4.2.11 Access Section

4.2.11.1 Access sections shall be provided between cooling coils to allow air blasting or steam blasting of coils for cleaning purposes.

4.2.11.2 Access sections shall be constructed as for casing construction with full encapsulated insulated hinged doors.

4.3 INSTALLATION

4.3.1 General

4.3.1.1 The Manufacturer/Contractor shall ensure that all air handling units are adequately packed and protected prior to shipment and in transit to site. Similarly on delivery to site all air handling units shall be properly protected from damage until all work is completed and handed over to the Employer.

4.3.1.2 The Manufacturer/Contractor shall adequately protect the surface of the coil fins with wood covers which shall remain on the coils until systems balancing commences. If required by the Engineer, the Manufacturer shall comb every coil at commissioning stage and at Completion.

4.3.1.3 Full access shall be provided to the inside of each unit for maintenance. Accessibility shall be demonstrated to the satisfaction of the Engineer.

4.3.1.4 The Manufacturer/Contractor shall supply factory trained representatives to supervise installation, testing, start up, and instruct the installing Contractor on Operation and Maintenance, and to the owner at Practical completion.

4.3.2 Mounting

4.3.2.1 The air handling units shall be located as indicated on the drawings.

4.3.2.2 All air handling units shall be resiliently mounted on spring vibration isolators.

4.3.2.3 All support beams, support legs, platforms, hangers and anchor bolts required for the proper installation of the units as recommended by the manufacturer shall be provided by the Contractor.

4.3.2.4 Vee belts shall not be placed on drives (except for initial fittings) until the equipment is about to be commissioned. Belts which have taken a permanent set through remaining idle shall be replaced.

4.3.3 Finishes

4.3.3.1 All units shall be factory painted in accordance with the manufacturer's recommendations.

4.3.3.2 Any damage to finishes which may have occurred during transit, storage, installation or otherwise shall be made good in the manner recommended by the manufacturer and to the satisfaction of the Engineer.

4.3.3.3 In addition, the units may require to be insulated and given another finished coat (or coats) to match the Engineer's color coding for the plant room.

4.3.4 Identification

4.3.4.1 All air handling units shall be provided with an identification plate showing the code number for each unit as indicated on the system schematics. The plate shall be securely fixed to the air handling unit casing in a prominent position.

4.3.4.2 In addition, each unit shall have a specification plate which shall show full details of the fan size, r.p.m., amperes, impeller diameter, fan characteristics, lubricants, air flows at specified duty, pulley and belt sizes, coil duties, filter media, water flow rates, design flow temperatures and any other information as may be required by the Engineer. This plate shall also be securely fixed to the air handling unit casing.

4.3.4.3 All air handling units shall bear the manufacturer's nameplate giving manufacturer's name, serial and model number and date of manufacture.

PART 6 – MECHANICAL IDENTIFICATION

6.2 GENERAL

Label all equipment including AHU's, FCU's, ACCU's, A/C controls, fans, plant casings and the like, to facilitate operation and maintenance. Labels shall be direct engraved on mechanical equipment and its pipeworks and ductworks and similar items, otherwise engraved labels must be fixed as required.

6.2 MATERIALS

- Plastic nameplates and tags – Laminated three-layer plastic generally white/black/white, with special or emergency equipment labeled in other color e.g., red/white/red.

- Metal tags – brass with stamped letters; tag size minimum 40mm diameter with smooth edges.

- Stencils with clean cut symbols

- Plastic Pipe Markers/Tape Pipe markers.

6.3 INSTALLATION

- Ductwork – Identify ductwork with stenciled painting as to air handling unit number and area served. Locate identification at both sides of penetration of structure or enclosed and at each obstruction.

- Piping – All piping shall be identified as to the service of the pipe and the normal direction of flow. The letter shall be one inch high on small pipe sizes and two inches high or large pipe sizes and the flow arrows shall be at least six inches long. The letters and flow arrows shall be made by pre-cut stencils and black oil base paint with aerosol can.

- Controls – Each valve except runout valves, but including control valves shall be tagged with a brass disc 40mm inches in diameter. The disc shall contain a number and a valve list shall be provided under glass in the main mechanical room showing the location of the valve the service of the valve and any pertinent remarks regarding the operation of the valve. Securely fasten disc to the valves with brass "S" hooks or chains.

- Equipment – All equipment except if finished rooms, shall be identified by stenciling the title of the equipment as taken from the plans in a position that is clearly visible from the floor. The letters shall be made with black paint and shall be not less than two inches high. The titles shall be short and concise and abbreviations may be used as long as the meaning is clear. In finished rooms, equipment shall be identified by engraved nameplates as specified in the next paragraph.

- Control Panel – All panel mounted controls and instruments shall be identified by engraved plastic nameplates mounted just under the control or instrument.

- FCU – All fan coil units shall be identified by engraved plastic nameplates mounted just under the control or instrument/thermostat.

- AHU – All Air Handling Units shall be identified by engraved plastic nameplates.
- ACCU – All Air Cooled Condensing Units shall be identified by engraved plastic nameplates
- Fans – All Fans (supply, exhaust or smoke extract fans) shall be identified by engraved plastic nameplates.

PART 8 – THERMAL INSULATION

8.1 DUCT INSULATION/USE ASTM STANDARD ACI

8.1.1 General

Materials and installation must comply with ASTM Standards and as detailed further below.

Insulation Surface Facings

Aluminum foil: Reflective foil laminate factory bonded to insulation material with a heavy-duty classification equivalent to ASTM C1290-11

Internal facing: Use perforated reflective foil and perforated metal sheet where specified.

Vapour barrier: Reflective aluminum foil laminate where specified.

Fire Rating:

Early fire hazard properties shall be not greater than:

Ignitability index	0	
Spread of flame index		0
Heat evolved index		0
Smoke developed index	3	

8.1.2 Vapour Barrier

Provide vapour barrier on the warm side of the insulation on duct work and duct mounted equipment carrying cooled air, to prevent condensation, sweating and water logging of the insulation. The vapour barrier is to provide a complete seal, be completely free of perforations or leaks.

The vapour barrier and insulation is to be fixed over all joints and standing seams and is to be made continuous around access panels and doors by the use of gaskets. Where pipes and fittings pass through the vapour barrier the seal is to be made continuous by the use of gaskets or other approved methods.

Where cold bridges are unavoidable, a copper drip tray will be provided under the duct to collect water drops. Drip trays must be fixed and drained to approval.

Provide vapour barrier for ductwork or casings as stated:

Internally insulated ductwork: The insulation is to be placed inside the duct so that the duct or casing forms the vapour barrier.

Externally insulated ductwork: The insulation is to be placed on the outside of the duct-casing with vapour barrier on the outside of the insulation.

8.1.3 External Insulation systems

Type E1: For use on outside of ducts – semi-rigid bonded fiberglass or polyolefin foam, with fire retardant aluminum foil finish facing.

Resin bonded fiberglass of not less than 48kg/m^3 density or physically crosslinked polyolefin foam of not less than 25kg/m^3 density specifically designated by the manufacturer as duct insulation. The insulation is to be in the unfaced semi-rigid form, having a thermal conductivity of not greater than 0.036W/mK at a mean temperature of 20^{o}C. It is also to be non-hygroscopic.

The insulation is to be placed on the outside of the duct in accordance with external insulation application (unclad). The insulation is to be factory bonded to reinforce aluminum foil.

Type E2: For use on outside of ducts – rigid board fiberglass or polyolefin foam, with fire retardant aluminum foil finish facing.

Resin bonded fiberglass of not less than 48kg/m^3 density or physically crosslinked polyolefin foam of not less than 25kg/m^3 density specifically designated by the manufacturer as duct insulation. The insulation is to be in the unfaced semi-rigid form, having a thermal conductivity of not greater than 0.036W/mK at a mean temperature of 20^{o}C. It is also to be non-hygroscopic.

The insulation is to be placed on the outside of the duct in accordance with external insulation application (unclad). The insulation is to be factory bonded to reinforce aluminum foil.

8.1.4 Insulation Application General:

Fixing Pins: The following types, installed in accordance with the manufacturer's instructions, may be used:

2 Welded pin with integral head
3 Welded pin with press-on

Fixing pins will be located with respect to interior dimensions and regardless of airflow direction as follows:

Velocity m/s	Transversely around perimeter mm	Longitudinally mm
Up to 12	At 75 from corners and at intervals not exceeding 300	At 75 from transverse joints and 50mm from an end at intervals not exceeding 300
13 to 30	At 75 from corners and at intervals not exceeding 150	At 75 from transverse joints not exceeding 300

Characteristics: Fixing pins will:

- Not reduce the fire classification of the liner;
- Be corrosion resistant;
- Not damage insulation and not depress the surface more than 5mm;
- Not project more than nominally 15mm through the insulation into the air system;
- Indefinitely sustain a 23kg tensile dead lead test perpendicular to the duct wall;
- Be the correct length for the specified insulation thickness;
- Have a head diameter of at least 25mm;
- Not cause leakage of the duct or condensation.

Insulation Overlap: Provide an overlap of at least 300mm where the insulation changes from the inside of the duct to the outside.

System Integrity: Ensure that the integrity of the adjoining ductwork insulation system is maintained where damper assemblies and the like are installed.

8.1.5 External Insulation Application

Wrap the insulation around the outside of the duct. Completely cover with insulation the portions of the duct designated to be insulated. Keep the number of joints to a minimum.

Joints: Square and butt together the edges of adjacent pieces of insulation. Join together with 100mm minimum pressure sensitive tape applied centrally over the joint. On circumferential joints overlap the tape ends by 100mm. Ensure that longitudinal joints are on the accessible sides of the duct.

Vapour Sealing: Lap the vapour barrier at least 75mm at the joints and bond with an approved adhesive. Seal with reinforced laminated aluminum foil pressure sensitive tape.

Where the blanket is impaled over pins, apply a 100mm square piece of pressure sensitive tape.

Fixing:

Straps: hold the insulation in position by means of 15mm poly strap or 1mm x 40mm galvanized steel circumferential straps at 600mm centers over continuous corner angles.

Angle sizes:

- For insulation up to 25mm thick: 40 x 40 x 1mm
- For insulation from 26mm to 50mm thick 65 x 65 x 1mm

Exposed Ductworks and pipeworks insulation

Provides aluminum and or S/S metal cladding for all exposed ductworks and pipeworks insulation. All ductworks insulation should be with aluminum foil. All pipeworks insulation should be wrapped with polyvinyl tape or plastic tape.

8.1.6 Insulation Schedule

System	Insulation Type	Thickness Mm	Finish	Vapor Barrier	Density (kg/cu.m)
Ducts passing over air-conditioned space	E1	25	Aluminum foil	Yes	48
Ducts passing over non conditioned space	E1	50	Aluminum foil	Yes	64

Note: 1. For ductwork exposed to weather use 50mm thick type E2 and finished with aluminum sheet.

8.2 PIPE INSULATION

Insulation Materials
Chilled Water Piping and Condensate

8.2.1 Polystyrene foam: To ASTM B88 copper pipe and fittings requirements, moulded to form tubular half-sections for pipe insulation or batts for insulating fittings.

Expanded polystyrene of the self-extinguishing type. Factory bond the insulation to reinforced aluminum foil (Sisilation 450 or approved equal) with provision to lap the aluminum foil 50mm at longitudinal joints. Use 100mm use wide minimum reinforced aluminum foil at radial joints to ensure 50mm lap of the foil. Glue sections of insulation, longitudinal and radial joints together with approved insulation contact adhesive. Bed the sections of polystyrene insulation on the pipe and join all longitudinal and radial joints with Fosters 30-45 Foam seal insulation adhesive or approved equal. Provide insulation with thermal conductivity not greater than 0.038W/mK at 25^{o}C.

Pipe Size ID:	Insulation Thickness:
Less than 65	-50mm
65mm and above	-75mm

8.2.2 Expanded Rubber: Flexible, closed cell, chemically blown PVC nitrite rubber sponge type of material equivalent to “Armaflex” or equal approved.

Polyolefin Foam: Physically crosslinked closed cell foam of material equivalent to “Thermobreak” or equal approved.

Provide with thermal conductivity not greater than 0.04W/mK at a mean temperature of 20^{o}C. Provide the insulation in tubular form, with or without a longitudinal joint, or in a sheet form for large piping or vessels. Do not split the tubular insulation longitudinally to install on pipework except where approved. Join the insulation as necessary using an appropriate contact adhesive as recommended by the insulation manufacturer.
Provide the insulation with a thickness as shown in the schedule.

8.2.3 Metal Sheathing

Where scheduled or specified, sheath pipework with the following:

Zincanneal: Case the insulation in 0.6mm (minimum) zincanneal cut and rolled to size, joints lapped not less than 40mm with longitudinal laps downwards to shed water. Hold the casing in position with the 12 x 0.5mm straps at not greater than 450mm centers. Ensure no strap is more than 250mm form any joint. On bends, cut the metal casing and form it into lobster back segments which are fitted to the insulated bend and secured as above.

Where metal sheathing is applied to the vapour sealed pipes no drilling, fitting of screws and pop rivets shall be done so that the vapour seal is not broken.

Aluminum Foil: Equal to Sisilation 450. Provide this finish of reinforced aluminum foil factory bonded to the insulation with provision to lap the longitudinal joint by not less than 50mm and provide a complete vapour barrier where used on cold surfaces.

The reinforced aluminum foil shall consist of two outer layers of aluminum forming an integral part of the composite product. The center shall consist of non-combustible craft paper and fiberglass reinforcing yarn. Glue the longitudinal lap with an adhesive. After gluing the lap, a 75mm wide pressure sensitive adhesive back aluminum foil tape (fire retardant grade) shall be applied over the longitudinal and circumferential joints. Provide the overlap on circumferential joints not less than 50mm.

Aluminum Sheet: Case the insulation in aluminum sheet as for zincanneal casing.

8.2.4 Vapour Barriers

Provide vapour barriers on all cold pipes using Aluminum Foil Laminate.

Installation: Continue the barrier through the supports. Terminate it beyond the insulation on the adjoining uninsulated surface.

8.2.5 Extent of Insulation

Cold piping: Piping carrying fluids at temperatures below ambient including chilled water piping, cold refrigerant and condensate piping, and associated valves and fittings.

8.2.6 Applying Insulation

Commencement: Except for factory-insulated pipe, do not begin to apply insulation until pipework pressure testing is complete. Before installing insulation, remove scale, rust, grease and the like from the pipework surface and ensure that the surface is clean and dry.

Application: Fit the insulation tightly to the pipework surface without gaps. Close butt the ends of insulation sections. Use the minimum number of joints. Finish the insulation surface to a neat, true, smooth appearance without irregularities.

Valves, Flanges and Fittings: Irrespective of the finish on adjacent insulation, finish the insulation at valves, strainers and water boxes with a removable zincanneal or aluminum sheet casing box of not less than 0.6mm thickness in order to facilitate maintenance.

Make the boxes in two places which shall be fastened together with quick acting snap catches of a type which will tighten the box onto the insulation when the catch is closed.

Where this specification requires a finish over the insulation and vapour barrier on the adjacent pipework, apply the same finish to flanges, valves and fittings.

Take care to prevent the metal box from contacting any part of the valve fittings or pipe, etc, and forming a heat conductive path.

Insulate all flanges, except those connecting to non-insulated valves and equipment.

Neatly cone down insulation on piping adjacent to non-insulated valves, flanges, strainers, pumps and equipment at the non-insulated fitting or equipment. Extend the vapour barrier down and seal it to the pipe surface.

Provide insulation of the same type and brand as that used in adjacent pipe runs unless otherwise specified.

Fit insulation as for piping except that insulation shall be removable for pump servicing.

PART 9 - FIRE STOPPING

9.1 GENERAL

Scope

Supply and install Fire Stopping in accordance with the reference documents, comprising the following elements:

- Fire Resistant Pillow Systems
- Fire Resistant Gap Filler
- Foaming Sealants
- Flexible Fire Barrier Materials
- Fire Stop Collars

Requirement

Install fire stopping to penetrations through fire rated elements of construction in accordance with Statutory and NFPA requirements, such that the fire resistance rating of the element is not reduced.

Seal holes through fire rated elements of construction in floors, ceiling and walls for that have attained the required fire rating to match that of the fire rated element trough which the piping, cables, conduits etc. are installed.

Sealing Materials

Provide sealing materials suitable for use as a fire barrier generally classified as follows:

a. Fire Resistant Pillow Systems – suitable for openings up to approximately 200mm wide and consisting of pillow of fire-retardant fabric filled with fire resisting material expanding type.

b. Fire Resisting Gap Filler – suitable for gaps greater than approximately 10mm and consisting fire resisting gap filler of suitable consistency.

Note: Materials which are subject to excessive shrinkage or which crack will not be accepted.

c. Foaming Sealants – suitable to gaps less than approximately 10mm wide and consisting of a fire resisting compound which includes intumescent agents.

d. Flexible Fire Barrier Materials – suitable for a wide variety of applications and consisting of fire retarding fibrous materials in the form of blanket, rope or strip.

e. Fire Stop Collars – suitable for providing a fire rated seal where PVC pipes penetrate a fire rated wall/floor and consisting of a suitably sized canister of intumescent material.

9.2 STANDARDS

Samples

Submit samples of each of the following fire stopping materials:

Provide a sample board of all systems for approval prior to any installation.
Labeling
Where penetrations are sealed, label these penetrations as follows:
"CAUTION, FIRE BARRIER, MUST REMAIN SEALED"

Approved Products
Provide the following products:

- Products approved by Statutory Authorities
- Products tested and certified by an independent authority as complying with NFPA requirements

9.3 FACTORY TESTS

Requirements
For each type of fire stopping installation, provide a test certificate from an independent testing authority showing that a representative specimen of the element of construction, incorporating the proposed fire stopping, has attained the required fire resistance rating when tested to NFPA requirements

Type tests: Recent test obtained by the manufacturer are acceptable provide the test specimens are truly representative of the project installations.

Project test: If an acceptable type test is not available, prepare and test a representative specimen.

9.4 MAINTENANCE

Maintenance Period
Co-extensive with the Defects Liability Period.

Requirement
During the maintenance period:

- Carry out six monthly inspection of all penetrations
- Promptly rectify faults. Replace faulty materials and equipment without charge
- Complete log book entries recording these procedures

All the end of the maintenance period:

- Certify in writing that the installation complies with the reference documents.

Operational Instruction

Coinciding with the routine visits, at times to be agreed with the Construction Manager, Instruct the Clients operational maintenance staff in the recommended methods of maintenance of the system.

PART 10 - NOISE AND VIBRATION CONTROL

10.1 GENERAL

Scope

This section applies to noise and vibration associated with the operation of the air conditioning and mechanical services as shown on the drawing(s) and included in this contract.

Applicable Standards:ASHRAE Standard 2011 AHRI 575 SMACNA STANDARDS

Criteria

To ensure that the transmission of noise and vibration from air conditioning and mechanical services is minimized and complies with the criteria levels set by this specification, the following sections include criteria for:-

- Noise and vibration
- Equipment selection
- Equipment balancing
- Equipment isolation
- Seismic restraints for isolated equipment
- Certification of seismic restraint designs and installation supervision
- Sound absorption
- Sound attenuation

Equipment

Supply and install equipment and components which are not mechanically faulty, over-stressed or over-loaded and which do not have distinct noise or vibration effects inconsistent with the type or class of equipment.

10.2 NOISE AND VIBRATION CRITERIA

Standards: Noise – building and Occupied Spaces

Acceptable levels of noise and the instruments and methods to assess these are defined in Schedules – Maximum Noise Levels.

Standards: Noise – Environmental

Acceptable levels of noise at neighbouring boundaries and the instruments and methods to access these are defined by the Environmental Protection Authority (EPA) and/or Noise Control Legislation relevant to the particular locality.

Standards: Vibration

Keep vibration from all air conditioning and mechanical services plant to a minimum and isolate vibration to achieve criteria defined in 'ASHRAE' 2011 Application Handbook (Chapter 48Table 40, 41).

The above documents apply to acceptable vibration levels except where amended or required by the Schedules – Maximum Vibration Levels.

Standard: Balancing

For the static and dynamic balancing of all rotary machinery, comply with the requirements to achieve the standards: Vibration.

Standards: Seismic Restraints

The seismic restraint of all equipment and components installed shall, as a minimum comply with the following code requirements:-

- National Building Code of the Philippines
- Applicable Local Codes
- Earthquakes Code
- California Title 24, California OSHPD

The 'ASHRAE' 2011 Application Handbook shall be used as a guide.

Whenever a conflict occurs between the above codes, the most stringent shall apply.

Testing on Completion

Standards

Criteria detailing testing of noise and vibration is provided in section "TESTING" Levels of noise and/or vibration that impair the efficiency of working or standard of comfort or do not comply with the specified maximum levels in any environment will not be acceptable.

Unacceptable Results

In the vent of unacceptable noise or vibration levels resulting from faulty plant or negligence during the installation, carry out all alterations and additions to the installed plant as directed by the Construction Manager, in order to reduce levels to acceptable values. Carry out this work without variation to the contract price. In the event of unacceptable noise and vibration being a result of the location, construction or selection of plant particularly stated and contained in the specification, then the cost of the work necessary to reach acceptable levels will be a variation order.

Test Results
Provide a certificate of conformance and certified copies of results.

10.2.1 Air Borne Noise

General

Execute the installation, balancing and adjustment of all air handling systems and mechanical services fluid systems to minimize noise generation and result in levels which do not exceed the criteria specified. Select air diffusion equipment for efficient air distribution and low noise levels at the operating conditions. Remove from all duct interiors, air outlets, dampers and similar air distribution equipment, raw edges of metal, sharp screw ends or pop rivets projecting into the air streams.

Ductwork

Provide the attenuation of fan and air handling equipment noise by acoustic lining of ductwork and/or packaged attenuators as shown on the drawing(s) and as specified.

Clearance Holes

Seal the clearance hole where pipes, ducts, cables and any other services provide in this contract pass through walls, roofs and floors.

Extent

There is no responsibility of the Contractor for the attenuation of air borne noise passing through the building fabric. A suspended ceiling will not be required to act as a noise attenuator.

10.2.2 Structure Borne Noise and Vibration

General

Isolate all mechanical equipment from the building structure such that the transmission of energy into the structure results in minimum noise and vibration levels not in excess of the criteria specified. Incorporate the following method(s) below to minimize the transmission of energy to building structure.

Balancing

Statically and dynamically balance all equipment containing rotating components to manufacturers instructions, and within limits necessary to ensure satisfactory operation without undue vibration when installed and connected up for normal operation.

Fans and Air Handling Units

Isolate all fans from ductwork with flexible connections.

Flanking Transmission Paths

Support ducting from the building fabric using vibration isolation mounts and hangers where shown on the drawing(s) and listed in the schedule. Additionally where shown on the drawing(s) or scheduled, connect rotating and reciprocating equipment to ductwork, piping etc. with flexible connections. For all service connections such as electrical, drainage, flues etc. to resiliently mounted equipment, provide a flexible section of approved type installed between the equipment and nearest support.

Mounts

Mount equipment of support channels, frames or rigid bases supported by vibration isolators.

Test Certificated

Provide test certificates for items of equipment listed in the schedule. Do not operate rotating equipment at speeds in excess of 80% of its critical speed.
Inertia Blocks

Provide inertia blocks of the mass and form scheduled.

10.2.3 System Generated Noise

General

Ensure that generated noise within the air distribution system due to installation, layout and equipment are kept to a minimum and comply with the specified criteria.

Duct work

Install ductwork as shown on the drawing(s) with the minimum number of bends and offsets and shall be free from internal noise generating features.

Diffusers and Grilles

Select air diffusers, grilles and accessories to ensure that their self-generated noise does not cause the required space noise level to be exceeded. Fit cushion heads to outlets as standard detail.

Dampers

Use branch dampers for balancing with only minor adjustment made at the diffuser face. Where damping of diffusers indicates an over supply of air, reduce the fan speed or readjust the terminal box. Re-balance air distribution systems which are noisy due to excessive dampering.

Terminal Units

Select constant volume and variable volume terminal boxes, induction units etc, to ensure that their self-generated noise, together with the noise from the main system which transmitted through the ductwork, does not cause the required space noise levels to be exceeded under any condition of operation.

10.2.4 Clearance Holes

General

Minimise the noise transmission across penetrations, and vibration energy transmission at penetrations, of a building structure or element where services pass from one area to another.

Sleeves

Provide sleeves for pipes and cables penetrating the building slabs or walls, firmly grouted in place by the Builder. Size the sleeves to allow a uniform clearance around the item and pack this space through its depth with an approved resilient material, fire rated where necessary. Seal the packing on both sides using a non-hardening resilient compound.

Acoustic Seals
Provide flexible acoustical seals where all pipes, ducts ad conduits penetrate plant rooms, critical floor and ceiling slabs or acoustic walls.

Clearance

At penetrations where mechanical fixing of the pipe or duct to the building structure is not required, allow clearance between the pipe (or duct wall) and the structure penetration of approximately 12mm. Insert into this cavity one of the following materials where appropriate and subject to fire rating requirements, etc:-

- Bradflex Generation II pipe insulation – minimum wall thickness 13mm.
- Dimet Compriband or Pabco Presstite bitumen impregnated polyurethane foam sealant compressed at least 50%.
- Sponge rubber.
- Rockwool.

10.2.5 Acoustic Attenuators

Construction

Provide acoustic attenuators of an approved commercial manufacture and consist of an outer casing, with air channels between parallel or concentric absorbing splitters, internal baffles and supports.

Casing: Construct casings of 1.6mm minimum galvanized steel duct sections with preferably fully welded longitudinal seams.

Testing: Test casings to 2kPa to show no air leakage or distortion of any king.

Absorption Material: Construct splitter(s) absorbing material of high density mineral wool and covered in scrim or cloth, held in place with sufficient compression to prevent setting and faced with 0.5mm minimum “acoustic” grade perforated zinc anneal sheets having a free area of greater than 20%. All materials and adhesives shall comply with Insulation Section. Provide sheet metal nosing to end pieces and galvanized sheet steel angles to all corner pieces.

Insulation: Place thermal insulation on the internal areas of the casing between the splitters with a minimum thickness of 50mm for all supply air and return air attenuators, unless specifically noted otherwise.

Splitters: Weld or seal all edge joints in acoustic attenuators comprising a number of splitters to prevent air and sound leakage. Construct casings with mild steel end flanges and reinforcing to the standards set out in the ductwork section.

Labeling: Clearly label all acoustic attenuator type, performance, number and direction of air flow.

Rating information: Base performance data for static insertion loss, air flow pressure drop, self-generated noise, radiated noise and dimensions on test carried out at recognized independent noise, radiated noise and dimensions on tests carried out at recognized independent laboratories. Submit the above performance data for acoustic attenuators offered with guaranteed insertion loss values and maximum pressure loss as set out in the schedule, when delivering the specified air quantities.
Attenuator Installation

Preferred attenuator locations are shown on the drawing(s). Make allowances for transition sections before and after each acoustic attenuator.

High Pressure Duct

Pressure test attenuators installed in high-pressure ductwork with the rest of the duct system. Repair all leaks.

10.2.6 Machinery Bases

General

Mount all machinery on integral rigid bases which do no deflect excessively under the weight of the equipment or due to the reactions between motors, driven machines etc.

Machinery Mounting

Seat each item of machinery on steel pads, accurately machined. Accurately align direct-coupled machines and motors and then Dowell through the feet at opposite corners. Re-check alignment on site and adjust if necessary.

Isolation Mountings

Mount bases on vibration isolating mountings.

Inertia Blocks

Install mechanical plant and equipment, fixed into inertia blocks as scheduled.

Support horizontal pipe connections to pumps from the inertia base.

In the case of horizontal spilt casing pumps, these blocks shall be ‘T’ shaped to include base elbow supports.

Vibration Isolation Mounts

General

Isolate all equipment incorporating rotating or reciprocating machinery on anti-vibration mounts. Provide these mounts with transmissibilities low enough so as not to cause excessive vibration of the building structure.

Materials

Provide isolation mount and connections for reciprocating and rotating equipment manufactured by approved manufacturers and of approved materials.

Selection

Make selections of vibration isolating mounts based on the design minimum isolation efficiency, floor static deflection, and plant/equipment mass, rotational/reciprocating speeds and power requirements. Select the method of vibration isolation carefully for each particular application.

Installation

Strictly observe, unless otherwise specified, the manufacturer's recommendation for installation of vibration isolation mounts.

Locations

Locate mounts high enough or spaced far enough apart to prevent the machine rocking excessively. Provide mountings that are easily visible and accessible for inspection and maintenance.

Operation Reactions

Take into account the static weight of the equipment and any dynamic reaction forces, in particular the thrust forces in the case of high-pressure fans, and the reaction forces at start up. Adjust all mounting when the equipment is operating at design conditions to ensure that each mounting is carrying its correct portion of the load.

Clearances and Level

The equipment base, including inertia block, shall be level under operating conditions, with a clearance not less than 25mm from the building floor and ceiling and a minimum clearance of 100mm from walls. Select mountings to ensure that bases do not come in contact with the structure under any conditions.

Bridging

When mounts are bolted down, the bolts shall not bridge out any acoustic pad on the underside of the mounting.

Care During and After Construction

During the construction period, ensure that mountings are not subject to prolonged excessive deflection due to piping and ducting being supported from equipment. Use load spreaders or pads under mountings to ensure that allowable structural point loadings are not exceeded. Ensure that any debris between items of plant and the building structure is removed.

Exposed Locations

Provide mountings for use in exposed or moist locations with galvanized steel housings and epoxy coated springs set in self-draining locating cups.

Mounting Schedule

Determine the static deflection and type of mountings required under each item of equipment from the schedule

Submit Schedule

Submit a full schedule of the mountings proposed for use with the shop drawing(s) and not less than 4 weeks prior to installation of any equipment. Show in the schedule the catalogue number, the load to be carried by each mounting, the static deflection of the load mounting under that load and the unloaded and mount heights.

Pad Isolation

Vibration isolation for deflection up to 10mm may be provided by either double deflection neoprene mounts or multiple layers of ribbed neoprene pad with a thin steel sheet between layers. For optimum performance the neoprene pads should be of approximately 40 durometer hardness and loaded to but not in excess of 350 kPa (3.6kg/cm^2).

Anchors

Where it is necessary to anchor through machinery/plant mounting feet resting on ribbed rubber or waffles pad isolators, a rubber collar of similar or slightly lower durometer hardness should be inserted between the bolt and mounting foot. When screwing down the anchor bolts care should be taken to ensure that the combined weight and bolt tension loadings do not exceed the limit specified in pad-isolation. A metal washer of appropriate size should be inserted between the head and rubber collar.

Springs

Provide metal (coil) springs with neoprene pads in series with the springs.

Balancing

Accurately balance all rotary machinery both statically and dynamically.

Combined Equipment

Mount combined machine units (e.g. motor/pump, motor/fan, etc) on a common rigid sub-frame or base with the weight distribution at the various mountings points as uniform as possible to ensure optimum stability and vibration isolation. Ensure mounts are correctly located during both side installation and subsequent maintenance periods.

Snubbers

Provide snubbers where shown on the drawing and where listed in the schedules.

10.3 PIPE AND DUCT HANGERS AND MOUNTINGS

General

Provide isolation mounts and connections for pipework and ductwork manufactured by approved manufacturers and be of approved materials.

Installation Recommendations

Unless otherwise specified strictly observe the manufacturer's recommendations for installation of vibration isolation mounts and connections.

Adjustments

Incorporate in all hangers height adjustment by means of a nut on the hanger rod.

Fixing

Attach hangers and mounting to structural members such as beams in preference to floor slabs and light roofs trusses. Check with the Construction Manager before any fixings are made to determine whether fixings are prohibited in any areas. Arrange hangers such that the supported equipment is clear pf all other plant and the building fabric when in the normal operating condition.

Environmental Conditions

Provide hangers for use in exposed or moist locations with galvanized steel boxes and epoxy coated springs set in self-draining locating cups.

Pipework

Use vibration isolating hangers and mountings to support piping located in the following areas:-

- Between any spring mounted equipment and the flexible connection – Specification (C) or (G) specified in Section Anti-Vibration Mounts Specification.

- Within 40 pipe diameters of any spring mounted equipment which is not isolated from the piping by a flexible connection, the two hangers closest to equipment – to Specification (C) or (G).

- In plat rooms if not included in (i) or (ii) above – to Specification (B) or (E).

- In ceiling spaces, or under floors of occupied spaces - to Specification (D), for piping less than 100mm diameter – to Specification (E), for piping 100mm diameter and larger.

Ductwork

Use vibration isolating hangers and mountings to support ductwork located in the following areas:-

- Between rotating equipment and the flexible connection – to Specification © of (G).
- In plant rooms which are located immediately below occupied areas, after flexible connections – to Specification (B) or (E).

10.4 ANTI-VIBRATION SPECIFICATIONS

General

Provide all vibration isolating mountings and hangers of the one approved commercial manufacture and with proven ratings.

Specification (a) – Waffle Pad Mount

Provide mounts consisting of a double pad of neoprene moulded into a waffle configuration with a 16mm nominal thickness. The pad shall be sized so that the load on the ribbed element does not exceed the manufacturer's recommendations or 350 kPa (3.6kg/cm^2) whichever is the lesser. If necessary a steel plate will be used to spread the load over the pad.

Specification (B) – Neoprene Mount

Provide mounts consisting of "double deflection" type in which the neoprene or rubber is loaded in a combination of a shear and compression and have minimum static deflection of 9mm. All metal surfaces to be moulded within the mountings, with friction pads top and bottom. Each mount shall be with metal pads or inserts allowing secure and separate attachment to machine and base or floor. Boltholes will be provided in the base and top and a tapped hole for fixing to equipment. Where necessary the neoprene or rubber-like materials will be special grades or types to withstand oils, greases, solvents etc.

Specification (C) – Spring Mount

Provide mounts consisting of the unhoused free standing spring type with spring location cups at top and bottom and with 88mm thick ribbed neoprene acoustic pads bonded to the base of these cups. Springs may be arranged in multiple units. The base plate to be provided with bolt holes for fixing, and the top plate with adjusting bolts for leveling and attachment to the equipment. The springs will have equal horizontal and vertical spring constants, will have a

minimum diameter of 80% of the compressed height of the spring at the rated load and will have an additional travel to solid equal to 50% of the rated deflection.

Vertical limit stops: Mounts used under an item of equipment which has an operating weight which is different from its installed weight, such as a chiller or boiler of which is subject to lateral loading such as an exposed cooling tower, excessive movement due to staring, etc. will incorporate a housing which includes a resilient vertical limit stop.
Clearance: Maintain a minimum clearance of 10mm around the restraining bolts and between the housing and the spring during normal operation.

Erection: The housing will serve as blocking during erection and the installation and operating heights to be the same.

Leveling: do not use leveling bolts. Achieve any variation in height using shims between the machine base and the top plate of the mounting. Provide all spring mounting with adjustable leveling bolts and locknuts.

Static deflection: the extend of static deflection is not to exceed 60% of the maximum range of compression.

Quantity and location: The number and location of spring mounts to be such that the supported equipment does not move or rock excessively under starting and normal operating conditions and such that the supporting base is level under normal operating conditions.

Housed spring mounts: Housed type spring mounts may be used only if the design is submitted and approved by the Construction Manager.

Hold down bolts: Hold down bolts are generally to be avoided but if they are used they must avoid bridging out the isolation pad.

Specification (D) – Waffle Pad Hanger

Provide hangers incorporating a double pad of neoprene, moulded into a waffle configuration within a 16mm nominal thickness between the hanger and the item being supported. Size the bearing area of the hanger so that the load on the ribbed element does not exceed the manufacturers recommendations or 350 kPa (3.6 kg/cm^2) whichever is the lesser.

Specification (E) – Neoprene Hanger

Provide hangers consisting of the neoprene in shear type. Provide a neoprene grommet where the hanger rod passes through the steel box supporting the isolating mount to prevent metal to metal contact. The minimum static deflection shall be 9mm.

Specification (F) – Spring Hanger

Provide hangers containing a steel spring and a double deflection neoprene element in series, all contained within a steel box. The neoprene element to have a minimum static deflection of 9mm. The spring characteristics will be as described in Specification (C). The spring will have a minimum static deflection of 25mm or 50% of the static deflection of the mounts supporting the driven equipment to which the piping is attached, whichever is the greater. Spring diameter

and the lower hole size of the hanger box will be large enough to permit the hanger rod to swing though a 30 arc. When used to support piping of 100mm diameter or larger the hanger will incorporate a deflection indicator with scale.

Specification (G) – Spring Hanger with Fixed Elevation

Provide hangers as Specification (F) but in addition capable of holding the item at a fixed elevation during installation, with a secondary adjustment to transfer the load to the spring and maintain the same position. Deflection to be indicated by an indicator and scale.

10.5 FLEXIBLE CONNECTIONS

General

Unless otherwise indicated, provide flexible connections to prevent vibration from rotating equipment, through piping and ductwork to the building structure.

Installation and Alignment

Arrange and install flexible connections where used, so that they do not unduly restrain the vibrating machine to which they are attached. Maintain piping and duct alignment at the connection.

Selection – Deflections

Select flexible connections to accommodate the maximum axial, lateral and torsional dynamic deflections of the equipment to be isolated.

Location

Locate the flexible connections as close to the rotating/reciprocating machinery as is practical and anchor the connection on the pipe or ductwork side of the flexible connection and as close to the flexible connections as is possible.
Piping Connections

Install flexible connections with their axes perpendicular to the direction of movement. Do not exceed the manufacturer's recommendation on permissible vibration amplitudes and take care not to introduce twisting. Flexible connections are to be suitable for the working pressures, temperatures and fluids.

Vibration direction: Where vibration is not limited to one plane or direction, install two flexible connections at right angles to each other.

Spherical pipe connections: Flexible pipe connections of the spherical type shall have their flanges drilled and tapped to avoid the use of nuts on flange bolts. Flange bolts shall not project more than one thread through the flexible connections flange.

10.6 SEISMIC RESTRAINT SYSTEMS

General

All equipment, piping, ductwork, wiring and components shall be seismically restrained to keep all system components in place during a seismic event.

Materials

Seismic restraints provided shall be manufactured by approved manufacturers and be of approved materials. Seismic restraints shall be the product of a single manufacturer.

Seismic Restraint Selection, Certification and Analysis

Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by registered professional engineer with at least five years of seismic design experience.

All restraining devices shall have a pre-approval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Pre-approvals based on independent testing are preferred. Calculations (including the combining of tensils and shear leadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45^{o} to the weakest mode.

Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraints devices shall be designed to accept, without failure, the forces detailed in the schedule acting through the equipment center pf gravity. Overturning moments may exceed forces at ground level.

Installation

Unless otherwise specified, seismic restraint systems must be installed in strict accordance with manufacturers written instructions and all certified submittal data.

Submit Data

The manufacturer shall submit a full schedule of the seismic restraints proposed for use with the shop drawing(s) not less than 4 weeks prior to installation of any equipment. The schedule shall show catalogue details and demonstrate compliance with the specification.

Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

Provide all details for equipment bases including dimension, structural member sizes and support point locations.

Provide all details of suspension and support for ceiling hung equipment.

Where walls, floors, slabs or supplementary steel work are used for seismic restraints locations, details of acceptable attachment methods for piping and equipment must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

10.6.1 Seismic Restraint Systems Specification

General
All seismic restraint systems shall be of the one approved commercial manufacture and shall have certified ratings.

Specifications (1) – Seismic Restraint of Sheet Metal Panels

Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge-bearing quality.

Specification (2) – Restraint Spring mountings

Restrained spring mountings shall have a spring mountings as described in paragraph 10.4(c), within a rigid housing that includes vertical limit stops to prevent spring extension when is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 12MM shall be maintained around restraining bolts and between the housing and spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Pre-approval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.

Specification (3) – Spring Mounting with Seismic Snubbing

Spring mountings as described in specification paragraph 10.4 (c), built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 6mm travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.

Specification (4) – Seismic Cable Restraints

Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all directional restraint. Cable

end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Pre-approval "R" Number form OSHPD in the State of California verifying the maximum certifies load ratings.

Specification (5) – Seismic Solid Braces

Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connections shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number from OSHPD in the state of California verifying the maximum certified load ratings.

Note: Specifications (4) – (6) apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.

Specification (6) – Pipe Buckling Prevention

Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Pre-approval "R" Number fro OSHPD in the State of California.

Specification (7) – Cross Bracing

Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have and Anchorage Pre-approval "R" Number from OSHPD in the State of California.

Specifications (8) – Molded Snubbers

All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 6mm thick. Rated loadings shall not exceed 7000 kPa. A minimum air gap of 3mm shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection if internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.

Specification (9) – Compounded Snubbers

All directional seismic snubbers shall consists of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 18mm thick. Rated loadings shall not exceed 7000kPa. Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at

9mm deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiple by the applicable "G" force. Submittals shall include the load deflection curves up to 12mm deflection in the x, y and z planes. Snubbers shall have an anchorage pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.

Specification (10) – Stud Wedge Anchors

Stud wedge anchors shall be manufactured from full diameter wire. Not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the ICBO evaluation Services, Inc. verifying its allowable loads.

Specification (11) – Female Wedge Anchors

Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have an evaluation report number from the ICBO Evaluation Service, Inc. verifying to its allowable loads.

10.7 SCHEDULES

Maximum Noise Levels

LOCATION	NOISE LEVEL
All	Refer to Part 4 paragraph 4.2.5.8 performance requirements.

Isolation Mountings
All mechanical plant shall be isolated in Accordance with 'ASHRAE' 1995 Application Handbook (Chapter 43.35, Table 42).

Flexible Connections

PLANT	LOCATION
Air Handling Unit Fans	Between fan discharge points and air handling unit casing
Fan Coil Unit	Between fan discharge points and air handling unit casing

Seismic Restraint Systems
All mechanical services shall be installed in accordance with paragraph 10.6 "Seismic Restraint Systems" and paragraph 10.6.1 "Seismic Restraint System Specifications.

Seismic Force Levels
The following face levels will be used on this project based on UBC-94, BOCA-93 and SBCCI-94.

Building Code		"G" Forces for All Pipe Duct & Conduit		"G" Forces for Rigidly Mounted Equipment		"G" Forces for flexibly Mounded Equipment		"G" Forces for Life Safety Equipment either Rigidly Or Flexible Mounted	
		Horiz.	Vert.	Horiz	Vert	Horiz.	Vert	Horiz	Vert
Zone4	UBC	0.3	0.1	0.3	0.1	0.6	0.2	0.9	0.3
Av	BOCA	0.5	0.17	0.8	0.3	0.8	0.3	1.2	0.4
Factor	SBCCI	0.5	0.17	0.8	0.3	0.8	0.3	1.2	0.4

PART 11 – FANS

11.1 GENERAL – RELATED DOCUMENTS

Applicable Standard: ASHRAE AWCA SMACNA
Drawings and general provisions of Contract, including General and Special Conditions apply to work of this Section.

11.2 DESCRIPTION OF WORK

The work includes providing all labor, supervision, materials, equipment, accessories, services and tests necessary to complete, make ready, and set to work for acceptance by the Owner, all fan coil units in accordance with Drawings and Specifications.

11.3 QUALITY ASSURANCE

A. Acceptable manufacturers: Firms regularly engaged in manufacture of fans units of the types and materials, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. Provide fans units produced by a manufacturer listed as an Acceptable Manufacturer in this Section, as approved by the Engineer.

B. Standards Compliance: Comply with requirements of applicable local codes and the standards outlined in the General Notes.

C. Construct all fans, except vane axial adjustable blade, to comply with the requirements of the latest editions of the AMCA (Air Movement and Control Association, International and Bulletins. Certify these fans by AMCA for performance ratings and provide the AMCA Performance and Construction Seal.

11.4 SUBMITTALS

A. Submit manufacturer's latest published data for dimensions, materials, accessories and installation details.

B. Submit full technical rating data based on tests in accordance with current AMCA standards and in an AMCA approved laboratory. Include manufacturer's certified fan volume-pressure performance curves, from shut-off to free delivery and certified sound power ratings. Correct all ratings and curves for altitude and temperature where applicable.

C. Operational and Maintenance Manual: Manufacturer's instruction for operation and maintenance.

11.5 REFERENCE STANDARDS

A. Fans to be standard products, selected from published literature of manufacturer.

B. Rating to AMCA for sound and air delivery performance. Provide AMCA seal on each fan unit.

C. Fans shall be factory balanced, statically and dynamically to AMCA Standards.

11.6 PROTECTION

Factory equip fan units with protective covers which shall remain in place immediately after installation, prior to start-up, to protect coils, fans, bearings and motors from damage due to dust infiltration during construction.

11.7 PRODUCTS

The contractor shall install and supply the acceptable brand new products and/or manufacturer listed below:

11.8 ACCEPTABLE MANUFACTURERS

A. Loren Cooks

B. Greenheck

C. Niagara

D. National

E. Penn Zephyr Ventilator

F. Nicotra

G. Approved / Equivalent

11.9 FANS

General

Fans shall be carefully selected and entirely suitable for their particular service with respect to corrosion, inflammability or other hazardous applications.

Fans shall be capable of handling the air quantity for the specified system performance against the resistance of the system. The resistance shown on the Schedule of Technical Requirements is for tendering purposes only and the Contractor shall be responsible for checking the final system resistance before ordering the equipment.

Fans shall be balanced and free from vibration. All fan rotors, including the drive pulleys shall be statically and dynamically balanced. The fans shall be selected as not to exceed the maximum allowable noise levels specified in the Schedule of Technical Requirements.

Unless otherwise specified, fans shall be designed and constructed for continuous operation.

All fans shall be fitted with engraved identification and directional labels giving full details of speed, h.p., pulley and belt sizes and type of grease required, and mechanically fixed where they can be easily seen. All fans including motors, pulleys, electrical wiring, control panels, etc within the air-stream of ventilation system for Kitchen Exhaust System shall be of the flame-proof types to comply with the requirements of the local Authorities.

In Line Duct Axial Fans

Fans shall be selected with direct driven motors giving non-overloading characteristics. Motor speed shall not exceed 1500 rpm. Casings shall be of standard length designed to protect both the motor and impeller, continuously welded throughout and hot-dipped galvanized after manufacture. Inspection door shall be provided to enable direction of rotation to be checked. Terminal boxes welded to the casing shall be provided for electrical connection to fan motor. Lubrication of bearing shall be possible from outside the fan casing. Impellers may be of glass reinforced polyester resin or die cast aluminum. Flanged connection to ductwork shall be made with cadmium-plated bolts.

Ceiling Cassette Type Exhaust Fan

The ceiling cassette fan (centrifugal type) shall be specially designed for hot and humid conditions in residential units and should counter act the outside air pressure. The ceiling cassette fan (centrifugal type) should be supported by two suspension-rod drop lengths and it incorporates anti-vibration devices. The ceiling cassette fan (centrifugal type) shall have a variable speed which is controlled by a remote speed controller (automatic or manual operation). The motor has its own capacitor to start/run the rotor which incorporates two caged ball bearings for long life. The fan blades shall be made of robust steel with tough powder coated paint finish. Ceiling cassette fan should be positioned based on the Architect requirements. Fan blades must never be less than 2.4 metres from the floor, i.e. minimum room height is 2.7 metres with 250mm drop or 3.2 metres with 750 mm drop length. Noise level should be in accordance with the acceptable code of practice. Use of DC Brushless motor , IC counter magnetic rotor capable of direct ppm controls on fan blade operation.

Domestic Type Exhaust Fans

Ventilation fans manufactured from plastic or other similar approved material designed for domestic uses shall be supplied and fitted generally as shown in the Specification Drawings. Fans shall be window-mounted or wall-mounted to suit the particular installation. Wall-mounted fans shall be supplied with wall boxes and wall plates suitable for removal for cleaning, or fully concealed within the wall boxes where shown in the Specification Drawings. Fans shall be complete with weatherproof flush fitting exterior grilles, draught-preventing iris or similar shutters linked to the fan switches and flush fitting interior grilles or any gravitational louvre damper. Unless otherwise specified, fan motors shall be suitable for single phase, 60 cycle operation.

Industrial Type Propeller Fans

Propeller-type ventilation fans manufactured from heavy gauge metal or other approved materials designed for industrial or commercial uses and capable of continuous operation shall be supplied generally as shown in the Specification Drawings. Fans shall be ring-mounted or diaphragm-mounted to suit the particular installation; diaphragm-mounted type shall be used for in-duct application. Where fans are fitted in a run of ductwork, extended lubricators shall be provided with a suitable size access panel in the ductwork.

Fan speed shall not exceed 1000rpm. Bearings shall preferably be of the sleeve type, and the fans shall be complete with resilient mountings, internal rings and wire guards. External grilles and fan chambers shall be provided as shown in the Specification Drawings.

Fans shall be directly coupled to totally enclosed squirrel-cage motors.

Where a fan is installed in a run of ductwork or similar enclosure, its selection shall take into account the added resistance.

11.10 CENTRIFUGAL FANS

Description

Fans shall be single or double inlet of a classification suitable for the performance scheduled.

Construction: Provide overhung impellers with the bearings accessible from the drive side for all single inlet fans.

Housing: Epoxy coated galvanized steel unless otherwise scheduled and complete with:

- Curved aerodynamic air inlets
- Spigots on air inlet where ducted
- Flanges in air discharge
- Lifting eyes
- Provision for bolting down.

Impeller: Epoxy coated galvanized steel backward inclined blades. Flat plate or curved aerofoil up to 400mm diameter. Greater than 400mm diameter or high velocity applications shall be aerofoil. Impellers with a shaft shall be balanced to 0.03mm kg/kg of rotating mass.

Shaft: Stainless steel with first critical speed occurring at least at 140% of fan operating speed.

Bearings:

- Self aligning steel ball or roller with accessible grease fitting.

Motor: In accordance with section “General Equipment Standards” and NEMA standards. All motors to be tropic proofed.

Drive: V-belt in accordance with ASME requirements with minimum rating of 150% if motor power. Higher service factors may be required for particular application, as scheduled.

Provision shall be made for belt installation and tension adjustment by movement of the motor on slide rails or other approved method of adjustment.

All motor drives up to 3kW shall be provided with adjustable pitch diameter pulleys.

All motor drives above 3 kW shall be provided with a minimum of two v-belts with taper lock pulleys and shafts.

All v-belt drives shall be provided with approved removable belt guards as specified under clause “General Equipment Standards”.

Base: Unless schedule otherwise, fan and motor to be mounted on rolled steel or extruded aluminum fabricated frame and complete with drive and guards shall form a complete unit. The base shall incorporate provision for anti-vibration mounts and seismic restraints.

Finish

Fan assemblies shall be finished in a factory applied coating in accordance with section "Corrosion Protection, Painting and Labeling".

1.11 AXIAL FLOW FANS

Description

The fans must possess non-overloading characteristics.

Performance: The fan curves and performance tables and noise data must comply with British Standard BS 848 parts 1 and 2.

Casings

Are to be long, fully enclosing cylindrical type with pre-drilled flanges at each end for connection to ductwork and fitting with an access door. Materials are to be mild steel, hot dip galvanized, after manufacturer.

Airflow direction

Is to be suitable for operation with axis horizontal or vertical with air flow directions to produce maximum motor cooling and quietest operation.

Impellers

- aerofoil section
- cast aluminum or glass fibre reinforced polyester resin
- adjustable pitch to suit system resistance
- direct drive

Motors

In accordance with section "General Equipment Standards" and NEMA standards,

Motor should be:
- totally enclosed.
- high temperature motors for smoke spill application as required by Fire codes and suitable for 2 hours of operation at 200^{o}C
- tropic proofed.

Mounting Feet

Provide mounting feet as either:

- Bolt on type

- Welded to fan housing.

Anti-Vibration Mounts and Seismic Restraints

Mounts and seismic restraints must comply with requirements set out in section “Noise and Vibration Control”.

Inlet and Outlet

Coned Inlets: Inlet cones or bell mouths nominally 0.2 x diameter long and reducing from 1.2 x diameter are to be provided where fans do not have a ducted inlet. Acoustic attenuator fitting to fan inlet is to have cone located upstream from the attenuator.

Discharge Cones: Discharge cones nominally 1.0 x dia. Long expanding to 1.25 x dia. Are to be provided where fans do not have a ducted outlet. Where an acoustic attenuator is fitted to the discharge, the cone is to be located downstream from the attenuator.

Guards: Provide heavy galvanised steel or bronze wire mesh guards to discharge an intake of fans where these are not connected to system ductwork and where shown on the drawings.

11.12IN-LINE CENTRIFUGAL FANS

Description

Suitable for inserting into ductwork.

Performance: The fan curves and performance tables and noise data must comply with British Standard BS 848 parts 1 and 2.

Housing

Small fans to be circular with inlet and outlet spigots and manufactured from precoloured fiberglass, reinforced plastic or galvanized formed steel.

Larger fans to be rectangular with integral flanges for inlet and discharge connections and manufactured from galvanized sheet steel.

Impeller

Backward or forward includes centrifugal, or galvanized sheet steel construction.

Drive

- Direct drive with impeller mounted on motor shaft.
- Integral motor/fan impeller assembly incorporating external rotor motor.
- Belt drives.

Access Panels: Provide an access panel in the casing to allow removal of the motor and impeller assembly.

Connections: Provide matched drilled inlet and discharged flanges.

11.13 EXECUTION

Inspection

Examine area and condition under which fan units are to be installed. Notify Project Manager and/or the Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

Installation

A. Furnish and install factory assembled fan units and controls of the types, sizes, capacities, and arrangements indicated on the drawings and specified herein.

B. Refer to installation details in the drawings if available; otherwise, follow manufacturer's recommendations. Follow SMACNA and AMCA recommended procedures for fan installation, belt guards, duct connections, etc.

C. Provide flexible connections as described herein to provide sufficient separation of ductwork from fan assembly to prevent metal-to-metal contact.

D. Install fans and motors with proper support and vibration isolation as specified in the herein.

PART 12 – SHEET METAL DUCTWORKS AND ACCESSORIES

12.1 GENERAL

This section sets out ductwork for air conditioning and ventilation systems.
Applicable Standards:ASHRAE /AMCA/ SMACNA

Samples

Requirement: submit a sample of each of the following:

b) Sheet metal (each gauge).
c) Typical duct joint including intermediate clip.
d) Sealant gasket and tapes.
e) Flexible duct.

Drawings

Variation Drawings: If it is proposed to change the installation from that shown on the Drawings, of if a change is required by a regulatory authority, prepare and submit a variation drawing showing the proposed change and obtain approval before commencing work.

Technical Data: Contractor shall submit technical data of the following:

- All dampers.

Dimensions

Duct Dimensions: Minimum clear internal dimensions are shown on the Drawings.

Clearances: Clearances, where shown, are measured from the extremity of the duct, its external insulation, and associated supports.

Alternatives: The construction Manager may permit a change in size of duct from the dimensions shown on the Drawings, provided that:

a. The proposed ductwork is demonstrated to have no less a capacity and no greater friction resistance or noise generating capacity than that of the ductwork specified.

b. The contractor accepts the responsibility of ensuring that the duct size when varied will not obstruct the building structure or nay other services to be installed.

Construction and Classification

All ductwork is to be constructed in accordance with SMACNA, Sheetmetal and Air Conditioning Contractors' National Association standards.

The ductwork is to be constructed to SMACNA Standards for the pressure classes of each air handling system.

12.2 LEAKAGE

Ducts shall be manufactured and installed so as to minimize air leakage. Leakage of air shall not exceed levels recommended by SMACNA based on low pressure duct application.

12.3 MATERIALS

Sheet Metal

f) ASTM A525 or ASTM A527 galvanized steel sheet, lock forming quality having zinc coating of 382g/sq.m. for each side in conformance with ASTM A90.

12.4 ALL OTHER DUCTWORK

All other ductwork shall be heavily galvanized sheet to SMACNA recommendations.

12.5 SEALANTS, GASKETS and TAPES

Requirement: Provide sealants, gaskets and tapes to seal all ductwork in accordance with its scheduled pressure class and in accordance with SMACNA recommendations.

Sealant, gaskets and tapes must comply with the following:

g) Sealant, gaskets and tapes must be non-toxic under service conditions.
h) All sealing materials must maintain their elasticity and adhesive properties through the normal temperature range that the ductwork system will experience.
i) All sealing materials must be resistant to oil and water after curing.
j) Adhesive shall be compatible with the sealant, which will not decrease the bonding quality. Adhesive tapes must be used as the primary sealing agent.

Fire Resistant

Material: To NFPA requirements for early fire hazard indicates to be not greater than:

Spread of flame:	0
Smoke developed:	3
Flammability:	5

Test Certificate: Submit ductwork and fittings from sheet metal as scheduled, machine bent and free from waves and buckles. Remove burns and sharp edges and ensure that there are no protrusions into the airways. Dented or patched or damaged ducts will be rejected and replaces. Ducts are to be constructed with neat and accurate fabrication independent of whether they are concealed or exposed.

12.6 SHEET METAL DUCT CONSTRUCTION

12.6.1 General

Fabrication: Fabricate ductwork and fittings from sheet metal as scheduled, machine bent and free from waves and buckles. Remove burns and sharp edges and ensure that there are no protrusions into the airways. Dented or patched or damaged ducts will be rejected and replaces. Ducts are to be constructed with neat and accurate fabrication independent of whether they are concealed or exposed to view.

12.6.2 Rectangular Ductwork

Construction must comply with SMACNA and as further defined below:

Longitudinal Seams: Longitudinal seams on straight duct and fittings are to be constructed using Pittsburgh Lock Seams. Snaplock button punched joints may be used on straight ducts up to 1000mm wide but not on:

k) Ducts 750Pa static or more
l) Ducts in riser shafts
m) Ducts in excess of 1.0mm material thickness

These seams may only be substituted under written agreement by the Construction Manager. Stiffening: Reinforce and Stiffen ducts by way of Crossbroken or beaded ad by use of rolled steel angles.

12.6.3 Rectangular Ductwork Fittings

Requirement: Provide rectangular ductwork fittings, including tapers and offsets, bends, tees, branch take-offs, connection and end enclosures where required and as specified in accordance SMACNA.

Bends: Square throat elbows are to be installed with aerofoil turning vanes. Radius bend elbows are to be installed with multiple splitters.

12.6.4 Rectangular Ductwork Obstructions

Streamliners: If it is impossible to offset a duct around an obstruction such as a pipe or small beam, or around a small building column, the obstruction may be encompassed with a two-piece streamliner. The area of the duct at the obstruction must not be less than 100% of the area of the duct before the obstruction.

12.6.5 Flexible Ductwork

Fabrication and Installation: To SMACNA standards.

Metallic Construction: May comprise either of the following:

- Corrugated duct, helically wound with lock seam capable of being bent or set by hand without spring back and without deforming the circular section;

- Single or multiple layers of strip formed into corrugations and wound in helical or annular form, without any obvious seam or joint.

- Strip thickness must not be less than 0.127mm.

- Reinforced Fabric Construction: May compromise either of the following:

- Tough, tear resistant, airtight material liner and cover incorporating a reinforcing former to retain circular section and permit flexibility with minimal spring back when formed to the required shaped.

- Tough, flexible laminate.

Compliance with Test Criteria: All flexible ductwork must be type tested in accordance with UL181.

Installation: Joints in flexible ductwork are to be made as follows:

- Collars to which the duct is to be connected are to be a minimum of 50mm in length.

- Joining two sections of duct is not permitted unless specifically shown on the drawings.
- Collars and sleeves are to be inserted a minimum of 25mm into duct before fastening.

- Flexible ducts is to be secured to collars and sleeves by means of sealant and a draw bend. If the collar or sleeves exceeds 300mm diameter the draw band shall be positioned behind a bead on the collar or sleeve.

- Seal joints in duct and jacket with 500mm wide tape.

Hangers and Support Systems: Flexible ducts are to be supported in the following manner:

- At manufacturer's recommended intervals but at no greater distance than 2m

- Maximum permissible sag between supports is to be 40mm/m of support spacing

- Ducting is to extend for a minimum of 100mm from a connection before any change of direction.

- Hanger or saddle material in contact with the duct is to be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section of the duct rests on the hanger or saddle. Under no circumstances is the width of the material in contact with the duct be less the 25mm.

- Hanger are to be adequately attached to the building structure as for rectangular ducts.

- Terminal devices connected by flexible duct are to be supported independently of the flexible duct.

Length: No flexible duct is to be longer than 1500mm. Extend the rigid duct as necessary to comply with this requirement. Inserts of circular metal duct in a flexible duct run to stay within the 1500mm are not permitted. In such cases, install the metal duct at the main duct take-off or at the outlet connection.

Insulation of flexible Ductwork: The insulation of flexible ductwork is to be achieved by integral insulation must be tested in accordance with NFPA & SMACNA requirements.

Test Holes: Do not make test holes in flexible ducts.

Fire Rated Ductwork

Fire rated duct work shall be constructed to give a minimum of 2 hours fire rating internally and externally. All fire rated ductwork shall be to the approval of the Local Authorities, and must meet all the criteria for stability, integrity and insulation as called for under BS 476.

Sheet metal ductwork shall be constructed of not less than the gauge specified elsewhere in the Specification.

The Contractor's Professional Engineer is to certify on PWD's form that the materials and installation of the fire rated ducts are in compliance with the Local Code's requirements.

The fire rated ductwork shall be directly connected to the fans without the use of flexible connections.

All fire rated ductwork shall be installed at the highest level above other ductwork and services.

Sleeves

Where ducts penetrate walls of plant rooms/fan rooms or penetrate floors, the insulation (if external) shall be sheathed with 16 B. G. galvanized sheet steel. The space between the duct sleeve and duct/sheath shall be tightly packed with suitable fiberglass or mineral wool insulation and sealed at both ends with approved non-hardening resilient sealant.

Flexible Connections

Flexible connections shall be provided on the suction and discharge connections of each fan or AHU. The method of connection shall permit renewal of the flexible connection without dismantling the ductwork.

Flexible connection shall not exceed 100mm in length and shall be made of glass fabric material which shall be non-combustible when tested in accordance with methods specified under BS 476, Part 6, 1981 "Fire Propagation Test for Materials.

Glass fabric material shall be coated with neoprene or other approved fire-retardant material on one side of the surface.

Flexible connections shall be heat resistance type and shall withstand 148 degrees Celsius for short periods and 93 degrees Celsius continuously.

Flexible connections shall not be used for connection between ductwork and stairwell pressurization or smoke stop lobby ventilation fans. In such cases, flange joints shall be used.

Ducts

For low pressure ducts where air mean velocities are less than 10m/s and static pressure in duct does not exceed 5 mbar, such ducts shall be constructed of galvanized sheet steel in accordance with the table below:-

Dimension of duct (mm)	Sheet steel gauge (B.G.)	Type of Girth Joints	Type of Girth Reinforcing
Up to 330	26 (0.498mm)	Beaded and solid riveted slip joint, minimum 100mm long	Not required
331 to 560	24 (0.629mm)	Beaded and solid riveted slip joint, minimum 100mm long	Not required
561 to 900	22 (0.794mm)	32 x 32 x 32 angle flanged joint	32 x 32 x 3 and at 1800 centres
901 to 1300	20 (0.996mm)	32 x 32 x 32 angle flanged joint	32 x 32 x 3 and at 1800 centres
1301 to 1500	18 (1.257mm)	32 x 32 x 32 angle flanged joint	32 x 32 x 3 and at 1800 centres

Space thermostat shall be provided within air conditioned rooms or on return air paths. Location of thermostat s shall be Architect's or Engineer's acceptance.

Duct and Fan Coil Unit sensors shall be of Manufacturer's make or construction. Averaging element shall be used for on-coil and off-coil thermostat.

12.7 GENERAL WORKMANSHIP

12.7.1 General Layout

Ductwork is to be suitably constructed, stiffened, anchored, supported, guided and fitted with expansion devices if necessary so that thermal expansion damage does not result.

Installation: Arrange the ductwork to present a neat appearance. Provide adequate access to ductwork components requiring inspection, entry, maintenance and repairs and to other ductwork or associated plant and requirement for the installation of the specified thermal installation system and air outlets.

Concealed ductwork: Where ductwork is located in false ceiling, roof spaces, plantrooms, underground floors and the like, where possible, arrange the duct runs adjacent and parallel to each other and to walls, beams and the like. Provide spacing of at least 25mm between ducts and insulation and at least 50mm between ducts and electrical cables. Keep ducts under suspended ground floors at least 150mm clear of the ground surface.

12.8 DAMPERS

12.8.1 General

Dampers are to be free of rattles, fluttering of stack movement, and be capable of adjustment over the desired range without excessive self generated noise or the need for special tools. Blades are not to have sharp edges and must be sufficiently rigid to eliminate movement.

Face Dimensions: Duct unless otherwise shown on the Drawings.

12.8.2 Volume Control Dampers – Non-Motorized with Quadrant

Construction: Construct Volume dampers in accordance with SMACNA

Provide butterfly rotating blade type dampers on all duct spigots to flexible ducts unless otherwise noted on the drawings or agreed. Balancing at the air outlet at the end of a flexible duct will only be done if access cannot be achieved to the flexible duct spigot on the branch duct or balancing dampers on all branch ducts serving two or more diffusers of grillers and where otherwise required to properly balance the systems.

Provide multi-blade dampers as follows:

Frames: Extruded aluminum with mitered corners, mechanically locked with heavy aluminum gussets or welding.

Blades: Extruded aluminum or airfoil blade or minimum 3mm aluminum shut mode rigid byfold along both edges to form blades.

Shafts: Zinc plated steel rod pinned through the blade and shaft. Folded blades to have full length shafts. All dampers over 750mm width to have full length shafts.

Linkage: Zinc plated steel interconnecting hardware driven by blade shafts not be blades.
Bearings: Self oiling sintered bronze or nylon bearings.

Splitter Dampers: Approval may be obtained for the use of splitter type dampers. Splitter dampers are to be adjusted by screwed bar, fixed to leading edge of damper blade by yoke and clevis pin and terminating outside the duct wall with butterfly and locking nuts. Splitter dampers shall be fabricated from 1.2mm galvanized iron.

12.8.3 Motorized Control Dampers
Provide motorized dampers as follows:
Frames: Extruded aluminum with mitered corners, mechanically locked with aluminum gussets or welding.
Blades: Extruded aluminum airfoil blade with 3mm thickness.
Shafts: Extruded plated steel rod pinned through the blade and shaft. All blades to have full length shafts.
Linkage: Zinc plated steel or aluminum interconnecting hardware driven by blade shafts, not by the blades.

Bearings: Bearings of self oiling sintered bronze (nylon bearings are not acceptable).

Seals: Self inflating blade and end seals constructed to allow ease of replacement.

Side seal: Flexible aluminum or stainless steel.

Leakage: No greater than 25 litres per second per metre squared at 1500 Pa pressure differential.

Banking of dampers will be rejected unless approved by the Construction Manager prior to construction.

12.8.4 Non-Return Dampers

Non-return dampers will open fully when the upstream pressure is 50Pa or more above the downstream pressure (except in systems where pressure is impractical). Dampers must close against any reverse flow and leakage must not exceed 2.5% if system rated air flow when the pressure difference does not exceed 500Pa.

Dampers blades are to be silent in operation, not flutter and be cable of withstanding frequent cycling. All non-return dampers will be prototype tested by the contractor or manufacturer. Only non-return dampers with tested performance to match the above specification will be accepted.

Damper Operation

Operating Mechanism:

- Manual operation – fit, in a position accessible for visual inspection, maintenance and adjustment, a means of providing damper adjustment and locking in any desired position, such as lever and quadrant. Label the OPEN and CLOSED positions clearly and permanently.

- Motor operation – Mount motors in an accessible position. The mounting must be rigid enough to prevent flexing pr distortion of the ductwork during operation. Provide modulating test switches on the modulating damper motor.

Damper Spindles

Damper spindles are to be of cadmium plated steel, square or round section and are to pivot in sintered bronze or iolite bearings mounted on the outside of the damper frame. One spindle end is to be squared to accommodate a quadrant lever. The spindles are to be of adequate size to ensure rigidity and must not be less than the following:

Damper Length	Spindle Size
Up to 600mm	10mm
610mm to 900mm	12mm
910mm and over	12mm with intermediate bearings at not more than 900mm centres

12.8.5 Fire and smoke Dampers

Construction: To SMACNA, NFPA and UL requirements, having a free cross section area not less than 85% of the face area. The dampers must be rated for a 4 hour fire rating unless otherwise approved and as an effective barrier to smoke.

Marking: To NFPA requirements.

Certification: Prior to commencement of work submit test certificates from an independent testing authority registered for the appropriate tests, evidencing compliance with SMACNA for air leakage and fire resistance.

Installation: To SMACNA and NFPA requirements and as shown on the Drawings. Provide for easy access for maintenance. Provide duct access panels to access all fire dampers.

Fire dampers must be installed within the thickness of the wall or floor slab to the approval of statutory authorities. Where necessary local thickening of the wall or slab or extension of the damper frame to achieve this will be carried out subject to prior approval from construction Manager.

Closure: In positions where dampers cannot be installed to close in the direction of the air flow, subject details of the proposed installation prior to commencement of work. The dampers must be capable of closure against air flow 50% higher than maximum duct air flows.

Thermally Released Links:

- Type: Frangible bulb or fusible links to NFPA requirement, UL listed and labeled.

- Maintenance: Mount links so that they can be replaced with one hand without the use of bolts or the like.

Maintenance testing: Dampers must be capable of being tested for closure without the actuation of thermally released links.

Motorized Smoke Dampers: Where shown on drawing or specified, smoke dampers are to be under control of spring control motors controlled from the fire and smoke alarm system. Motorized dampers must be arranged for positive operation when a fire or smoke signal occurs. All linkages between motor and damper are to be of the rigid mechanically type, positive in action in the operation of the damper and counter-weighted as necessary. Wire pulleys will not be accepted.

On operation of the alarm release mechanism, the spring return action of the motor will shut the damper air-tight.

On canceling the alarm, the motor will operate and return the damper to the normal position.

The fire dampers shall be as manufactured by RUSKIN, Potoroff, Actionair, Hercules or approved square.

Subducts

Subducts must be constructed and installed in accordance with NFPA requirements and as shown on the drawings.

12.8.6 Air Outlet Dampers

Single Blade Dampers: Are to be built into linear type outlets such as slot diffusers, linear grilles and luminaire air saddle diffusers. Blades will allow site adjustment between horizontal and vertical flow.

Multi-blade Dampers: Are to be built into all other grilles, registers and diffusers and are to be supplied by the air outlet manufacturer for specific application in conjunction with the outlet.

Finish: Matt black if visible from the outside.

Fixing: The damper setting is to be secured with the tightening of a screw.

PART 13 - AIR INLET AND OUTLET

13.1 GENERAL

13.1.1 Scope

The Contractor shall supply and install air inlet and outlet materials, components, methods of construction, installation and performance requirements for air grille, registers, louvers, and their ancillary equipment, supplied and/or installed as part of the works. Supply and installation of fire damper, non-return damper etc.

13.1.2 Performance Data

Certified performance data and published selection tables, stating guaranteed airflows, throws, velocities, pressure drops and noise levels shall be available for inspection.

13.1.3 Sound Performance

Diffusers used in the mail room, Office/lobby etc. will required sound test certificates to prove they can met the sound limits as outlined in the equipment schedule on the drawing.

13.1.4 Sizes

Provide the sizes of equipment as shown on the drawings and as scheduled.

13.1.5. Support

Support grills, registers, diffusers and louvers from ductwork, plenums or cushion head boxes. Support plenums and cushions head boxes from the structure of substantial ceiling system components. Supports must not unduly stress or distort adjacent surface and will not transmit sound or vibration any sound attenuating walls, ceilings or surfaces.

13.1.6 Positions

Locate and position as shown on the drawings. Coordinate final positions with other service, or building elements, to the approval of the Construction Manager.

13.1.7 Installation

Grilles, register, diffusers and louvers must be close fitting to walls and ceilings. Securely fix all items by means of concealed fastenings. And provide insulation over the fitting penetrating any sound attenuating surfaces to maintain the sound integrity of the surface.

13.1.8 Gaskets

Use gaskets between flanges and walls or ceiling faces to prevent leakage and marking of adjacent surfaces.

13.1.9 Volume Control

Provide air volume control, and for supply air diffusers, air pattern adjustment devices for all individuals items except where otherwise specified. Adjustment: Such devices are to be in an accessible position for adjustment, and must not require tools not commonly used or readily available.

Visible items: Volume controls or pattern adjustment devices which are visible through an air diffusers, register, grille or louvers are to be painted black.

13.1.10 Finish

The finish of air grilles, registers, diffusers, louvers, and their ancillary equipment will be standard commercial or special surface treatments as specified for individual items. The finish of all items will be of a high standard free of imperfections and blemishes. Mitred joints must be neat and even, without gaps, and with matching surfaces correctly aligned

13.1.11 Samples

Submit for approval representative samples of all air grilles, registers, diffusers, louvers, and their ancillary to be supplied as part of the works. Any samples, which fails to comply with specified requirements, will be rejected and a new sample must be submitted for approval. Manufacture of any item must not commence until the representative sample has been approved. Samples will be retained for comparison with items subsequently supplied for incorporation in the works. Color to match adjacent building surfaces and be to the approval of the Construction Manager.

13.1.12 Air Balancing and Commissioning

Balance airflows at all air grilles, registers, diffusers and louvers to the quantities indicated on the drawings. Adjust all directional or pattern control elements, to achieve correct, even and draught-free air distribution, or to satisfy particular specified requirements. Fine-tuning where agreed or shown on the drawings may occur at the outlets, however major system balancing must occur at the ductwork dampers and flexible duct spigot dampers. The contractor shall hire independent testing and balancing contractor.

13.2 CEILING DIFFUSERS, LOUVRE FACE

13.2.1 Description

Each diffuser face is to be the multi-louvered type of 1, 2, 3 or 4 way blow pattern as shown on the drawings and appropriate for proper distribution of the air. Diffuser frames are to facilitate installation in the ceiling or to the ducts as applicable.

Construction: The ceiling diffusers are to be fabricated from extruded or die-cast aluminum.

Pattern: For uniformity of appearance, the blow pattern is to be achieved by blanking behind redundant faces of 4 way diffusers.

Core: The louvered core is to be easily removable, but the fixing arrangement is to be concealed.

13.2.2 Volume Control

Volume control must not be provided at the diffuser, but at the branch take-off supplying the diffuser.

13.2.3 Insulation

Insulate and vapour seal all surfaces of the diffuser frame and neck within the ceiling space. Insulation is to be minimum 20mm thick expanded nitrite rubber with reinforced double-sided aluminum foil vapour barrier, bonded to the frame and neck and sealed to provide complete protection against condensation on diffuser surfaces.

13.2.4 Connection

Connect the diffusers directly into the ductwork as shown in the drawings.

13.2.5 Finish

The finish of each diffuser is to be powder-coat in colour to match the adjacent surfaces and to the approval of the Construction Manager.

13.3 LINEAR DIFFUSERS, SLOT TYPE

13.3.1 Description

Each diffuser face is to incorporate multiple slots providing 1 or 2 way blow pattern as shown on the drawings and appropriate for proper distribution of the air. Diffuser frames are to facilitate installation in the ceiling or to the ducts, as applicable.

Construction: The linear diffusers are to be fabricated from extruded aluminum.

Core: Each slot is to incorporate pairs of adjustable blades for pattern and volume adjustment. Blades are to be modular, maximum length 500mm, to facilitate pattern variation.

Frame: The frame is to be of the “multiple tee” type, with concealed internal spacing frames and alignment keyways for true and accurate alignment in continuous applications. Provide neatly mitered corner fittings for changes in direction, and framed end fittings to terminate non-continuous diffusers.

Requirement: The contractor shall provide linear diffusers, slot type at function room, lift lobby, main lobby, corridors and others areas shown on the drawings.

13.3.2 Variable Pattern

The core blades are to be capable of adjustment to enable controlled variation of air discharge pattern from individual slots, between vertical and horizontal in either direction (180 adjustment).

13.3.3 Volume Control

Opposed blade dampers are to be incorporated at the inlet to the diffusers plenum.

13.3.4 Connection

Provide internally insulated plenum boxes fitted to the necks of the diffusers, with centre or end inlets, sized and arranged as shown on the drawings. Insulation is to be as specified for ductwork connecting the plenums.

13.3.5 Finish

The finish of each diffuser frame is to be powder-coated to match adjacent surface and to the approval of the Architect.

13.4 ARCHITECTURAL 600 x 600 MODULAR SLOT DIFFUSER

13.4.1 Description

Each diffuser is to incorporate two on four slots all around providing 4-way blow pattern as shown on the drawings or schedules.

Construction: Extruded aluminum face with steel back pan and round inlet.

13.4.2 Insulation

Insulate and vapour seal all surfaces of the diffuser frame and neck within the ceiling space. Insulation is to be minimum 20mm thick expanded nitrite rubber with reinforced double-sided aluminum foil vapour barrier, bonded to the frame and neck and sealed to provided complete protection against condensation on diffuser surfaces.

13.4.3 Connection

Connect the diffusers directly into the ductwork as shown in the drawings.

13.4.4 Finish

Aluminum finish diffuser frame should always be based on the architects requirements with Engineers approval.

13.5 CIRCULAR DIFFUSER

13.5.1 Description

Each diffuser face is to incorporate multiple annular diverting cones to provide a controlled discharge air pattern designed to blow a horizontal air pattern for location heights to 6 metres. In installations at heights above 6 meters the central cone section will be set at combined angle of 35 degrees to provide greater depth of penetration and air induction. Production studios to have 35 degrees central cone sections, the audio and Sound studios to have the horizontal air pattern.

Construction: The ceiling diffusers will be fabricated from spun aluminum sheet. The support frame for the annular cones will be non-adjustable, firmly fix and present a streamlined face to the airflow.

13.5.2 Volume Control

For sound control purposes volume control must not be provided at the diffuser, but at the branch take-off of the supplied duct where a single OBD will balance the supply air to the branch duct. The individual diffuses will not be separately balanced.

13.5.2 Connection

Connect the diffusers directly to the circular ductwork droppers as shown on the drawings. Insure continuance of insulation onto the diffuser.

13.6 RELIEF GRILLES, CEILING

13.6.1 Description

The grilles shall incorporate fixed lattice “egg-crate” cores. Frames are to facilitate installation in the ceiling or to the duct, as applicable.

Construction: The grilles and registers are to be fabricated from extruded aluminum.

Core: The core is to comprise a lattice formed from 13 mm deep aluminum sections inter-connected on a nominal 13 mm grid, firmly and durably retained in the frame.

13.6.2 Connection

Connect the grilles or registers directly into the ceilings as shown on the drawings.

13.6.3 Finish

The finish of each grille or register is to be powder-coat in color to match adjacent building surfaces and to the approval of the Construction Manager to be advised.

13.7 RELIEF GRILLES, WALLS

13.7.1 Description

The grilles are to incorporate fixed horizontal full-chevron blades forming a sight-proof barrier. Frames are to facilitate installation in the door, partition or wall, as applicable.

Construction: The grilles and registers are to be fabricated from extruded aluminum.

Core: The core is to comprise a lattice formed from 13mm deep aluminum sections inter-connected on a nominal 13mm x 13mm grid, firmly and durably retained in the frame.

13.7.2 Connection

Connect the grilles directly into the doors, partitions or walls as shown on the drawings.

13.7.3 Finish

The finish of each grille is to be powder-coat in color to match adjacent building surfaces and to the approval of the Construction Manager.

13.8 VOLUME CONTROL DEVICES

13.8.1 General

Volume control devices are to be provided for diffusers and registers where shown on the drawings or specified elsewhere in this sub-section.

13.8.2 Opposed Blade Dampers

Description: Adjustable counter-rotating multiple blades mounted in a rectangular frame for attachment to the neck of a register or diffuser. Blades fully closed at 45 degree angle to air flow direction, adjustment screw accessible through face of register or diffuser.

Construction: Fabricated from aluminum extrusions, with blades firmly and durably supported in the frame.

Finish: Matt or low gloss black powder-coat or paint finish.

13.8.3 Stream Splitter Dampers

Description: Adjustable curved multiple blades pivoted on their trailing edges and securely linked on their leading edges, mounted in an angled rectangular frame for attachment to the neck of a register or diffuser. Adjustment screw accessible through face of register of diffuser.

Construction: Fabricated from zinc coated steel, with blades firmly and durably supported in the frame.
Finish: Matt or low gloss black powder-coat or paint finish.

13.9 CUSHION HEAD/PLENUM BOXES

13.9.1 General

Cushion head and/or plenum boxes are to be provided for air grilles, registers and diffusers where shown on the drawings or specified elsewhere in this sub-section.

13.9.2 Cushion Head Boxes

Description: Internally insulated plenum fitted to the neck of a supply air diffuser, sized to suit the neck of the diffuser, and incorporating a circular or (where space is limited) oval spigot for connection of a flexible supply duct.
Construction: Galvanised steel plenum constructed as for low pressure steel ductwork, insulated internally with minimum 25 mm thick internal duct insulation. All joints must be sealed air tight.

13.9.3 Plenum Boxes

Description: Plenum box fitted to the neck of one or more grilles, registers or diffusers, sized and located as shown on the drawings, and incorporating provision for connection of grid steel or flexible ducts.

Construction: Galvanised steel plenum constructed as for low pressure steel ductwork, insulated internally with minimum 25 mm thick internal duct insulation. All joints must be sealed air tight.

13.9.4 System Balancing

Balance system air quantities and air outlet directional devices to produce draught free air conditioning.

PART 14 – HANGERS AND SUPPORTS

14.1 GENERAL

Pipework and ductwork supports are to be arranged so that minimum stress is imposed upon the pipelines or ductwork. Additional supports are required on either side of equipment such as valves, strainers, and the like on pipework and heating coils, attenuators and the like on ductwork. It is important to ensure that all materials used for pipework supports are compatible with the pipeline materials.

14.2 PIPEWORK SUPPORT SPACINGS

Provide pipework supports such that the maximum intervals listed below are not exceeded.

TABLE 1

PIPE BORE (mm) NOMINAL	MAXIMUM SUPPORT SPACING (m)	
	STEEL PIPE	
	Horizontal	Vertical
Up to 15	1.8	2.4
20	2.4	3.0
25	2.4	3.0
32	2.7	3.0
40	3.0	3.6
50	3.0	3.6
65	3.7	4.6
80	3.7	4.6
100	3.7	4.6
125	3.7	5.4
150	4.5	5.4
200	5.0	6.0
250	5.0	6.0
300	6.1	10.0
350	10.0	12.0
400	10.5	12.6
450	11.0	13.2
500	12.0	14.4
600	14.0	16.8

14.3 PIPEWORK SUPPORTS – GENERAL REQUIREMENTS

14.3.1 Pipework brackets and supports shall be provided at the intervals stated elsewhere and in addition shall be provided at or adjacent to all major/heavy valves and other pipeline ancillaries such that the weight is not taken directly by the pipework. All brackets and supports shall allow free movement of the pipes due to expansion and contraction with special regard to prevention of damage to any thermal insulation and vapour barrier.

14.3.2 Supports common to two or more pipes of differing diameter and material shall be spaced at the least intervals stated for the appropriate pipe with adequate provision for the unequal movement due

to expansion and contraction. Supports shall also be provided at bends where there is a run of pipework 1 metre or more both sides of the bend.

14.3.3 Cantilever type supports from walls will not be allowed except on single pipes of diameters up to 50 mm.

14.3.4 Static point loadings transferred to the structure which cannot be accommodated by the structural fixings shall be spread over a larger area by means of additional brackets and/or additional load spreading primary steelwork.

14.4 DUCTWORK SUPPORT SPACINGS

Provide ductwork supports such that the maximum intervals listed below are not exceeded.

RECTANGULAR (GALV M.S.)		
LONGEST DUCT SIDE mm	**MAXIMUM SPACING (m)**	
	Horizontal	**Vertical**
Up to 600	3.0	4.0
650 - 900	2.5	3.5
1000 - 1400	2.5	3.5
1500 - 1900	2.5	3.0
2000 & above	2.5	2.5

CIRCULAR (GALV M.S.)				
DIAMETER	**MAXIMUM SPACING (m)**			
(mm)	**STRAIGHT SEAM**		**SPIRALLY WOUND**	
	Horizontal	**Vertical**	**Horizontal**	**Vertical**
Up to 315	1.8	2.8	3.0	3.0
355 to 1250	2.5	3.5	3.0	3.5
1250 & above	2.5	3.5	2.5	3.5

14.5 SUBMISSION OF DETAILS FOR BRACKETS AND SUPPORTS

Provide detailed fabrication drawings and sketches for Approval for all brackets, hangers, supports, etc. for pipework, ductwork and equipment. The drawings/sketches shall show the methods of installation, sizes and the specification of materials to be used.

14.6 TYPICAL SUPPORT BRACKET DETAILS

14.6.1 Pipework supports and brackets shall generally comply with MSS SP-69 and SP-89, and ductwork supports and hangers shall comply with the recommendations contained in SMACNA where applicable. Note that spacings are to be as detailed above.

14.6.2 The details shown elsewhere indicate brackets, and support details which may be acceptable subject to the application but the final working details, drawings or sketches shall be submitted for Review.

14.6.3 Workmanship

14.6.3.1 Obtain approval for any fixings to structural concrete or structural steelwork.

14.6.3.2 Use largest size of bolt, screw to suit diameter of hole in equipment to be fixed. Ensure that fixings are tested for tensile loading to ASTM, this particularly applies to expanding anchors.

14.6.4 Support Fixings and Primary Steelwork

14.6.4.1 Supports shall be solidly fixed to the structure using proprietary manufactured drill and plug fixing devices with removable bolt or screw. Wooden plugs, loose fill or masonry nails will not be allowed. Gun fixings will only be allowed when specifically Approved.

14.6.4.2 At each support fixing a steel channel or angle iron section shall be secured to the structure from which pipework, ductwork supports and brackets and equipment supports shall be attached.

14.6.4.3 Holes in steelwork supports and brackets shall be formed by correctly drilling, using the recommended tolerances for that which is to be inserted. Flame gun/welding torch holes burned out will not be allowed.

14.6.4.4 Where individual pipes up to 50 mm diameter are supported on timber or lightweight walls, ceilings or partitions, brackets shall be of the screw fixing type and primary channel or angle iron brackets shall not be used. On solid/heavy walls over 100 mm thickness, individual pipework may be supported by the use of built-in, long shank holderbats or pipe brackets.

14.6.4.5 Supports from the building structural steelwork shall be made using proprietary manufactured steel clamps or girder lugs and direct drilling of the structural steelwork will not be allowed.

14.6.4.6 Where high level pipework, ductwork and equipment cannot be supported from the structure, a primary steelwork supporting frame shall be provided, fixed to the floor and of suitable design to spread the load evenly, from which all pipework and equipment shall be supported.

14.7 SECONDARY STEEL SUPPORTS

- Pipework, ductwork and certain items of equipment shall be supported from the primary steel channel or angle iron by the use of steel adjustable drop rods which shall be adequately sized to support the total operating weight of the pipe, duct or equipment. They shall be hung from the primary steelwork support by a nut, locknut and washer. Ductwork, equipment and banks of pipes shall be supported on a steel channel section of adequate dimensions hung from the drop rods and fixed by a nut, locknut and washer.

- Where suitable fixing points to the structure do not align with the location of the primary support a secondary support system shall be provided to allow for this situation.

- Pipework, ductwork at low level and equipment which is not fixed directly to the floor shall be supported on steel rods, steel tubular or channel iron posts and secured by a steel backplate, blank flange or steel footplate drilled and bolted directly to the floor.

14.8 PIPEWORK BRACKETS

14.8.1 Where expansion takes place in pipework, pipes shall be supported on cast iron roller chair assemblies with retaining strap or 'U' bolts to restrain transverse movement. Where expansion is minimal pipework shall be held in position by 'U' bolts, split bands or split pipe rings. Single pipe supports from walls shall be held in position by two piece screw-on clips which shall be removable without disturbing the fixings. Calliper, single piece rings, or "snap on" type brackets will not be allowed.

14.8.2 Brackets shall be manufactured from the following materials:-

14.8.2.1 Steel Pipework

Mild steel or malleable iron, with cast iron rollers, mild steel nuts, bolts and washers and mild steel screws.

14.8.2.2 Copper Pipework

Brass or gun metal with cast iron rollers plastic coated, and brass screws, nuts, bolts and washers. Alternatively mild steel plastic coated pipe brackets may be used on larger diameter pipework.

14.9 DUCTWORK BRACKETS

14.9.1 Shall adequately support the ductwork to avoid distortion and sagging and shall be adjustable in height to accommodate the building tolerances. The brackets shall generally consist of a primary steelwork channel or angle iron fixed to the structure from which drop rods or vertical members are suspended as close to the edge of the duct as possible but not touching the duct or insulation. An angle iron or channel horizontal section with insulation inserts shall be hung from the vertical members to support the ductwork. Insulation inserts shall be sized to suit the thermal insulation.

14.9.2 Angle stiffenings and flanged joints shall not be used for supporting the ductwork and support brackets shall be located adjacent to the ductwork joints. Ceilings, lighting fittings, pipes etc. near or under ductwork shall be independently supported and shall not be attached to the ductwork or ductwork supports.

14.9.3 On vertical or sloping ductwork the supports and brackets shall be bolted or riveted to the ductwork to ensure rigidity and to retain the ductwork in its correct position.

14.9.4 Ductwork accessories such as dampers, attenuators, cooling coils, air diffusers and the like shall be independently supported and shall not be supported directly from the ductwork.

14.9.5 Ductwork at low level shall be supported from the floor on a channel or angle iron pedestal frame under the duct rigidly fixed to the ductwork, and a floor plate bolted directly to the floor.

14.9.6 On rigidly fixed brackets a rubber or neoprene pad/ strip 5 mm thick shall be provided between the insulation bracket insert and the ductwork to prevent transfer of vibration. Thermal insulation and vapour barriers shall be continuous over the bracket and support.

14.10 Pipework, Ductwork Resilient Mounting Supports

14.10.1 Supports on pipework above 25 mm bore and ductwork which are in an area of high ambient noise level (greater than 75 dBA) shall have proprietary manufactured resilient spring type isolators inserted between the structure and the pipework supports to prevent vibration transmission to the structure. On supports on pipework and ductwork which connect to vibrating machinery the first 3 bracket supports away from the machinery shall be fitted with spring type isolators. The first bracket shall have the same deflection as the isolators on the moving machinery.

14.10.2 Isolators shall be of the steel-spring type contained in a steel casing with suitable connections for supports or, alternatively of the rubber in compression type housed in an outer steel casing also with suitable connections for supports. Both units shall have a noise stop pad of mineral fibre or similar.

14.11 Inserts for Insulated Pipework and Ductwork Brackets

Brackets on pipework and ductwork which is insulated shall have proprietary made heavy density phenolic foam (with zero ODP) circular rings or flat sections, of equal thickness to the insulation, inserted between the bracket and pipe or duct. The inserts shall incorporate a factory applied metal spreader plate and a class 0 vapour barrier. The length of the insert shall extend outside the bracket by at least 15 mm each side. Where pipework expansion takes place on roller chairs, the insert shall extend the full expansion distance plus 15 mm and an outer galvanised sheet steel casing of suitable thickness shall be secured to the insert to prevent damage. On pipework or ductwork systems operating at elevated temperatures the inserts shall be suitable for the operating conditions.

Vapour barriers shall be continuous over the inserts and in the case of roller chairs, under the outer galvanized sheet casing.

Pipe and ductwork insert density is to be as follows:-

PIPE SIZE (mm)	DENSITY kg/m³
Up to 100	80
Over 100	120

DUCTWORK SIZE (mm)	DENSITY kg/m³
Up to 1000	80
Over 1000	120

PART 15 – TESTING AND COMMISSIONING

15.1 GENERAL

Scope

This section sets out the requirements for testing and evaluation and commissioning of all systems.

The Contractor shall hire an independent specialist Testing, Balancing and Commissioning Contractor. Independent Specialist shall be regularly engaged in Testing, Balancing and Commissioning for the Mechanical Services identified herein and shall have been practicing the said services for not less than 5 years. Contractor shall submit the following details regarding the proposed firm:

Principal representative and qualifications.

Proposed personnel and relevant project experience.

Previous similar assignments and references.

Scope of work to be undertaken.

Company resources and equipment.

15.1.1 Inspections

Notice: Give reasonable written notice so that the Construction Manager and, where applicable, the authorized representative of the relevant regulatory authority, may attend and inspect testing required by the Contract. State the date, time, and place of the test.

Insufficient notice: If the Construction Manager is unable to attend a test because of insufficient notice, he may order the test to be repeated at the Contractor's cost.

Requirement: Commission and test the entire mechanical services systems to prove the systems comply with every requirement of this specification and the design intent of the system.

Equipment: Provide everything necessary for the carrying out of the required tests, including labor, materials, instruments and apparatus.

Program: Submit a proposed testing and commissioning program consistent with and part of the construction program. Include particulars of test stages and procedures.

Certification: All testing must be provided by registered Contractors only.

Seasonal Tests: On air conditioning systems, during the maintenance period carry out two performance tests (summer and wet season) generally as specified for acceptance testing.

Testing Conditions: If the ambient and other conditions specified for a test are not obtainable at the programmed test time, the test may, if so approved, be either:

Deferred until suitable conditions occur, or
Modified to suit the actual conditions.

Manufacturers' Representatives: Representatives of Manufacturers of designated items of plant are to attend the site commissioning and testing procedures and must certify that the plant is operating and performing correctly before handover. Plant items requiring this include air conditioning units and exhaust fans.

15.1.2 Testing Stages

Definitions: The following definitions will apply:

Manufacturers' Tests: Factory tests and/or type tests. Factory tests: Tests carried out on production items before dispatch from the factory. May include type tests.

Type Tests: Tests carried out on an item identical with a specified production item.

Site Tests: Tests carried out on the site installation to demonstrate the satisfactory operation and performance of the system and its components. Includes acceptance tests and may include preliminary tests.

Preliminary Tests: Tests (usually site tests) required to be carried out by the Contractor to demonstrate that the system appears to meet the performance and operating requirements prior to acceptance testing. (Also called performance tests, operating tests, preliminary acceptance tests).
Acceptance Tests: Tests carried out on the completed installation to demonstrate that the system, including all components and equipment, operates correctly, safely and efficiently, meets the performance requirements, and is acceptable for handover. Hold points are noted through the specification against acceptance tests.

Final Tests: Acceptance tests carried out before expiry of the Defects Liability Period to demonstrate that the system has been properly maintained during the Defects Liability Period and complies with the Specification.

15.1.3 Test Records

For each required test, provide a report or certificate in a form suitable for inclusion in an operation and maintenance manual, signed and dated, legibly typed recording:

the type of test;
the test procedures;
the apparatus and instruments used;
the date, time and place of the test;
the ambient and other relevant conditions;
the name, status, function and signature of each person present;

the test results;

where applicable, calculations, instrument readings, control settings, name plate ratings, and the like;
variations to the Specification, if any.

Samples: Before starting to test, submit samples of the form of report or certificate for approval.

15.1.4 Manufacturers' Certificates

For each factory or type test provide a certificate from the manufacturer stating that the relevant item has been tested and meets the specified requirements. Certify that each type tested item is identical with the specified production item.

Imported Items: Manufacturers' certificates of tests performed in the country of origin may be accepted for imported items at the Construction Managers' discretion.

Pressure Vessels: Provide the manufacturer's certificate required by PSME & Statutory requirements. Mount the certificate in a glazed frame on a wall adjacent to the vessel.

15.1.5 Instrument Calibration

Certification: For each measuring instrument included in the site test apparatus, provide a current calibration certificate from an approved authority.

Recalibration: Recalibrate each instrument on or before the certified date for recalibration. Recalibrate or replace faulty instruments or instruments rejected by the Construction Manager.

Scales: Electrical instrument scales will be such that readings will be at least one half of the full-scale deflection. Scales for other instruments such as gauges, thermometers and the like are to be calibrated over the range of test readings.

Order of Accuracy: +/- 1% of full-scale deflection.

15.1.6 Remedial Work

If a tested item fails to meet the performance requirements, then the item must be rectified before Practical Completion and retested.

15.1.7 Testing Controls

During the testing of a service system, test the associated control system. Record control settings and tolerances on work-as-executed drawings. Prove by test that the requirements of section Building Management System (BMS) and Automatic Controls is achieved in all aspects.

15.1.8 System Acceptance Tests

15.1.8.1 Preliminary Test: When the installation is complete, commission the plant by putting it into working order and operating it for not les that the specified minimum running period. Make the adjustments necessary to achieve the required performance under continuous operating service conditions, including balancing, setting the controls,checking the operation of overload and safely devices, and correcting malfunctions.
Then carry out preliminary tests of the acceptance test requirements. Record and submit the results.

15.1.8.2 Acceptance Tests: Acceptance tests will commence only when the Contractor's preliminary test results demonstrate to the Construction Manager satisfaction that the plant is ready for
acceptance test.

15.1.8.3 Test Loads: Where necessary to test the performance of equipment such as air conditioning sets, provide artificial loads by approved means.

15.1.8.4 Adjustments: Carry out necessary adjustments by method designed to promote optimum equipment life and operating economy consistent with the required performance.

15.1.8.5 Final Tests: Carry out final acceptance tests immediately prior to the expiry of the Defects Liability Period.

15.1.9 Handover

The Client is to accept handover of the plant when the system acceptance tests demonstrate that the required performance has been achieved.

15.1.9.1 Progressive Handover: If so required and approved, bring designated sections of the plant progressively up to the handover stage.

15.1.9.2 Handover Period: A handover period of 5 days may run from the acceptance of handover by the Client.

15.1.9.3 Plant Operation: During the handover period arrange for one or more experienced operators to be in constant attendance during working hours, and on call at other times, to monitor the plant operation, and make adjustments as necessary to keep it operating properly.

15.1.9.4 Operational Instruction: The maintenance operators must be available during working hours in the handover period, and thereafter at times, to be agreed with the Construction Manager, coinciding with the maintenance service visits, to instruct the Clients' operational and maintenance staff in the recommended methods of maintenance and control of the systems.

15.2 NOISE AND VIBRATION TESTING

15.2.1 Type Tests

Where noise levels are specified for individual items of equipment, submit type test data stating the sound level of the equipment offered, and the method of determination used to prove that the plant complies with the specified performance.
Acceptance Tests

Carry out noise level acceptance tests in conjunction with the acceptance tests of the completed installation. Demonstrate that individual items of equipment and the complete service system do not exceed the required noise level limits under operating conditions. Refer to NOISE and VIBRATION CONTROL for maximum noise levels.

15.2.2 Hold Point

Acceptance testing of complete service system is a Hold Point.

15.2.3 Measuring Instruments

Sound Level: Sound level meters to IEG651 Type 2, calibrated to the dB (A) scale.

15.2.4 Measurements

Take readings (with the plant operating normally) over the full spectrum of octave band center frequencies from 31.5Hz to 8kHz and associated dB (a) readings.

Measurement position: Not less that 1m above the floor, not closer than 1m from walls or equipment. Take readings at points 2m and 16m distance from large items of equipment such as the chiller plantroom.

15.2.5 Background Noise

During testing, background noise is to be relatively steady and continuous at the usual level. Measure background sound spectrum and dB (A) levels with the plant stopped.

15.2.6 Test Report

The test report is to schedule the noise spectra and dB (A) readings with the plant on and off. The schedule will also note the specified required noise levels, and the proposed method of resolution.

15.3 AIR CONDITIONING PERFORMANCE TESTS

15.3.1 Requirement
Test the capacities and performance of air conditioning systems under tropical conditions.

15.3.2 Temperature and Humidity Measurement

Record humidity and temperatures as follows:

In areas containing critical equipment: Continuously for two separate periods, each of not less than 48 hours, measure dry-bulb temperature and humidity. Separate measurements are to be taken for each 70m^2 of floor area.

In all other conditioned rooms and areas: at 9 am and 3 pm on two consecutive half-hour intervals, measure dry-bulb and wet-bulb temperatures. Separate measurements are to be taken for each 100m^2.

Adjust and refine air volumes and controls as necessary to rectify the areas which fall outside of the specified temperature and humidity control tolerance ranges. Retest until all areas fall into the specified control tolerance ranges.

During the Defects Liability Period, the air quantities and control shall be adjusted as necessary to achieve an even temperature balance and stable control.

Where a humidity or temperature gradient or differential is specified in DESIGN CONDITIONS, then these are to be tested and adjustment made to the controls to achieve the specified requirements.

15.3.3 Coils

Test the capacity performance of cooling coils under summer conditions. Set the control valves to the full open positions, and record the following at two consecutive half-hour intervals:

15.3.3.1 General:

Ambient temperatures: Dry-bulb and wet-bulb;
Air temperatures: Air dry-bulb and wet-bulb temperatures on and off the coil (wet-bulb for cooling coils only);
Air flow: Across the coil;
Calculate capacity using the above date.

15.3.3.2 Water coils:

Pressure differential of water and air: Across the coil;
Water temperature: In and out of coil;
Water flow rate;
Calculate the capacity using the above data.

15.4 AIR BALANCING

15.4.1 Requirement

Balance the air distribution system to give flow rates with +10% / -0% of the specified air quantities, subject to the following conditions:

- Distribution: The air is evenly distributed over the face of the outlets;

- Fan: There is the minimum practicable air resistance at the fan, and the fan is set to run at the lowest practicable fan speed and power consumption.

15.4.2 Method

Balancing is to be carried out by use of duct dampers mounted in the main branch and duct runs. Register dampers are only to be used for minor throttling and only where agreed prior to construction or shown on the drawings. Balancing devices are to be locked after balancing. Submit the proposed balancing method for acceptance before commencing to balance.
Procedure

- Commence balancing only when the air handling installation is complete and the building is clean and sealed. Before energizing the fans for balancing, clean the air handling system and remove dust, foreign matter, and the like.

- Multiple systems: If there is more than one air handling system, operate all the systems concurrently, but without simultaneous starting.

- Filter resistance: Quantities are to be measured under simulated dirty filters condition, simulate a resistance across filter banks equal to the mean of the initial and final resistance of the filter bank.

- Where the total air quantity of a system is more than 10% above and more than 0% below the specified quantity, adjust the fan speed, blade pitch, pulley size and motor, as appropriate.

15.4.3 Records

Include the following:-

Static pressure differential across systems;
Air quantities at air outlets after balancing;
Fan capacity, blade pitch and fan speed. Show the final operating point on the fan characteristic curve;

15.4.4 Outlets

Air flow patterns are to be adjusted for air distribution that eliminated down draft. Adjustments to air quantities causing noise levels in excess of those specified will be carried out.

15.4.5 Final Air Quantities

Some trimming may be required to achieve the specified temperature balance.

15.5 DUCT LEAKAGE TESTING

15.5.1 Requirement

Test the completed ductwork for air leakage.

15.5.2 Test Procedures

Smoke tests: With the ductwork at test pressure, survey the joints for leaks and mark each leak. Depressurise, repair the leak and retest. Repeat until audible leaks are eliminated.

15.6 SMOKE SPILL OPERATIONS TESTS

15.6.1 Requirement

Test the capacities and performance of the smoke spill systems. The systems must be adjusted to the satisfaction of the Regulatory Authority before the systems are submitted for Acceptance Testing.

15.6.2 Hold Point

Acceptance testing of the Smoke spill Systems is a Hold Point.
Standards

Conduct testing in accordance with NFPA 92A to prove the systems comply with the intent of the code.

15.7 PIPEWORK TESTING

15.7.1 Tests

Progressively test sections of pipe during the installation.

15.7.2 Concealed Work

Do not cover or conceal enclosed work or insulate work until it has been inspected and tested, in sections where necessary. Leave pipe joints exposed to enable observation during the tests.

15.7.3 System Testing

Test completed pipework systems including equipment designed to withstand the test pressure. Isolate items of equipment not so designed. Securely anchor pipes and fittings in position to prevent movement during the tests.

Hydrostatic Tests

Test the system at the pressure and for the duration stated in the HYDROSTATIC TESTS SCHEDULE. A test will be deemed successful if no loss of pressure occurs.

Retesting

If a section of pipework fails a required test, repair the fault and retest.

15.8 ELECTRICAL WORKS TESTING

Tests

Wiring and Switchboards must be tested in accordance with Section Electrical.

15.9 SCHEDULES

15.9.1 System Acceptance Tests

Type of Installation	Minimum Running Period
Air Conditioning & Ventilation	7 days
Smoke/Fire Mode Systems	2 x 1 hours tests per fire compartment
Other Mechanical Services System	2 days

15.9.2 Pipework Test Schedule

Pipework System	Test Pressure	Min Duration
Steel Pipes	Greater of 1400kPa or 1.25 times working pressure	24 hours

PART 16 AIR COOLED WATER CHILLERS

16.1 GENERAL

16.1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

16.1.2 SUMMARY

n) Section Includes:

o) Packaged, Air-cooled, electric-motor-driven chillers.
p) Heat-exchanger, brush-cleaning system (optional).

q) Related Section:

r) Division 15 Section "Refrigerant Detection and Alarm" for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

16.1.3 DEFINITIONS

- BAS: Building automation system.
- COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.
- IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
- kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW) at any given set of rating conditions.
- NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.
- RTD – Ratio Temperature Difference

16.1.4 PERFORMANCE REQUIREMENTS

- Seismic Performance: Centrifugal chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

- The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."

- Condenser-Fluid Temperature Performance: Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 88°F (31.1°C) and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.

- Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

- Performance Tolerance: Comply with the following in lieu of ARI 550/590:

  - Allowable Capacity Tolerance: 0 percent.
  - Allowable IPLV/NPLV Performance Tolerance: 0 percent.

16.1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of chiller.
5. Oil capacity of chiller.
6. Fluid capacity of evaporator, condenser
7. Characteristics of safety relief valves.
8. Minimum entering condenser-fluid temperature.
9. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5°F (3°C) increments.

B. LEED Submittal:

1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring

D. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.

3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.

4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

E. Certificates: For certification required in "Quality Assurance" Article.

F. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Source quality-control reports.

H. Startup service reports.

I. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

J. Warranty: Sample of special warranty.

16.1.6 QUALITY ASSURANCE

A. ARI Certification: Certify chiller according to ARI 550 certification program.

B. ARI Rating: Rate chiller performance according to requirements in ARI 550/590.

C. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure

Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-134a refrigerant, include an ASME U-stamp and nameplate certifying compliance.

F. Comply with NFPA 70.

G. Comply with requirements of UL and UL Canada, and include label by a qualified testing agency showing compliance.

H. Green Seal Compliance: Signed by Green Seal certifying compliance with GS-31.

16.1.7 DELIVERY, STORAGE AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each oil-lubricated chiller with a full charge of oil.

1. Ship oil factory installed in chiller.

16.1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

16.1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.
b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerant and oil charge.

d. Parts and labor.
e. Loss of refrigerant charge for any reason.

B. Warranty Period: Two years from date of Substantial Completion.

16. 2 PRODUCTS

16.2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product:

1. Trane
2. McQuay International
3. Carrier
4. YORK International Corporation

16.2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.

1. Disassemble chiller into major assemblies as required by the installation after factory
testing and before packaging for shipment.

2. For chillers with dual compressors, provide each compressor with a dedicated motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

B. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

16.2.3 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, variable-displacement, rotary screwltype compressor driven by an electric motor.

1. Where indicated, provide oil-free compressor technology using a permanent magnet synchronous motor, magnetic bearings, integral wye-delta starter electronic controls.

B. Compressor:

1. Casing: Cast iron, precision ground.
2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

C. Drive: Direct- or gear-drive, hermetic design using an electric motor as the driver.

1. Gear Drives: For chillers with gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating. Gears shall comply with American Gear Manufacturer Association standards.

2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.

D. Compressor Motor:

1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.

2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.

3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.

4. For chillers with open drives, provide motor with open-dripproof enclosure.

5. Provide motor with thermistor or RTD in each of three-phase motor windings to monitor temperature and report information to chiller control panel.

6. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.

7. Provide open-drive motor with internal electric heater, internally powered from chiller power supply.

E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range.

1. Overspeed Test: 25 percent above design operating speed.

F. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.

2. Provide lifting lugs or eyebolts attached to casing.

G. Economizers: For multistage chillers, provide interstage economizers.

H. Capacity Control: Modulating, variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 15 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Drop-in entering condenser-fluid temperature of 2.5 deg F (1.4 deg C) for each 10 percent in capacity reduction

4. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency. (N/A).

I. Oil Lubrication System: Consisting of pump, filtration, heater, cooler, factory-wired power connection, and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, coastdown, and standby conditions including power failure.
2. Manufacturer's standard method to remove refrigerant from oil.
3. Dual oil filter, one redundant, shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
4. Refrigerant- or water-cooled oil cooler.
5. Factory-installed and pressure-tested piping with isolation valves and accessories.
6. Oil compatible with refrigerant and chiller components.
7. Positive visual indication of oil level.

16.2.4 REFRIGERATION

A. Refrigerant:

1. Type: R-134a; ASHRAE 34, Class A1.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.

E. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell.

F. Purge System:

1. For chillers operating at sub-atmospheric pressures (using R-134 refrigerant), factory install an automatic purge system for collection and return of refrigerant and lubricating oil and for removal of non-condensables including, but not limited to, water, water vapor, and non-condensable gases.

2. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.

3. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
4. Construct components of non-corrodible materials.

5. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.

6. Efficiency of not more than 0.02 lb of refrigerant per pound of air (9 g of refrigerant per gram of air) when rated according to ARI 580.

7. Operation independent of chiller per ASHRAE 147.

G. Positive-Pressure System:

1. For chillers operating at sub-atmospheric pressures (using R-134 refrigerant), factory install an automatic positive-pressure system.

2. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (3 kPa) (adjustable) up to a pressure that remains within the vessel design pressure limits.

3. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

16.2.5 EVAPORATOR

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from condenser and both shall be rated 300 psig (2067 kPa).

B. Shell Material: Carbon-steel rolled plates with continuously welded seams or seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.

2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.

3. Material: Copper
4. External Finish: Manufacturer's standard.

5. Internal Finish: Enhanced

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:

1. Cast-iron or carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.

2. Marine type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes and marine water-box covers with lifting lugs or eyebolts.

4. Hinged or davited water boxes.
5. Hinged or davited marine water-box covers.

6. Nozzle Pipe Connections: Grooved for mechanical-joint coupling] [Grooved with mechanical-joint coupling and flange adapter.
7. Thermistor or RTD temperature sensor factory installed in each nozzle.

8. Fit each water box with 25-mm drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection:

1. Electrolytic corrosion-inhibitor anode.
2. Coat wetted surfaces with a corrosion-resistant finish.
3. Using same material as tubes, clad surfaces of end tube sheets in contact with fluid. Coat other wetted surfaces, including water boxes, with a corrosion-resistant finish.

16.2.6 AIR COOLED CONDENSER

A. Air cooled condenser coil shall have aluminum fins mechanically bonded to internally finned seamless copper tubing. The condenser coil shall have integral subcooling circuit and also provides oil cooling for the compressor bearing and injection oil. Condenser shall be factory proof and leak tested for 500 psig.
B. Direct drive vertical discharge condenser fans shall be dynamically balanced. Three phase condenser fans motors shall have permanently lubricated ball bearings and internal overload protection shall be provided.

16.2.7 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to fused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system.

1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.

a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

b. NEMA AB 1, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit-trip set point.

2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.

3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch (610-mm) length of liquidtight conduit.

E. Factory install and wire capacitor bank for the purpose of power factor correction to 0.95 at all operating conditions.

1. If capacitors are mounted in a dedicated enclosure, use same NEMA enclosure type as motor controller. Provide enclosure with service entrance knockouts and bushings for conduit.
2. Capacitors shall be non-PCB dielectric fluid, metallized electrode design, low loss with low-temperature rise. The kVAr ratings shall be indicated and shall not exceed the maximum limitations set by NFPA 70. Provide individual cells as required.

3. Provide each cell with current-limiting replaceable fuses and carbon-film discharge resistors to reduce residual voltage to less than 50 V within one minute after de-energizing.

4. Provide a ground terminal and a terminal block or individual connectors for phase connection.

16.2.8 MOTOR CONTROLLER

A. Enclosure: Factory installed, unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key or padlock and key.

B. Control Circuit: Obtained from integral control power transformer with a control power source of enough capacity to operate connected control devices.

C. Overload Relay: Shall be sized according to UL 1995 or shall be an integral component of chiller control microprocessor.

D. Across-the-Line Controller: NEMA ICS 2, Class A, full voltage, nonreversing; include isolation switch and current-limiting fuses.

E. Star-Delta, Reduced-Voltage Controller: NEMA ICS 2, closed transition.

F. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition; include isolation switch and current-limiting fuses.

G. Solid-State, Reduced-Voltage Controller: NEMA ICS 2.

1. Surge suppressor in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Visual indication of motor and control status, including the following conditions:

    a. Controller on.
    b. Overload trip.
    c. Loss of phase.
    d. Starter fault.

H. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Externally Operated, Door-Interlocked Disconnect: Fused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system.
2. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
3. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
4. Control Relays: Time-delay relays.
5. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.

6. Number-of-Starts Counter: Numerical readout on face of enclosure.

7. Meters: Panel type. Where indicated, provide transfer device with an off position. Meters shall indicate the following:

    a. Ammeter: Output current for each phase, with current sensors rated to suit application.
    b. Voltmeter: Output voltage for each phase.
    c. Frequency Meter: Output frequency.
    d. Real-time clock with current time and date.
    e. Total run time.

8. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

a. Selectable, digital display of the following:

1. Phase Currents, Each Phase: Plus or minus 1 percent.
2. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
3. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
4. Three-Phase Real Power: Plus or minus 2 percent.
5. Three-Phase Reactive Power: Plus or minus 2 percent.
6. Power Factor: Plus or minus 2 percent.
7. Frequency: Plus or minus 0.5 percent.

8. Integrated Demand with Demand Interval Selectable from Five to 60 Minutes: Plus or minus 2 percent.

9. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

b. Mounting: Display and control unit flush or semirecessed in instrument compartment door.

9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Power Protection: Chiller shall shut down within six cycles of power interruption.

16.2.9 VARIABLE FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 1, with hinged full-front access door with lock and key.

D. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

E. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

F. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current

source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.

2. Regulator shall provide full digital control of frequency and voltage.

3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.

G. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

H. Operating Requirements:

1. Input AC Voltage Tolerance: 380 V ac, plus 10 percent or 418 V maximum.
2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
3. Capable of driving full load, without derating, under the following conditions:

   a. Ambient Temperature: 0 to 50 deg C.
   b. Relative Humidity: Up to 95 percent (noncondensing).
   c. Altitude: 3300 feet (1005 m)

4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
6. Overload Capability: 1.05 times the full-load current for 7 seconds.
7. Starting Torque: As required by compressor-drive assembly.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.

10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

I. Internal Adjustability Capabilities:

1. Minimum Output Frequency: 6 Hz.
2. Maximum Output Frequency: 60 Hz.
3. Acceleration: 2 seconds to a minimum of 60 seconds.
4. Deceleration: 2 seconds to a minimum of 60 seconds.
5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

J. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

1. Overtemperature.
2. Short circuit at controller output.
3. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
4. Open circuit at controller output.

5. Input undervoltage.
6. Input overvoltage.
7. Loss of input phase.
8. Reverse phase.
9. AC line switching transients.
10. Instantaneous overload, line to line or line to ground.
11. Sustained overload exceeding 100 percent of controller rated current.
12. Starting a rotating motor.

K. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

L. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

M. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
10. Motor output voltage.
11. Input kilovolt amperes.
12. Total power factor.
13. Input kilowatts.
14. Input kilowatt-hours.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage total harmonic distortion.
20. Three-phase input current total harmonic distortion.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

N. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

O. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

P. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 5 percent.

Q. Input Line Conditioning:

R. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Control Relays: Auxiliary and adjustable time-delay relays.

S. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

16.2.10 CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

B. Enclosure: Unit mounted, NEMA 250, Type 1, hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

C. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:

1. Date and time.
2. Operating or alarm status.
3. Fault history with not less than last 10 faults displayed.
4. Set points of controllable parameters.
5. Trend data.
6. Operating hours.
7. Number of chiller starts.
8. Outdoor-air temperature or space temperature if required for chilled-water reset.
9. Entering- and leaving-fluid temperatures of evaporator and condenser.
10. Difference in fluid temperatures of evaporator and condenser.
11. Fluid flow of evaporator and condenser.
12. Fluid pressure drop of evaporator and condenser.
13. Refrigerant pressures in evaporator and condenser.
14. Refrigerant saturation temperature in evaporator and condenser shell.
15. Compressor refrigerant suction and discharge temperature.
16. Compressor bearing temperature.
17. Motor bearing temperature.
18. Motor winding temperature.
19. Oil temperature.
20. Oil discharge pressure.
21. Phase current.

22. Percent of motor rated load amperage.
23. Phase voltage.
24. Demand power (kilowatts).
25. Energy use (kilowatt-hours).
26. Power factor.
27. For chillers equipped with variable frequency controllers and harmonic filters, include the following:

    a. Output voltage and frequency.
    b. Voltage total harmonic distortion for each phase.
    c. Supply current total demand distortion for each phase.
    d. Inlet vane position.
    e. Controller internal ambient temperature.
    f. Heatsink temperature.

28. Purge suction temperature if purge system is provided.
29. Purge elapsed time if purge system is provided.

D. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperatures, control set points, and motor load limits. Evaporator fluid temperature shall be reset based on return-water temperature.
3. Current limit and demand limit.
4. Condenser-fluid temperature.
5. External chiller emergency stop.
6. Variable evaporator flow.

E. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

1. Low evaporator pressure or temperature; high condenser pressure.
2. Low evaporator fluid temperature.
3. Low oil differential pressure.
4. High or low oil pressure.
5. High oil temperature.
6. High compressor-discharge temperature.
7. Loss of condenser-fluid flow.
8. Loss of evaporator fluid flow.
9. Motor overcurrent.
10. Motor overvoltage.
11. Motor undervoltage.
12. Motor phase reversal.
13. Motor phase failure.
14. Sensor- or detection-circuit fault.
15. Processor communication loss.
16. Motor controller fault.
17. Extended compressor surge.

F. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

G. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

H. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

I. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

J. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

1. Hardwired Points:

a. Monitoring: On-off status, common trouble alarm, electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.
b. Control: On-off operation, chilled-water, discharge temperature set-point adjustment electrical power demand limit.

2. LonTalk communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

16.2.11 MULTIPLE CHILLER PLANT MANAGER CONTROL SYSTEM

A. Aside from the standard unit mounted microprocessor panel described under this section, the chiller shall be supplied with microprocessor multiple chiller control panel manufac-tured by the same chiller company. The chiller plant control panel shall provide intelligent control and comprehensive monitoring of system components such as pumps, cooling towers, valves once it is inter-phased with the proposed Building Management System. The Chiller Plant Manager shall be the focal point of control in operating the multiple chil-lers arranged in Variable Primary Low Flow System. This shall include:

1. Capability for remote monitoring and control of the chillers at the Maintenance and Security offices and other designated area by the facilities.

2. Capability for automatic sequencing, scheduling rotation and system controls of chillers and its respective pumps including its respective variable frequency drive motor, cooling towers, valves via I/O modules and thru the unit control module of individual chillers as well as the system bypass line with the modulating control valve. The automatic sequencing shall include the lead lag control of chiller based on 1. System Load and 2. Runtime, fixed rotation, calendar date etc.

3. Capability of proper sequencing of the chillers to maintain the flow rate through each evaporator within the range recommended by the chiller manufacturer. As the system flow nears the maximum limit for the operating chiller(s), another

chiller must be brought online. Similarly, as the system load and flow decrease, chillers must be shut down to reduce the need for bypass water flow.

4. Capability to customize sequence for unequal sized chillers.

5. Capability to start next available chiller in the event of chiller failure.

6. Capability to perform chilled water system reset-based on outdoor air tempera-ture, CHW system or return chilled water temperature.

7. Capability of data logging of chiller's operating parameters via Data Collection Module.

B. The chiller supplier must refer to the other parts of the specification for the detailed de-scription of sequence of operation of the central A/C plant as well as the control schemat-ic diagrams in preparing the proposal. Request copies from the Project Management Team or the Consultant.

16.2.12 FINISH

K. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

1. Provide at least one coat of primer with a total dry film thickness of at least 2 mils (0.05 mm).
2. Provide at least two coats of alkyd-modified, vinyl enamel finish with a total dry film thickness of at least 4 mils (0.10 mm).
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat to be manufacturer's standard.

L. Provide Owner with quart container of paint used in application of topcoat to use in touchup applications after Project Closeout.

16.2.13 ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify field-mounting location before installation.
2. Paddle Flow Switches:

a. Vane operated to actuate a double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.
b. Contacts: Platinum alloy, silver alloy, or gold-plated switch contacts with a rating of 10 A at 230-V ac.
c. Pressure rating equal to pressure rating of heat exchanger.
d. Construct body and wetted parts of Type 316 stainless steel.
e. House switch in a NEMA 250, Type 4 enclosure constructed of die-cast aluminum.
f. Vane length to suit installation.

3. Pressure Differential Switches:

    a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.

    b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
    c. Set Point: Screw type, field adjustable.
    d. Electrical Connections: Internally mounted screw-type terminal blocks.
    e. Switch Enclosure: NEMA 250, Type 4.
    f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

B. Vibration Isolation:

1. Chiller manufacturer shall furnish vibration isolation for each chiller.
2. Neoprene Pad:

    a. Two layers of 0.375-inch- (10-mm-) thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
    b. Fabricate pads from 40- to 50-durometer neoprene.
    c. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig (138 and 276 kPa) with a 0.12- to 0.16-inch (3- to 4-mm) deflection.

3. Spring Isolator:

    a. Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions. Isolators shall be designed so that the Kx/Ky ratio shall be 1.0 or more for stability.
    b. Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Aluminum components shall be etched and painted. Nuts, bolts, and washers shall be zinc electroplated.
    c. Isolators shall be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate. An elastomeric pad with a minimum thickness of 0.25 inch (6 mm) shall be bonded to the baseplate.
    d. Spring assembly shall be removable and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolated restraining bolts shall not be engaged during normal operation and shall connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.
    e. Isolators shall be selected for a nominal 1-inch (25-mm) deflection.

C. Sound Barrier:

1. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.
2. Provide for repeated installation and removal without use of tape or calk.

3. Inner and outer cover shall consist of a PTFE-impregnated fiberglass cloth enclosing heavy-density, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.

4. Covers shall be double sewn and lock stitched with edges folded and sewn so no raw cut edges are exposed.
5. Form covers around control devices, gages, conduit, piping, and supports without degrading sound-barrier performance.
6. Continuously lap all exposed seams at least 2 inches (50 mm) for better sound containment.

7. Permanently label each section of cover to indicate its location, description, size, and number sequence.
8. Randomly place stainless-steel quilting pins to prevent covers from shifting and sagging.

D. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

16.2.14 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM (OPTIONAL)

A. Furnish for field installation a brush-cleaning system on each chiller condenser for tube cleaning and improved heat transfer.

B. System shall maintain tube fouling at or below design conditions without interrupting normal equipment operation.

C. System shall consist of a brush inserted in each tube and a catch basket attached to each end of the tube. A four-way valve shall operate to reverse the direction of water flow to push the brush through the tube while removing tube deposits. Four-way reversing valve's actuator shall be controlled by a preset time cycle that provides regular tube brushing during equipment operation. Frequency of the brushing cycle shall be set up to match Project requirements.

D. Components:

1. Brush: Each brush shall have nylon bristles, titanium wires, and polypropylene tips. Brush interference fit with the ID of the tube shall not exceed 0.025 inch (0.6 mm).
2. Basket: Single-piece polypropylene basket with neck OD to press fit inner diameter of tube. Design shall provide for insertion of eddy current probe or removal of brushes without removing baskets from the valve.
3. Four-Way Valve:

   a. Construct valve body of carbon steel with internal sealing parts of hard rubber and Type 304 stainless steel.

   b. Configure valve with parallel flow connections to minimize field installation piping.

c. Construct to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, at a system working pressure equal to condenser.

d. Pipe connections shall be flanged.

e. Valve manufacturer to test and certify a maximum leakage rate of less than 0.05 percent of the design flow rate at operation conditions of maximum differential pressure.

f. Hydrostatically test to 1.5 times the design working pressure.

g. Design the valve to cause no more than 0.5-psig (3-kPa) pressure drop at design flow conditions.

h. Provide valve with valve-mounted indicating/warning light, which shall light before the valve begins rotation.

i. Valve Actuator: Mount electric actuator to operate valve.

j. Valve Actuator: Mount pneumatic piston-type actuator to operate valve. Actuator shall be suitable for operation using field-supplied air pressure.

k. Position Switches: Factory mount microswitches on the valve to indicate the complete turn of valve in both normal and reverse flow.

4. Control Panel: Factory or field mount a control panel on chiller. Control panel shall include the following features:

   a. NEMA 250, Type 3R enclosure.
   b. Timer to automatically initiate the cleaning cycle over a 24-hour period.
   c. Manual override of preset cleaning cycle.
   d. Visual indication of "Power On," "Diverter Position," "Normal Flow," "Reverse Flow," and "Valve Malfunction" indicating a slow turn or incomplete valve turn.
   e. For pneumatic actuators, mount four-way solenoid valve for actuator operation in the control panel.
   f. Flow switch bypass.
   g. Unloading signal to chiller.

16.2.15 SOURCE QUALITY CONTROL

A. Perform functional run tests of chillers before shipping.

B. Factory performance test chillers, before shipping, according to ARI 550/590.

1. The supplier shall certify and show proof that all components of the equipment they offer are brand new.

2. The supply of chiller shall include factory witness test together with the customer's representative, project manager and mechanical consultant prior to shipment of chiller

to site. The intent of the factory witness test is to validate that the proposed chiller shall be capable of delivering the required capacities at various percent load conditions from maximum to minimum evaporator flow rates at stable operating condition without surging and at the designed kw/ton efficiency based on the design operating parameters.

3. Test the following conditions:

   a. Design conditions indicated.
   b. Reduction in capacity from design to minimum load in steps of 10 with condenser fluid at design conditions.
   c. Reduction in capacity from design to minimum load in steps of 10 with varying entering condenser-fluid temperature from design to minimum conditions in 5 deg F (3 deg C) increments.
   d. At five points of varying part-load performance to be selected by Owner at time of test.

4. Allow owner, project manager and mechanical consultant access to place where chillers are being tested. Notify owner and consultant 30 days in advance of testing.

5. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. Factory sound test chillers, before shipping, according to ARI 575.

1. Test the following conditions:

   a. Design conditions indicated.
   b. Chiller operating at calculated worst-case sound condition.
   c. At five point(s) of varying part-load performance to be selected by Owner at time of test.

2. Allow owner, project manager and mechanical consultant access to place where chillers are being tested. Notify Owner, Project Manager and Mechanical Consultant 30 days in advance of testing.

3. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

D. For chillers using R-134a refrigerant, factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. For chillers located indoors, rate sound power level according to ARI 575.

16. 3 EXECUTION

16.3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

16.3.2 CHILLER INSTALLATION

A. Install chillers on support structure indicated.

B. Equipment Mounting: Install chiller on concrete bases using isolation pads or spring vibration isolators with earthquake snubbers properly selected as per chiller manufacturer's recommendation. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete. Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/4 inch (6 mm).
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Equipment Mounting: Install chiller using isolation pads or spring vibration isolators. Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Minimum Deflection: 1/4 inch (6 mm).

D. Equipment Mounting: Install chiller on concrete bases. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Charge chiller with refrigerant and fill with oil if not factory installed.

G. Install separate devices furnished by manufacturer and not factory installed.

16.3.3 HEAT-EXCHANGER, BRUSH-CLEANING SYSTEM INSTALLATION (OPTIONAL)

A. Install brush-cleaning system control panel adjacent to chiller control panel.

B. Arrange piping to provide service access to four-way valve assembly without affecting access to chiller. Secure valve to prevent lateral movement and vibration during operation.

C. Provide field electric power, as required, to each system control panel and electric actuated valve.

D. Provide pneumatic piping with pressure regulator and isolation valve to each pneumatic supply connection. Coordinate field source of air with manufacturer to ensure that requirements are satisfied for proper valve operation.

E. Interconnect brush-cleaning system controls with chiller controls. Coordinate requirements to ensure safe, trouble-free operation.

F. Functionally test the entire brush-cleaning system, including the valve, actuator, position indicator, and control panel, with chiller in operation.

16.3.4 CONNECTIONS

A. Comply with requirements for piping specified in Division 15 Section "Hydronic Piping" and Division 15 Section "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to chiller to allow service and maintenance.

C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, test port, auto air vent, victaulic connector, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, victaulic connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, and drain connection with valve. Make connections to chiller with a victaulic coupling, (min. of 3 victaulic connection from the chiller).

D. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, victaulic connector, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, victaulic connector, flow switch, thermometer, plugged tee with shutoff valve and pressure gage,[flow meter,] and drain connection with valve. Make connections to chiller with a victaulic coupling, (min. of 3 victaulic connection from the chiller).

E. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions. Comply with ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. For chillers equipped with a purge system, extend separate purge vent piping for each chiller to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.

G. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

16.3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

16.3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions.

PART 18 HYDRONIC PUMPS

18.1 GENERAL

18.1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions
and Division 1 Specification Sections, apply to this Section.

18.1.2 SUMMARY

This Section includes the following:

- Close-coupled, end-suction centrifugal pumps.
- Separately coupled, base-mounted, double-suction centrifugal pumps.
- Separately coupled, vertical-mounted, double-suction centrifugal pumps.

18.1.3 DEFINITIONS

- Buna-N: Nitrile rubber.

- EPT: Ethylene propylene terpolymer.

18.1.4 SUBMITTALS

- Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

- Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

- Wiring Diagrams: Power, signal, and control wiring.

- Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

18.1.5 QUALITY ASSURANCE

- Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

- Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- UL Compliance: Comply with UL 778 for motor-operated water pumps.

18.1.6 DELIVERY, STORAGE, AND HANDLING

- Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- Store pumps in dry location.
- Retain protective covers for flanges and protective coatings during storage.
- Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- Comply with pump manufacturer's written rigging instructions.

18.1.7 COORDINATION

- Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

18.1.8 EXTRA MATERIALS

- Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

  Mechanical Seals: Two mechanical seal(s) for each pump.

18.2 PRODUCTS

18.2.1 MANUFACTURERS

- In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

18.2.2 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

Manufacturers:
- Armstrong Pumps Inc.
- Aurora Pump; Division of Pentair Pump Group.
- Bell & Gossett; Div. of ITT Industries.
- PACO Pumps.
- Taco, Inc.

Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 250-psig

(1720-kPa) minimum working pressure and a continuous water temperature of 200 deg F (93 deg C).

Pump Construction:

- Casing: Horizontally split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 250 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.

- Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.

- Pump Shaft: Stainless steel.

- Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.

- Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

- Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 15 Section "Motors."

Capacities and Characteristics: Refer to plans

18.2.3 SEPARATELY COUPLED, VERTICAL-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
   - Armstrong Pumps Inc.
   - Aurora Pump; Division of Pentair Pump Group.
   - Bell & Gossett; Div. of ITT Industries.
   - PACO Pumps.
   - Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed

for installation with pump and motor shafts mounted vertically. Rate pump for 250-psig (1720-kPa) minimum working pressure and a continuous water temperature of 250 deg F (121 deg C).

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom of volute, mounting support, and ASME B16.1, Class 250 flanges.

   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   3. Pump Shaft: Stainless steel.

   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.

   5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.

   6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration.

E. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to casing. Comply with requirements in Division 15 Section "Motors."

F. Capacities and Characteristics: Refer to Equipment Schedule

18.2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 300-psig (2060-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 300-psig (2060-kPa) pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

18.3 EXECUTION

18.3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

18.3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 15 Section "Basic Mechanical Materials and Methods."
    1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

    2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

    3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

    4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

18.3.3 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 15 Section "Hangers and Supports."

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls." Hanger and support materials are specified in Division 15 Section "Hangers and Supports."

F. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches (19 to 38 mm) between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

G. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

18.3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

18.3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

I. Install check valve and gate or ball valve on each condensate pump unit discharge.

J. Install electrical connections for power, controls, and devices.

K. Ground equipment according to Division 16 Section "Grounding and Bonding."

L. Connect wiring according to Division 16 Section "Conductors and Cables."

18.3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.

      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

      c. Verify that pump is rotating in the correct direction.

   5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   6. Start motor.
   7. Open discharge valve slowly.

18.3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 1 Section "Demonstration and Training."

PART 20 – SCHEDULE OF AIR CONDITIONING AND MECHANICAL VENTILATION EQUIPMENT

Refer to drawing plans for Schedule of Air Conditioning and Mechanical Ventilation Equipment. Series 4000

FIRE PROTECTION SERVICES

1 PART 1 - PREAMBLES

1.1 INTRODUCTION

Specification

1.1.1 Supply, install, set to work, test and commission the complete fire protection services installation as described in this specification and as shown on the tender drawings.

1.1.2 Read the specification in conjunction with the Preliminaries of the Main Contract.

Standards and Codes of Practice

1.1.3 References to Standards, Philippine Codes of Practice, Regulations and the like do not give the year of issue or amendment. The published versions which will apply will be those current ten days before the date set for return of tenders.

Engineer

1.1.4 References to the Engineer shall mean the person nominated in the contract as Contract Administrator or his authorised representative.

Approvals

1.1.5 References to "approval of the Engineer" or similar terms shall mean the written acceptance in principle of the Engineer.

Tender Drawings

1.1.6 The specification lists all tender drawings hereby referred to as “working drawings” for the fire protection engineering services.

1.1.7 If required inspect the Architect's and Structural Engineer's drawings at their respective offices.

Preferred Standard Equipment

1.1.8 The specification and drawings contain references to products and equipment, and all such references quote by name, type, figure number or by detailed specification, particular products of specified manufacturers. The drawings have been prepared using the dimensions and salient features of such preferred standard equipment.

1.1.9 Base the tender on the equipment specified.

1.1.10 If the Contractor desires to submit alternative equipment for the approval of the Engineer, do so after the Contract is let. Provide calculations to demonstrate the sizing and selection of all fire services plant and equipment. Only one (1) alternative equipment shall be evaluated.

1.2 INFORMATION TO BE PROVIDED

General

1.2.1 Provide design, installation, builder's work information and drawings and other information as detailed in the specification.

Installation/Shop Drawings

1.2.2 Prepare drawings, based on the working drawings and/or co-ordination drawings showing proposals for the execution of the works. Prepare the drawings in such detail as to enable the works to be installed. Agree the precise location of the pipes openings with the Engineer.

1.2.3 The contractor shall be responsible for producing the following installations/shop drawings:

- complete individual services drawings (ISD's).
- complete combined services drawings (CSD's)
- complete structural, electrical, mechanical drawings (SEM's)

These shall be based on the design working drawings. The contractor shall be responsible for ensuring his fire protection services are fully coordinated with other services such as, mechanical, plumbing and drainage, lift and electrical services.

The contractor shall be responsible for ensuring all structural openings, etc. are reflected on his SEM drawings. All installation/shop drawings shall be submitted with enough time to ensure no clashes between other services occur or incorrect structural openings take place.

The contractor shall rectify any clashes or non-coordinated building services at his own cost.

1 Working Drawings

1.2.4 Keep on site a complete set of prints of installation/shop drawings. Mark all variations, deviations and amendments on these drawings as the installation work proceeds. Use these 'marked-up drawings as the basis for the record drawings referred to later.
Keep working drawings on site and available at all times for inspection by the Engineer.

1.3 STATUTORY & GENERAL OBLIGATIONS

Statutory Obligations

1.3.1 In respect of the installation, materials, components, equipment and workmanship comply with statutory and other obligations, regulations of any Local Authority, Public Services or Statutory Undertaking relating to the execution of the works. In particular comply with the requirements of:

(a) The Philippine Society of Mechanical Engineers (PSME).
(b) National Fire Protection Association (NFPA).
(c) Philippine National Building Codes.
(d) Philippine Fire Codes and the Regulations.
(e) The Health and Safety at Work, etc Act.
(f) The Rules and Regulation of Local Authority.

(g) The Building Regulations.
(h) Construction (Design & Management) regulations (CDM)
(i) British Standard Institution (BSI)
(j) All other relevant Standard Specifications and Philippine Code of Practice, whether mentioned in this Specification, or not.

1.4 MANAGEMENT AND ADMINISTRATION PROCEDURES

Schedule of Rates

1.4.1 Within two working weeks of being awarded the contract submit for approval of the Engineer three copies of the Schedule of Rates upon which the tender has been based. Schedule detailed quantities and rates for all works, and fully price and total the schedule to equal the original tender figure.

Valuation of Instructions and Variations

1.4.2 Oral instructions have no effect unless confirmed in writing.

1.4.3 Submit to the Engineer, within fourteen days of the receipt of the written instruction, the price of each variation showing the quantities and rates applicable for all materials etc employed in accordance with the schedule of rates. No work will be certified for payment until this information is provided.

Programme

1.4.4 Prepare a programme for the works, and submit it for approval within two weeks of commencement of the contract. Take into account the Main Contractors programme, materials procurement and the needs for liaison with other services. Include all such relevant dates, and supply three copies to the Engineer.

1.4.5 Review the programme at least on a monthly basis and update the programme if any circumstances arise which affect the progress of the works. Submit three copies of all revisions to the Engineer.

Specialist Activities

1.4.6 Employ specialists to undertake installations, including:

(a) Testing and Balancing Contractor

1.5 WORK AT COMPLETION

Notices, Charts and Labels

1.5.1 Provide all necessary statutory and warning notices.

1.5.2 Submit sample copies of all notices, charts and the wording for all labels to the Engineer for approval before ordering them.

1.5.3 Identification tapes for pipelines to be provided at 3 meter intervals changes of direction, both sides of each isolation/regulation device and each side of wall and floor penetration. Tapes to

include service description and direction of flow.

1.5.4 White traffolite, or other approved laminate type labels engraved with 6mm high black characters to be securely fixed by means of nuts, bolts and washers to all main items of plant and equipment indicating the following:

(a) Name of unit or equipment.
(b) Reference number.

1.5.5 **Inspection, Testing and Commissioning of the Works**
The contractor shall hire an independent specialist testing, balancing and commissioning contractor.

Attendance

1.5.6 Provide attendance during the testing and commissioning of all fire protection plant, equipment and apparatus connected under this contract.

Inspection and Testing of Installations

1.5.7 On completion of the works carry out tests on all Fire Protection Piping and Equipment in accordance with the requirements of the documents listed in the Statutory and General Obligations clause of this specification.

1.5.8 Tabulate the results of all tests in an approved format. Note and record on the tabulated forms the date such tests were carried out. Hand these forms to the Engineer on completion of the works.

1.5.9 Provide all necessary instruments and tools for the tests. Supply the Engineer with copies of recent test certificates confirming the accuracy of all test instruments.

1.5.10 On completion of the works, forward to the Engineer duplicate copies of all test certificates and the completion certificates and inspection certificate as prescribed in the Statutory and General Obligations clause of this specification.

Instruction

1.5.11 Following satisfactory commissioning of the works and prior to the completion of the works explain and demonstrate to the Employer's representative(s) the purpose, function and operation of all the works covered in this Specification including all items and procedures listed in the operating and maintenance manual. Include in this undertaking instruction from manufacturers' service engineers. Allow a minimum of 3 working days for this exercise which is to be carried out during normal working hours.

2 Operating and Maintenance Instructions

1.5.12 No later than two weeks prior to the commencement of commissioning provide two draft copies of the manual for comment.

1.5.13 Issue the final version of the manuals on completion of the works.

1.5.14 Each Manual to be A4 size, in plastic covered loose leaf four ring binders with hard covers, indexed, divided and appropriately titled.

1.5.15 Ensure each manual contains the following information:

(a) An index.
(b) A full technical description of each system written to ensure that the Employer's staff fully understand the scope and facilities provided.
(c) A description of the mode of operation of each system.
(d) A list of record drawings with a brief description of each.
(e) A legend for all colour coded services
(f) Schedules, system by system, of plant and equipment stating their locations, duties and performance figures.
(g) The manufacturers name, address and telephone number for each item of plant and equipment together with catalogue list numbers.
(h) Manufacturers technical literature for all items of plant and equipment.
(i) A copy of all test certificates
(j) A copy of all manufacturer's guarantees and warranties.
(k) Recommendations as to the preventative maintenance frequency and procedures to be carried out to ensure efficient operation.
(l) A list of normal consumables.
(m) A list of recommended spares.
(n) A copy of each record drawing.
(o) A list of emergency telephone numbers.

1.5.16 Edit manufacturer's standard operating and maintenance instructions to ensure only that information relevant and pertaining to the works is used.

Defects Liability Period

1.5.17 The defects liability period shall be 12 months following hand over, during the defects period attend to further/additional items that need attention.

1.5.18 Approximately three weeks before the end of the defects period the Engineer will produce a final defects lists. Ensure that any items noted thereon are rectified prior to the end of the defects period. Write to the Engineer confirming such defects have been rectified and the work is complete.

3 Warranty

1.5.19 The warranty of all equipment shall be a minimum of 12 months from the building practical completion date.

1.6 DELIVERY AND STORAGE

Handle and store, and protect materials in accordance with the manufacturer's recommendation. Replace damaged or defective items with new items.

1.7 CATALOGUED / PRODUCTS / SERVICE AVAILABILITY

Materials shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year period shall include applications of materials under similar circumstances and of similar size. The 2-year period shall be satisfactory completed by a product for sale on the commercial market through advertisements, manufacturer's catalogs or brochures.

2 PART 2 – SCOPE OF WORKS

42.1 GENERAL

2.1.1 This part of the specification describes the scope of the fire protection services installation and should be read in conjunction with the remainder of this specification and the Drawings. Together they cover the manufacture, supply, delivery to site, off-loading and positioning, co-ordination, erection, testing, setting to work and commissioning of the Fire Protection Services Installation.

2.2 THE BUILDING

5 2.2.1 The scheme is for the development of the **Proposed Davao International Airport Building** located in Davao, City, Philippines

2.3 SCOPE OF WORK

2.3.1 The work to be done under this division of the specifications consist of the supply and delivery of all necessary materials, accessories, fabrication, installation complete in all details all fire services, pipe penetrations and opening, pipe sleeves at the subject project premises and all work and materials incidental to the proper completion of the installations, except those portions of the work which are expressly stated to be done by others. All work shall be in accordance with the governing codes and regulations and with specifications. The requirements in regard to materials and workmanship specify the required standards for the furnishing of the labour, materials and workmanship specify the required standards for the installation/operation of the work specified herein and indicated on the drawings. The information as given on the specification and drawings is to outline the design intent and performance of the works to be required but are not intended to include all detailed design and construction

It is the sole responsibility of the contractor to offer complete satisfactory workmanship and all other as may be required to meet every aspect, whether or not as specified, in the specification the requirement of local authorities and of all performance to be acceptable for handling over to the owner.

2.3.2 The contractor, before submitting his proposal shall examine all tender document, specification and drawings relating to his work and verify all governing conditions at site and shall become fully informed as to the extent and character of the work required.

No consideration will be granted for any alleged misunderstanding of the equipment/materials to be furnished or work to be done, it being understood that the submission of a proposal is an agreement to all items and conditions referred to herein or indicated on the accompanying drawings and actual site conditions. If specified materials are not locally available, contractor

must immediately place an order as soon as project is awarded. Any exceptions, omission or substitutions shall be presented in writing with the contractor's bid.

2.3.3 The contractor, before commencing work shall examine all adjoining areas on which this work is in any way dependent for perfect workmanship according to the intent of this specification and shall report to the Owner's representative any condition which will prevent this contractor from performing first class work. No waiver of responsibility for defective work will be considered unless notice has been filed at the time this contractor submits his proposals.

2.3.4 It is the intention of these specifications and drawings to call for furnish work tested and ready for operation. Whenever the word "provide" is used, it shall mean "furnish and install, complete, test and commission and ready to use" for the construction. No matter any work or details shown or specified or not, but which are necessary for the proper installation and operation, shall be included in the work, the same as if herein specified.

2.4 WORK INCLUDED

Under this division of the specifications, provide all materials and equipment and perform all the work necessary for the complete execution of the fire services works as shown on the fire services drawings as herein specified except as otherwise excluded and which without excluding the generality of the foregoing, shall include but not be limited to the following principal items of work:

2.4.1 Provide, supply and installation of all Automatic Fire Sprinkler and Hose Reel systems as shown on the drawings in accordance with NFPA13 including testing and commissioning.

2.4.2 The provision of all Fire Protection System mains whether or not as shown but are necessary for the satisfactory completion of the system including installation, connection, testing and commissioning.

2.4.3 The provision, installation connection, testing and commissioning of Fire Department connection assembly valve and Hose System throughout as required by the relevant Philippines and NFPA standards, including required valving, pipe sleeves, risers and hose cabinets.

2.4.4 Provision, installation, and testing of all fire extinguishers and fire blankets as shown on drawings and specified herein including fixings and signage as required.

2.4.5 Testing and commissioning and maintenance and warranty of all systems and equipment installation such as fire pump and jockey pump, controllers and its accessories.

2.4.6 Provision of design and working drawings for all systems in hard copy and submit to the Engineer for comment prior to the installation.

2.4.7 Provision of 'As Installed' or "as-built" drawings of all system in hard copy.

2.4.8 Provision of hardbound catalogues, operating and maintenance instruction manuals for all systems and equipment installed and adequate detailed training sessions for operating and maintenance staff in the use and maintenance of all equipment and system installed.

2.4.9 The provision of all final certificated and approvals authorised by the relevant authorities required to ensure correct and operating systems have been installed throughout the project.

2.4.10 Provision of tactical fire plans and associated equipment, including vertical plan cabinets.

2.4.11 Provide primer paint and final paint to all fire services pipeworks in accordance with the standard color code and local code.

2.5 WORKS NOT INCLUDED

The following items of work will be done under other divisions or will be supplied and installed by others:

Hacking of structural load bearing walls, roofs, floors and partitions to provide openings or passage for pipe. The contractor shall coordinate, however with other trade contractors such passage requirements and shall provide the proper sleeves .

2.6 WORKMANSHIP

The work throughout shall be executed in the best and most thorough manner to the satisfaction of the Architect and the Engineer, who will jointly interpret the meaning of the Drawings and Specifications and shall have power to reject any work and materials which, in their judgment, is not in full accordance therewith.

The Contractor shall assume unit responsibility and shall provide the service of a highly qualified Engineer to supervise the complete installation of equipment and systems and who shall be available for conducting the final acceptance tests.

2.7 WARRANTY

The contractor shall provide manufacturer's written warranties covering defects in materials and workmanship of products and equipment utilized for the project. Warranties shall be for a period of one (1) year from the date of the building practical completion certificate.

3 PART 3 – FIRE SPRINKLER AND HOSE SYSTEMS

3.1 GENERAL

Description of Work

The works includes supply, installation and testing of the sprinkler and hose system for the complete fire protection coverage throughout all areas as shown on the drawings. The equipment, materials, installation, workmanship, examination, inspection, and testing shall be in strict accordance with the required and advisory provisions of NFPA 13, except as modified herein. Each system shall be designed for earthquakes and shall include all materials accessories, and equipment inside and outside the building to provide each system complete and ready for use. Provide each system to give full consideration to blind spaces, piping, electrical equipment, duct work and other construction and equipment in accordance with

detailed drawings to be submitted for approval. Locate sprinkler heads in a consistent pattern with ceiling grid, lights and supply air diffusers. Devices and equipment for fire protection service shall be UL or FM approved for use in sprinkler system. In the NFPA publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the work "shall" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" shall be interpreted to mean the Engineer.

Submittals

Partial submittals will not acceptable. Annotate descriptive data to show the specific model, type and size of each item the Contractor proposes to provide. The Engineer will review and approve submittals. Before any work is commenced, submit the design, manufacturer's data, and complete sets of working drawings for each system.

A. Samples: Submit a sample of each of the following:

1. Each type of sprinkler head.
2. Pipe and fittings.
3. Pipe hanger.
4. Fire hose cabinets.
5. Fire seal stop.
6. Escutcheon plates.

B. Manufacturer's Data:

1. Valves, including gate, check and globe.
2. Sprinkler heads.
3. Pipe hangers and supports.
4. Pressure switch.
5. Fire Pumps, UL/FM approved.
6. Detection devices and control panel
7. Jockey pump, UL/FM approved.
8. Fire Extinguisher, UL/FM approved.
9. Fire Pump Flow Meter, UL/FM approved.
10. Alarm Check Valve, UL/FM approved.
11. Supervisory Switch, UL/FM approved.
12. Fire Hose Cabinet.

C. Shop Drawings:

1. Sprinkler head and pipe system layout.
2. Hydraulically System Calculations.
3. Plant Room for Fire Pump
4. Detail Layout, Section etc.
5. Certificate of Compliance.

D. Operation and Maintenance Manuals:

1. Fire Pump, UL/FM approved.
2. Control Panel.
3. Jockey Pump, UL/FM approved.

Requirement: For each separately operation service system, provide not later than the date of Practical Completion, the five (5) number of hard copies and one (1) electronic copy of Operating and Maintenance manual written in clear concise English, containing a title page with the supplier's name, address and telephone number, a table of contents and the data specified in this clause.

Forms: A4 size, printed or typed on durable printing paper, each page consecutively numbered, neatly bound in durable vinyl or similar hard covers permanently labelled with the project name and date of issue. Place diagrams on the same page as the relevant text, or on the facing page, or on gatefold pages at the end of the volume. Provide dividers between sections with plastic-covered labelled tags.

Contents: Each Operating and Maintenance Manual shall contain information pertinent to the installation. A mere assemblage of manufacturer's catalogue, instruction and general descriptive matter is not acceptable.

Provide the following information:

- Table of Contents

- Scope

A short statement of the equipment falling within scope of the manual. Provide names, address, telephone and facsimile number for the designers and installers of the system.

- Emergency Information

  Provide contact information for obtaining service during the Defects Liability Period.
- General Description

  An outline description of all equipment and systems provided. Provide an overview on their purpose, function and operations.

- Operating Instruction

  Clear and concise instructions on how to operate equipment. Include safety precautions.

- Detailed Functional and Controls Description

  A complete detailed description of system and equipment functions and control arrangements. Include descriptions of all control systems and sequences for each item of equipment and system in automatic, manual, fault and alarm conditions. Refer to the controls drawings and controls programs so that the operation and the controls is clear and unambiguous.

- Commissioning Data

  Results of all commissioning tests for each item of equipment. Provide copies of Certificates of Compliance and Installer's Certificates.

- Maintenance Procedures

  Provide recommend maintenance procedures and maintenance intervals, alignment and adjustment instructions for each item of equipment and each system. Also provide a list of spare parts which are recommended to be held on site and a list of special tools required together with instruction on their use.

  Where the manufacturer of a major item of equipment or system provides a comprehensive manual for the equipment or system and it is not feasible to remove the maintenance procedures, the complete manual may be included detailed cross reference to the maintenance procedures are included in this section.

- Equipment Schedules and Manufacturer's Literature

  Provide an Equipment Schedule for each item of equipment which lists at least the following information:

  - Equipment Identification
  - Manufacturer
  - Equipment supplier, address, telephone and facsimile number
  - Equipment design parameters and capacities

  Append the relevant manufacturer's literature comprising warranties, guarantees, service manuals, brochures, recommendations etc., to each equipment schedule. As far as practicable, manufacturer's literature shall only contain information on the equipment installed. Where this is not possible, provide sufficient information in the Equipment Schedule to define the equipment installed, including all equipment options, so that it is unambiguous which parts of the manufacturer's literature apply to the installed equipment. Alternatively, mark the irrelevant parts, NOT ACCEPTABLE.

- Work-As-Executed Drawings

  A list of all work-as-executed drawings and a print of each drawing at either 1:50 or 1:00 scale folded within clear plastic covers.

  Provide a table of contents at the start of each section if the section contains more than two pages.

  Log book: Provide a log book bound and presented generally as specified for manuals, with sufficient pages to receive the entries for the maintenance period and for a further period not less than 12 months. Make typical entries recording the required procedures during the maintenance period.

  Certificates: Include in the log book the test and approval certificates required by this Section.

Copies: Provide 1 copy of each manual for approval then four (4) copies for Final issue to the Construction Manager/Engineer prior to Practical Completion.

Operating and Maintenance manuals are required and shall be carried out in accordance with the contract.

CAD Drawings

Provide As-installed drawings using a computer aided drafting (CAD) system. After the drawings have been approved include disks of the drawings within plastic sleeves within the Operating and Maintenance Manuals. Each disk shall be clearly labelled to indicate the project name and drawing numbers.

CAD summary: Provide a CAD file summary including:

- Index of CAD file names related to drawings names.
- List of all layers, line types and blocks.
- Scales at which CAD files are plotted.

Electrical Work (By Electrical Contractor)

Liaise with and ensure that the Electrical Contractor provide control and fire alarm wiring, including connections to fire alarm systems, under this section in accordance with NFPA 70, NFPA 72 A, NFPA 72 B and NFPA 72 E. Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical tubing conduit may be used in dry locations not enclosed in concrete or where not subject to mechanical damage.

3.2 REGULATIONS

The Contractor of the fire protection system shall comply in accordance with the standards of the NFPA, The National Building Code of Philippines, Section 1302 of this Code, Fire Code of the Philippines with Implementing Rules and Regulation, and Specification and all other Authorities having jurisdiction over the installation.

3.3 PIPING, VALVES AND FITTINGS

The reticulation of pipe in the installation of all fire protection equipment shall be in accordance with NFPA 13, NFPA 14 and NFPA 24. All system isolating valves shall be wired to the Fire Control Panel to facilities monitoring at all times and shall be suitably strapped and padlocked.

Where dissimilar details are likely to result in cathodic corrosion they shall be adequately connectedly in accordance with the requirements of NFPA 13.

3.4 SPRINKLER HEADS

General

All sprinkler heads and attached fittings, ie. Escutcheon plates, cover plates, heat collectors, sprinkler guards, etc. proposed to be used throughout the Project shall be listed and approved by Underwriters Laboratories Inc. (UL) and Factory Mutual (FM).

Where pendant sprinklers are installed with Escutcheon plates, the Contractor shall ensure the minimum sprinkler deflector distances from the ceiling are adhere to strictly in accordance with the manufacturer's requirements for the type of sprinkler arrangement.

Sprinkler Schedule

a. The Main Building areas shall have either semi-recessed or flushed type pendent below ceiling heads fitting with escutcheon plates and cover plates and be 165^{o}F glass bulb 15mm spray type heads as shown on the drawings.

b. Exposed Heads shall be glass bulb, 165^{o}F, 15mm type brass finish heads installed pendent or upright.

c. All wall wetting sprinklers shall be 165^{o}F, 15mm fast response vertical sidewall type as shown on the drawings and located not more than 300mm from face to window/wall.

d. Variation cost for additional sprinklers and/or piping will not be considered unless additional work or amendments materially affect the building or equipment arrangement indicated on the drawings. Notwithstanding the number of sprinkler head shown on the drawings, the Contractor shall conform with requirements of this Specification and allow for fifty (50) extra exposed heads, fifty (50) concealed space heads ad fifty (50) flush mounted heads, three (3) metres of pipe work per sprinkler and connections over and above the number indicated on the Drawings to be used at the discretion of the Construction Manager. Any remaining heads at the completion of the contracts shall be deducted at the tender rate from final Contract Sum

e. Sprinkler installed under Kitchen hoods and kitchen area and within exhaust ducts shall be minimum 225^{o}F installed intermediate and complete with dust box for easy removal.

3.5 DESIGN PARAMETERS AND COMPUTATIONS

The Sprinkler and Hydrant/Hose Systems shall be fully hydraulically re-calculated by the Contractor. The Contractor shall submit hydraulic computations for the total sprinkler and fire services system for approval by the Engineer. The calculations (and drawings) must also be approved by a Professional Mechanical Engineer.

Calculations must be submitted for approval at the same time as the drawings to which they relate. No on-site submitted for approval at the same time as the drawings to which have been approved.

The design parameters for the sprinkler for hydrant installations shall be determined in accordance with the applicable NFPA standards for areas such as general offices residential units and Plant Rooms.

In additions, the fire service pumps have been sized to provide **500gpm @ 100psi** located at the pump room at ground floor with a jockey pump rated @**10gpm @ 110psi.**

3.6 SPRINKLER INSTALLATION CONTROL VALVE ASSEMBLES

The main isolating valves shall be provided.

The Contractor shall supply and install sprinkler subsidiary stop valve assemblies in the locations as shown on the drawings.

Each sprinkler system subsidiary stop valve assembly shall be provided with all necessary equipment to enable it to function in accordance with the requirements of NFPA 13, and shall include the following (refer fire control valve and auxiliary drain detail).

a. Indication type, floor control valve with supervisory switch
b. Pressure relieve valve.
c. Pressure reducing valve.
d. Pressure gauge.
e. Drain and test valve assembly.

3.7 FIRE SERVICES WATER SUPPLY AND FIRE WATER STORAGE TANK

Water supply and fire water storage tank has been supplied refer to Structural Specification.

3.8 COMMISSIONING TESTS – WATER SUPPLY

On completion of the system, and before practical completion, The Contractor shall satisfactory carry out the following:

System Proving Tests: Perform the tests necessary to certify completion as specified in NFPA 13 and NFPA 25. Sprinkler type works is to be fully air tested for a 12 hours period prior to charging system with water.

Hydrostatic Test: Test pipe work to NFPA 13 and NFPA 25. Maintain the test pressure beyond the specified period if necessary to complete the inspection of pipe work under test. Sprinkler system to be water pressure tested to 500 kPa above designed installation pressure.

Recording Equipment: Provide the flow and pressure recording equipment, of a type approved for satisfactory performance of the test.

Calibration: Provide a Test Certificate to evidence that the calibration of test instruments has been checked for accuracy not more than one month prior to testing.

3.9 DRAWINGS

The Contractor shall, prior to installation of any works, submit duplicate sets of full hydraulic (shop) drawings for coordination and permission to use. Duplicate sets of full hydraulic calculations of all sprinkler and hydrant/hose systems shall accompany the shop drawings. Drawings shall show, but not be limited to all sprinkler locations, pipe routes, pipe sizes, hydrant and hose station locations and details of associated equipment such as pipe hanger positioning and type and earthquake bracing details.

No work is to be commenced until the shop/working drawings for these works has been given permission to use by the Engineer.

At time of practical completion, the Contractor shall supply to the Construction Manager/Engineer a full set of "as installed" drawings and maintenance manuals in accordance with the contract.

3.10 INSPECTIONS AND TESTING – SPRINKLER SYSTEMS

The Contractor shall arrange and allow for all fees associated with, inspection and testing as required during and upon completion of the installation of the works. The Contractor shall hire independent testing and balancing contractor.

The Contractor shall advise the Fire Marshall of all dates and times of inspections and tests with sufficient notice to enable representatives of the Construction Manager and Fire Marshall to be present.

On completion of each system of sub-system, and before practical completion, the Contractor shall satisfactorily complete the commissioning tests and any additional tests which may be required by the relevant authority.

All testing to be completed in sufficient time to allow for a fourteen (14) day trial period prior to building occupation, during which no fault or instability occur.

All test results shall be recorded, signed and dated. A copy of the results to be forwarded to the Fire Marshal.

3.11 SYSTEM GUARANTEE AND DEFECTS LIABILITY

The Contractor shall guarantee that the system installed, and equipment used, conform to all requirements of the following:

- Underwrites Laboratories Inc (UL)
- Factory Mutual Corp (FM)
- Bureau of Fire Protection
- All applicable NFPA standards
- Applicable Philippines Codes and Regulations
- Any other Regulatory Authority having jurisdiction over the installation

All equipment and work shall be warranted against defective workmanship and materials for a period of twelve (12) months from the date of Practical Completion.

The Contractor shall allow in his Tender for extending the Warranty of any equipment to the above Warranty Period should the manufacturer provide a lesser Warranty Period.

Any equipment replaced during the Warranty Period shall be warranted for twelve (12) months from the date of its replacement.

3.12 MAINTENANCE AND TESTING – SPRINKLER, HYDRANT & HOSE SYSTEMS

The Contractor shall make allowances to provide on going maintenance and testing for the fire services installations during the defects liability period in accordance with the following detail:

Maintenance Period:
Co-extensive with the Defects Liability Period.

Requirement:
During the maintenance period, provide regular maintenance including the following:

- Level 1 Routine – to the applicable regulations
- Level 2 Routine – to the applicable regulations
- Level 3 Routine – Yearly procedures; carry out the yearly procedures at the end of the maintenance period, irrespective of the duration of the period.

Emergencies:
Attend to emergencies within 2 hours of being notified, and promptly rectify the faults, including the replacement of faulty materials or equipment. The cost of attendance, rectification and replacements shall be borne by the Contractor is the fault was caused by defective materials, equipment or installation.

Maintenance Documentation:
To NFPA 13 or applicable regulations.

Certificate:
At the end of the maintenance period, upon satisfactory completion of the above procedures, certify in writing that the installation is operating correctly.

The design of building elements, services and systems shall account for long term support and ease of maintenance with a view to containing life cycle costs. In particular, the following principles shall be reflected in design provision:

- Reliability and maintainability shall be given adequate consideration in design decisions.
- Adequate access to plant and equipment shall be provided, particular for components subject to routine inspection or maintenance.
- Basic instrumentation necessary for operational monitoring, maintenance programming and fault diagnosis shall be provided.

For planning purposes it may be assumed that a maintenance strategy will manage and coordinate maintenance largely in house and to implement and execute servicing and maintenance programs largely by out-sourcing.

3.13 LOG BOOKS

The Contractor shall supply test log books in accordance with NFPA 13 and any other applicable code for the sprinkler and hydrant and hose systems with sufficient pages to receive the entries for the maintenance period, and a further period of not less than 12 months.
A test log book shall be provided at all sprinkler control valves, sprinkler pre-action valves.

3.14 FIRE PRECAUTIONS DURING CONSTRUCTION

The Contractor shall provide Fire Protection during the course of construction as per the requirements of the NBC of the Philippines.

3.15 INTERNAL FIRE HOSE SYSTEM

Provide and install, where indicated on the drawings, fire hose stations conforming to the following requirements.
All hose stations shall be connected to sprinkler system reticulation piping as shown on the drawings and comprise a 30m length of double-jacketed, lined fire hose with 80mm long (6mm dia) nozzles which interlock with 25 mm diameter stop cocks and pipe connections. Hose stations to be complete with swivel guides. Allow for all hose cabinets, mounting brackets, up-stands and fixing to suit each and every hose valves shall be cast brass.

Hose stations shall be installed to meet the requirements of the Bureau of Fire Protection, the NBC of the Philippines and applicable NFPA standards.

3.16 FIRE SYSTEM PUMP SETS

The fire pump system of the sprinkler system consist of a fire pump **(500 gpm @ 100psi)** and jockey pump **(10 gpm @ 110psi)**. The contractor's scope of work on the fire pump system is to complete the installation of the fire pump system. The contractors will be the one responsible for providing the materials and equipment specified in this section.

Install fire pump and associated equipment complete and ready for operation. Equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection and testing shall be in accordance with NFPA 70. Devices and equipment for accordance with NFPA 20 and NFPA 70. Devices and equipment for fire protection service shall be UL listed and FM approved.

Annotate descriptive data to show the specific model, type and size of each item, the contractor propose to provide. Prepare working drawings on sheets not smaller than the contract drawings; include data for the proper installation of each system. The consultant will review and approve submittals before any work is commenced, submit the manufacturer's data and complete sets of working drawings for each system:

Manufacturer's data:

1. Pipe and fittings
2. Fire pump controllers (ATS and Combination Magnetic Starter - Wye-Delta Open Transition)
3. Jockey pump controllers (Combination Magnetic Starter – Direct online)
4. Valves (gate valve, check valve, butterfly valve, meter control valve, relief valve and meter throttling valve)
5. Alarm check valve
6. Flow meter
7. Low Level Switch
8. Vertical in line fire pump (Electric)
9. Vertical in line jockey Pump (Electric)
10. Pressure Gage

Sequence of Operation

System pressure shall be maintained by the jockey pump. The jockey pump shall start automatically whenever the system pressure drop to its cut in pressure psig. It shall stop automatically whenever the system pressure drop to its cut-in pressure manually. Failure of the duty pumps shall not prevent the Fire pumps to operate automatically. Cut-in and cut-off pressure shall be as indicated.

3.17 INSPECTIONS AND TESTING – HYDRANT/HOSE SYSTEM & SPRINKLER SYSTEMS

The whole of the hydrant and hose system and sprinkler system shall be tested in accordance with the requirements of NFPA Standards and the Fire Code of the Philippines.

All piping shall be hydrostatically field tested to a maximum test pressure of 200 psig for a period of two (2) hours.
All hydrant and hose stations shall be tested to show that the discharge available from each point complies with the requirements of the above standards. All test results shall be presented in tabulation form for approval.

It should be noted that the pressure test is intended to detect leakage at operating pressures which may actually be experienced during the life of the pipe work, and not as a test of ultimate pressure capacity.

The Contractor shall arrange and allow for all fees associated with, inspections and testing as required during and upon completion of the installation of the works.

The Contractor shall advise of all dates and times of inspections and test, with sufficient notice to enable representatives of the Fire Marshall and Construction Manager to be present.

3.18 PIPE WORK – ABOVE GROUND

All above ground fire services piping reticulation shall be installed, tested and commissioned in accordance with the NFPA standard. The following pipe standards shall be adopted for all fire protection pipe works.

A. Pipe and Fittings and Accessories

- Pipe Sizes 65 mm (2 ½ inches) and larger

  a. Steel Pipe

     ASTM A 53 Grade B Schedule 40, standard weight, ERWs, black steel pipe with buttwelding end connections or plain end connections or grooved end connections.

  b. Buttwelding Fittings

ANSI B 16.9. Provide the same materials and weight as the piping in which fittings are installed.

c. Flanges and Flange Fittings
ANSI B 16.5 Class 150 or class as appropriate. Provide ASTM A 193, Grade B7 bolts, ASTM A 194 nuts and neoprene gasket.

- Pipe Sizes 50mm (2 inches) and Smaller

a. Steel Pipe

ASTM A 53 Grade B Schedule 40, Standard weight, ERW, black steel pipe threaded end connections or grooved connections.

b. Threaded Fittings: ANSI B 16.3, Class 150, black malleable iron.

Unions: ANSI B 16.39 Class 150, black malleable iron.

- Victaulic Piping System

- Pipe Joints: (for pipe size 65mm and above)

a. Victaulic Mechanical Grooved Coupling.
Either Firelock Ridgid Coupling or Flexible Coupling. Housing shall be made of Ductile Iron. Gasket shall be EPDM resilient elastomeric type. Max Working Pressure 300 psi.

b. Pipe Fittings (for 65mm and above) shall be Victaulic Grooved End Pipe Fittings. Fittings shall be listed by UL approved by FM for fire protection use. Fittings shall be made of Ductile Iron and shall be compatible and come from same manufacturer as the mechanical grooved couplings.

For pipe sizes 50mm and below, use Threaded joints and fittings.

- Risers. Victaulic Mechanical Grooved End Flexible Coupling at every floor.

- Reducing Tees.
Crossmains: Victaulic Mechanical Tee Branch Outlets. Rated at 300 psi Max Working Pressure. Made of Ductile Iron housing and EPDM Gasket.
Mechanical Tee shall be UL listed FM approved. Bolts shall be tightened to required Torque as listed on the valve body.
Wet Riser to Feedmain/Dry Standpipe Riser to Hose Valve Tee Connections – Victaulic Mechanical Tee Branch Outlets.
- Pipe Preparation for Grooved Coupling connection. Pipes must be Grooved to specifications of the mechanical grooved end coupling manufacturers grooved specifications. Installation of couplings and valves and pipe fittings must follow manufacturers specifications and instructions. Gaskets of couplings and mechanical tees must be properly lubricated. (refer to manufacturer's specifications for type of lubricant). Pipe ends must be clean of dirt, rust, weld beads. Mechanical Tee must be

tightened to its specified torque (indicated on the Tee fitting body). Victaulic Coupling must be tightened until clamps has metal to metal contact.

B. Pipe Hangers and Supports

Provide in accordance with NFPA 13.

- Seismic Sway Bracing. A series of Victaulic Grooved End Mechanical Flexible Couplings and Victaulic Grooved End Elbows.

- Seismic Restraint Systems

  The fire protection system shall be installed and supported in accordance with NFPA 13, 14, 70, 72. The following is a list of general requirements.

  General

  All equipment and components shall be seismically restrained to keep all fire protection systems components in place during a seismic work.

  Materials

  Seismic restraints provided shall be manufactured by approved manufacturers and be of approved materials. Seismic restraints shall be the product of a single manufacturer.

  Seismic Restraint Selection, Certification and Analysis

  Seismic restrains calculations must be provided for all connection of equipment to the structure. Calculations must be stamped by registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.

  All restraining devices shall have a pre-approved number from California OSHPD or some other recognised government agency showing maximum restraint rating. Pre-approvals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restrain design must be stamped by a registered professional engineer with a least five years of seismic design experience and licensed to the state of the job location. Testing and calculations must include both shear and tensile loads as one test or analysis at 45^{o} to the weakest mode.

  Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilised for connection to equipment and structure. Analysis must details anchoring methods, bolts diameter, embedment and/or welded length. All seismic restraints devices shall be design to accept, without failure, the forces detailed in the schedule acting through the equipment centre of gravity. Overturning moments may exceed forces at ground level.

  Installation

  Unless otherwise specified, seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submitted data.

Submit Data

The manufacturer shall submit a full schedule of the seismic restraints proposed for use with the shop drawing(s) not less than 4 weeks prior to installation of any equipment. The schedule shall show catalogue details and demonstrate compliance with the specification.
Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

Provide all details of suspension and support for ceiling hung equipment. Where walls, floors, slabs or supplementary steel work are used for seismic restraints locations, details of acceptable attachment methods for piping and equipment must be included and approved before the condition is acceptable for installation. Restraints manufacturer's submittals must include spacing, static loads and seismic loads at all attachment and support points.

Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

C. Valves

NFPA 13. Provide valves of types approved for fire services. Gate valves shall open on counter clockwise rotation. Provide a rising stem valve beneath each alarm valve in each riser when more than one valve is supplied from the same water supply pipe. Check valves shall be flanged clear opening swing check type with flanged inspection and access cover plate for sizes 100mm and larger.

- Floor Control Valve. Victaulic Series 705W Grooved End Fire Protection Butterfly Valve with Indicator Post, built in supervisory switch. Valve must be UL Listed and FM approved up to 300 psi Max Working Presusre. Body must be Ductile Iron. Disc must be EPDM encapsulated. Dual Seal type. Valve must be for Dead End Service Bubble Seal shutoff. Grooved End connection for Victaulic Coupling or Victaulic Mechanical Tee with Grooved Outlet (65 mm or bigger).

- Check Valve. Victaulic Firelock Grove Check Valve style 717 Swing type Rated at 250 psi Max Working Pressure UL Listed FM Approved.

- Alarm Check Valve. Victaulic Wet Type Alarm Check Valve style 751 Grooved End connection and approved equal. Ductile Iron Body. Rated at 300 psi. Valve must have Access to internal parts like the clapper and clapper seal, without removing the valve body from piping system. Must be UL listed FM Approved.

D. Identification Signs
NFPA 13. Attached properly lettered and approved metal signs to each valve and alarm device. Permanently affix design data nameplates to the riser of each system.

E. Inspector's Test Connection
Provide test connections approximately 1800mm above the floor for each sprinkler system or portion of each sprinkler system equipped with an alarm device; locate at the hydraulically most remote part of each system. Provide test connection piping to a location where the

discharge will be readily visible and where water may be discharged without property damage.

- Inspector Test Loop Connections. Single body Victaulic Alarm Test Module Style 720 Testmaster II and approved equal. Angled Threaded connection with test/drain valve, sight glass orifice. UL Listed and FM Approved. Rated at 300 psi Max Working pressure.

F. Main Drains
Provide drain piping to discharge at safe points outside each building or to sight cones attached to drains of adequate size to readily receive the full flow from each drain under maximum pressure. Provide auxiliary drains as required by NFPA 13.

G. Pipe Sleeves
Provide where piping passes through walls, floors, roofs and partitions. Grout sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of wall, floors, roofs and partitions. Provide clearance between exterior of piping and interior of sleeve in accordance with NFPA 13. Firmly pack space with non-combustible insulation. Caulk both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a segmented elastomeric seal.

1. Sleeves in Masonry and Concrete Walls, Floors and Roofs
Provide ASTM A 53 or ASTM A 120, hot dip galvanised steel pipe sleeves. Extend sleeves 80mm above the finishes floor.

2. Sleeves in Partitions and Other Than Masonry and Concrete Walls, Floors and Roofs
Provide hot dip galvanised steel sheet having a nominal weight of not less than 0.90psf.
Escutcheon Plates
Provide one piece or split hinge type metal plates for piping passing through floors, walls and ceilings in exposed spaces. Provide polished stainless steel plates or chromium plated finish on copper alloy plates in finished spaces.

Provide paint finish on plates in unfinished spaced. Secure plates in proper position.

H. Alarms

1. Water Motor Alarm
Provide alarms of the approved weatherproof and guarded type, to sound locally on the flow of water in each corresponding sprinkler system. Mount alarms on the outside walls of each building, at a location as indicated.

2. Local Alarm
Provide electric alarm bell to sound locally on operation of any detection system, regardless of water flow. The current for these alarms may be taken from the normal building service provided the connection is made ahead of the other services.

3. Fire Alarm

Provide equipment for automatic transmittal of an alarm over the building fire alarm system and arrange to actuate by detection system and by the flow of water in each sprinkler system. Provide Class A supervision of detection and actuation circuits.

4. Trouble Alarm
   Provide local 100mm electric alarm horn to indicate trouble or failure of the detection system or pre-action sprinkler system.

I. Fire Pump Flowmeter

Victaulic Grooved End Venturi Flowmeter UL Listed FM Approved/equal.

3.19 INSTALLATION

Equipment, materials, installation, workmanship, examination, inspection and testing shall be in accordance with NFPA 13, except as modified herein. Install piping straight and true to bear evenly on hangers and supports. Keep the interiors and ends of new piping and existing piping affected by Contractor's operations thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs of other approved methods. When works is in progress, securely close open ends of piping to prevent entry of water and foreign matter. Inspect piping before placing into position.

3.20 FIELD PAINTING

Clean, pre-test, prime and paint new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metal work and accessories. Apply coatings to clean dry surfaces using clean brushes. Clean the surfaces to remove duct, dirt, rust and loose mill scale. Immediately after cleaning, provide the metal primer. Shield sprinkler heads with protective covering while panting is in process. Remove sprinkler heads which have been painted and replaced with new sprinkler heads. Provide primed surfaces with the following.

A. System in Unfinished Areas
   Unfinished areas are defined as attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases and spaces where wall or ceilings are not painted of not constructed of a pre-finished material. Provide surface with one coat of red enamel.

B. Systems in Other Areas
   Provide primed surfaces with two (2) coats of paint to match adjacent surfaces, except provide valves and operating accessories with one coat or red enamel.

3.21 FIELD TESTING AND FLUSHING

Contractor shall hire independent testing and balancing contractor to do the testings.

A. Preliminary Tests
   Hydrostatically test each system at 200 psig for a 2 hour period with no leakage or reduction in gauge pressure. Flush piping with potable water in accordance with NFPA 13. Piping above suspended ceilings shall be inspected, tested and approved before installation of ceilings. Test the alarms and other devices. Test the water flow alarms by flowing water through the inspector's test connection. When tests are completed and corrections made,

submit a signed and dated certificate similar to that specified in NFPA 13, with a request for formal inspection and test.

B. Formal Inspection and Test
The Engineer will witness formal tests and approve all system before acceptance. Submit the request for formal inspection at least 15 days prior to inspection date. An experience technician regularly employed by the system installer shall be present during the inspection. During the inspection, repeat any or all of the required tests as directed. Test each detection device and its connection to each valve by the application of heat. Correct defects in work provided by the Contractor, and make additional tests until the system comply with all contract requirements. Furnish appliances, equipment, water, electricity, instruments, connecting devices and personnel for the test.

3.22 INTERFACE WITH FIRE CONTROL PANEL

The electrical wiring circuit installation for transmitting all required fire and fault alarm signals from sprinkler control panel will be executed by the contractor. The contractor is also required to terminate and plug the wiring onto the relay outputs of the mashalling box located adjacent to the fire Control Panel for alarm register.

3.23 OCCUPATIONAL HEALTH AND SAFETY

A system shall be guaranteed to comply with all relevant Occupational Health and Safety Regulations, Standards and Codes, including the following:

All relevant Occupational Health and Safety Standards, Acts, Codes of Practice and Statutory Requirements.

3.25 SYSTEM GUARANTEES

The Contractor shall guarantee that all the systems and equipment installed will perform to the specified requirements and to the minimum requirements as required by the relevant Philippine and NFPA Standards as applicable to each phase of the work.

3.26 EQUIPMENT WARRANTY AND DEFECTS LIABILITY

All equipment and work shall be warranted against defective workmanship and materials for a period of twelve (12) months from the date of Practical Completion.

The Contractor shall allow in his Tender for extending the Warranty of any equipment to the above Warranty Period should be manufacturer provider a lesser Warranty Period.

Any equipment replaced during the Defects Liability Period shall be warranted for twelve (12) months from the date of its replacement.

Defects Liability Period shall commence from date of Practical Completion.

3.27 MANUFACTURERS REQUIREMENTS

The Contractor shall guarantee that all equipment is installed and commissioned in accordance with the recommendations of the manufacturers of each equipment. All equipment and devices used shall be listed and approved by Underwriters Laboratories Inc, (UL) or Factory Mutual (FM) or any other recognised testing laboratory.

3.28 CERTIFICATION

The Contractor shall certify that all installed system comply with this Section of the Specification, and applicable Philippine Standards and NFPA Codes and Regulations including the National Building Code of the Philippine sand subsequent amendments to regulations and codes.

Contractor shall engage Professional Mechanical and Electrical Engineers prior to Practical Completion to certify and report on all fire services protection and detection installation.

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

SANITARY WORKS SERIES 5000

TECHNICAL SPECIFICATIONS FOR SANITARY WORKS

SERIES 5000

SERIES 5000 – SANITARY WORKS

Sanitary and Plumbing System

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SANITARY AND PLUMBING SYSTEM

1.0 GENERAL

1.1 Scope

This work shall consist of the supply, installation, testing and commissioning of the complete Sanitary and Plumbing System for the Expansion of Passenger Terminal Building of Davao International Airport Development Project. Any item of work that is not specifically indicated but is necessary for the safe and efficient operation of the system, shall be deemed to be included.

(1) The complete plumbing system includes, but shall not be limited to, the following equipment and ancillaries:

(a) Cold water supply system complete with pumps, piping, motor control panel and all necessary accessories.

(b) Soil, waste and vent piping systems complete with floor drain, clean out, sewer pit, drain pumps and all accessories.

(c) Stormwater drainage system complete with piping system, drainage pit and all accessories.

(d) Plumbing fixtures and trim with all accessories.

(e) Stub-outs for concessionaires including isolating valve and blank-off.

(f) Cleaning-up, painting and labeling of all equipment, pipe work and accessories installed.

(g) Testing and commissioning of all equipment and services.

(h) Interfacing of plumbing system with the Building Management System (BMS).

(i) Submission of shop drawings, as-built drawings, test results, spare parts and tools for maintenance, operating instruction and maintenance manuals of all equipment and services installed.

1.2 Interface Work

(1) Interface work with the Building Management System (BMS) shall be as follows:

a. The Contractor shall provide all BMS interface points for the BMS to monitor the following but not limited to:

- On/off status monitoring of all pumps
- Alarm/trip monitoring of all pumps
- High water level alarm for drain pumps

b. The Contractor shall provide dry contacts, transducers and other interface equipment necessary to interface with the BMS.

c. Discrete/digital input and output such as contact status/maintained, momentarily etc. as well as voltage and current signal requirements shall be coordinated with the BMS to ensure proper operation.

(2) Interface work with the civil works shall be as follows:

Soil, waste water and storm water drainage piping shall be interfaced at the terminal manholes with the civil works as shown on the Drawings. The Contractor shall coordinate all interface requirements between plumbing and civil works.

(3) Interface work with the water supply works shall be as follows:

The construction and provision of the water receiving tanks, the fire water storage tank for Fire Station and the water service pump unit is included in the scope of work. The Contractor shall coordinate all interface requirements between plumbing and water supply works.

2.0 TECHNICAL SPECIFICATIONS

2.1 Pipes, Valves and Fittings

Piping materials for the various systems shall be as follows:

System	Pipe Material	Pipe Size
Cold Water	PPR	All
Soil/Waste	PVC (VP)	All above ground
Kitchen	PVC (VP)	All above ground
Water Drain	PVC (VP)	All above ground
Storm water	PVC (VU)/SGP/SUS	Refer to Drawings
Sanitary Vent	PVC (VU)	All

(1) Pipes

- Pipes and fittings shall be PP Random Copolimer (PP-R) conforming to the requirements of ASTM F 2389, DIN 8077, DIN 8078 ,EN ISO 15874 standards.

- Pipes shall be unplasticized polyvinyl chloride pipe conforming to JIS K 6741 (VU). Fittings shall be in accordance with JIS K 6739;

(2) Valves and Fittings

Gate Valves

Products requirements

(1) Reused or reconditioned or rebuilt valves shall not be permitted.

(2) Valves shall be of first quality of standard series of lines of products from manufacturers regularly providing items of types required.

(3) All valves of like kind, type and size shall be products of a single manufacturer throughout for work under this Section with like units and like parts and readily interchangeable. This Specification, the Drawings and Bills of Quantities shall be referred for the applicability of each type of valves.

(4) Type of connections shall be as follows:

(a) Valves 50mm diameter or smaller – screw ends; and

(b) Valves 65mm diameter and larger – flanged ends;

(5) Gate valves shall be as follows:

(a) Type
Inside screw (bronze valve) or inside screw and yoke. Outside screw and yoke for fire protection.

(b) Materials
50mm Diameter and smaller: bronze body and trim.
65mm Diameter and larger: cast-iron body and bronze trim.

(c) Pressure rating
5 kg/cm² or 75 psi
10 kg/cm² or 150 psi.
10 kg/cm² or 150 psi, UL and/or FM rated for fire protection.

(d) Applicable standard
Screwed ends to meet JIS B 2011.
Flanged ends to meet JIS B 2031.

(6) Globe valves shall be as follows:

(a) Type
Outside screw or outside screw and yoke.

(b) Materials
50mm Diameter and smaller: bronze body and trim.
65mm Diameter and larger: cast-iron body and bronze trim.

(c) Pressure rating
5 kg/cm² or 75 psi
10 kg/cm² or 150 psi

(d) Applicable standard
Screwed ends to meet JIS B 2011.
Flanged ends to meet JIS B 2031.

(7) Angle valves shall be as follows:

(a) Type
Outside screw.

(b) Materials
50mm Diameter and smaller: bronze body and trim.
65mm Diameter and larger: cast-iron body and bronze trim.

(8) Swing check valves shall be as follows:

(a) Type
Solid seat or renewable seat top covered. Rubber seated for fire protection.

(b) Materials
50mm Diameter and smaller: bronze body and trim.
65mm Diameter and larger: cast-iron body and bronze trim.

(c) Pressure Rating
10 kg/cm² or 150 psi.
10 kg/cm² or 150 psi, UL and/or FM rated for fire protection.

(d) Applicable Standard
Screwed ends to meet JIS B 2011.
Flanged ends to meet JIS B 2031.

(9) Hammerless check valves with spring shall be as follows:

(a) Type
Inside screw bronze valve or inside screw and yoke.

(b) Materials
50mm Diameter and smaller: bronze body and trim.
65mm Diameter and larger: cast-iron body and bronze trim.

(c) Pressure rating
5 kg/cm² or 75 psi.
10 kg/cm² or 150 psi.

(d) Applicable standard
Screwed ends: JIS B 2011.
Flanged ends: Per manufacturer's standard.

(10) Strainers shall be as follows:

(a) 50mm and smaller
Screw type, cast-iron or bronze, Y-shape.

(b) Larger than 50mm
Flange type, cast-iron or stainless steel, Y-shape or bucket type. All moving parts brass or bronze and remainder of unit corrosion resistant material or coated for protection as approved.

(c) Strainer plugs
Brass and bolted cast-iron cover for bucket type.

(d) Strainer screen
Stainless steel mesh or brass mesh.

(e) Strainer to be connected to vinyl lined galvanized steel pipe
To be lined by nylon 11 or 12.

(11) Butterfly valves shall meet the requirements to JIS B2064

(12) Ball valves shall be long neck type when to be used for insulating pipe, as per manufacturer's standard.

(13) Cock valves shall be the requirements of JIS B 2191

(14) Ball taps (to be supplied and installed not as a part of sanitary fixtures, etc.) shall be as follows:

(a) Bronze with ball of brazed copper.

(b) Anti-water hammer type.

(c) Fitting : 50mm diameter or less: threaded
65mm diameter more: flanged

(d) Tap : 20mm diameter or less : single/simplex
25mm diameter or more : multiple/duplex

(e) Connected to level regulating valve.

(15) Constant flow regulating valves shall be used for all fan coil units (FCU) as follows:

(a) Materials
The material of body shall be bronze cast iron (BC6).
The material of waist shall be C3604BD (BsBMD2).
The material of diaphragm shall be NBR heat-resistance synthetic rubber.

(b) Joints
Joint shall be threaded type.

(c) Pressure rating
The pressure of inlet shall be 10 kg/cm2 (0.98Mpa) G max.

(d) Applicable Standard
To meet JIS B 2011

(e) Accessories
6A PT ×half elbow two (2)
Air vent

(ii) Pressure Rating : 10kg/cm² or 150psi

(b) Check Valves

(i) Type
- 50 mm diameter and smaller : Swing check valve
- 65 mm diameter and larger : Hammerless check valve

(ii) Materials
- 50 mm diameter and smaller : Bronze body and trim
- 65 mm diameter and larger : Cast-iron body and bronze trim

(iii) Joint
- 50 mm diameter and smaller : Threaded ends
- 65 mm diameter and larger : Flanged ends

(iv) Pressure Rating : 10kg/cm² or 150psi

(v) Applicable Standard
- Threaded ends : JIS B2011 or approved equal
- Flanged ends : JIS B2031 or approved equal

(c) Automatic Air Vent Valves

Type	:	Float operated
Material	:	Cast bronze body
Joint	:	Threaded ends, 20mm in nominal size

Each vent shall be equipped with one (1) 20mm gate valve.

Each vent shall be equipped with one (1) 20mm gate valve.

Water Meters

Water meter shall be cast bronze body, double jet, vane wheel type direct reading water flow accumulator with dry type indicating elements and union coupled ends.

Pressure and Compound Gauges

Scope

This Section includes the following items:

(a) Water meters;
(b) Pressure and compound gauges;
(c) Thermometers;
(d) Water level sensor (electrode); and
(e) Related work.

Product requirements

(1) Meters and gauges shall be of first quality of standard series or lines or products from manufacturers regularly providing items of types required.

(2) Water meters shall be of the following types:

(a) For 13mm diameter wheel – single jet, wet dial, flat type; and

(b) For 20mm diameter to 40mm diameter wheel – double jet, wet dial, flat type and with inverse type current water volume dial indicators.

(3) Pressure and compound gauges shall be as follows:

(a) Outside diameter shall be 100mm and equipped with a cock.

(b) Scale shall indicate working pressure of system, highest scale shall indicate 150% to 300% of working pressure.

(c) Vacuum scale of compound gauge shall be 760mm hg (0.1M Pa).

(d) Applicable standards shall be JIS B 7505 or equivalent.

(4) Thermometers shall be glass made immersion type, L shape, with brass or bronze protection for sensing bulb, direct reading –10 to 50 degree Celsius range, conforming to JIS B 7411 or equal as approved by the Engineer.

(5) Electrodes shall be rod steel of stainless steel (SUS 304), and shall consist of hanger/support/holder/spaces of synthetic resins, and shall be protected by PVC pipes when to be used in sewage tank.

Execution

(1) Meters and gauges and related accessories shall be installed as per manufacturer's instructions and approved shop drawings.

(2) Thermometer shall be installed at location clearly legible at eye level.

(3) Pressure gauges shall be installed as required at pump suction and discharge line.

Gasket

Rubber : Durable and suitable for pressure, temperature and water characteristics of works as required.

Liquid : Synthetic rubber compound specifically formulated for service intended.

Sealing Tape

For threaded connections; Teflon tape suitable for temperatures ranging from -50ºC to +180ºC.

Flexible Joints

General : Synthetic rubber combined with reinforcement; inside diameter same as pipe conforming to specified requirements.

Rubber

- Tensile Strength : Not less than 10 kg/cm²
- Elongation : Not less than 104 percent
- Reinforcing : Cotton fabric for rubber hose conforming to JIS L2512 or equivalent

Stainless Steel

- Tensile Strength : Not less than 14 kg/cm²
- Elongation : Plus 2 to minus 3 percent
- Reinforcing : Stainless steel blade for stainless steel below conforming to JIS G4305 or equivalent

Flanged Ends : JIS B2210 or approved equal

2.2 Pumps

Elevator Pit Sump Pump
25 GPM, 40 FT, 1HP, 230V, 1P, 60Hz

Escalator Pump
25GPM, 40 FT, 1HP, 230V, 1P, 60Hz

Hydro-Pneumatic Tanks (1.20 m Dia. X 3.00m Length)
including Pumps, Valves and other
Accessories for Potable and Non-Potable Water

Drain pump unit for Underground Service Link shall be as follows:

(a) Submersible pumping set comprising of 2 Nos. pumps with automatic alternative operation. In case of emergency, both pumps shall operate.

(b) Pump capacity – 100L/min x 15m head x 0.25kW.

(c) The pumping set shall contain the following accessories and any additional items as indicated on the Drawings:-

High level and low level floats and associated wiring arrangements.
Fully equipped control panel with switches, duty lamps and pressure gauge.
Dry running protection.

2.3 Plumbing and Sanitary Fixtures

(1) Supply and installation of all sanitary fixtures, faucets and fittings in the toilet areas shall be inclusive of the connections to the water supply and sewerage piping system.

(2) All plumbing fixtures shall be provided with complete fittings and trims recommended by the plumbing fixture manufacturer.

(3) All fittings, metal trims, escutcheons, traps, exposed piping, etc. shall be chromium plated brass or bronze with polished bright surface.

(4) Respective units of equipment as shown or specified shall be the manufacturer's first quality line of standard and/or custom series of factory fabricated items.

(5) Where two or more units of the same class, types or kind are required, the units shall be products of a single manufacturer. However, various component parts of a system need not be products of the same manufacturer.

(6) Comparable assemblies of manufacturers other than the one specified may be proposed if they differ in minor details only and otherwise comply with the requirements shown or specified, subject to prior approval by the Engineer.

(7) Table 5100 shows a list of sanitary fixtures and fittings to be installed. The model number to be used shall be submitted by the Contractor for approval of the Engineer.

Table 5100 Sanitary Fixtures

Description
(T1) SENSOR FLUSH TYPE - WATER CLOSET complete with necessary accessories/miscellaneous items.
(T2) UNDER COUNTER TYPE LAVATORY WITH SENSOR TYPE FAUCET complete with necessary accessories/miscellaneous items.
(T3) SENSOR TYPE - URINAL complete with necessary accessories/miscellaneous items.
(T4) WALL MOUNTED TYPE LAVATORY complete with necessary accessories/miscellaneous items.
(T16) FLUSH TYPE - WATER CLOSET complete with necessary accessories/miscellaneous items.
(T17) SHOWER SET complete with necessary accessories/miscellaneous items.
(T19) Wall Mounted Janitor's Sink, type and color as per Architect/ owner's approval
STAINLESS STEEL HYGENIC SPRAY complete with necessary accessories/miscellaneous items.

(s) Grease Interceptor

Grease interceptor shall be of stainless steel (SUS 304) with compartments complete with inlet, outlet and removable cover for maintenance. Capacity shall be 50 liters/min.

(t) Floor Drain

Floor drains shall be cast iron body with integral trap and threaded end. Strainer shall be cast bronze chromium plated.

(u) Shower Drain

Shower drains shall be cast iron body with integral trap and threaded end. Strainer shall be cast bronze chromium plated.

(v) Floor Cleanout

Floor cleanout shall be bronze or brass body with counter sunk tap on screwed plug, chromium plated.

(w) Underfloor or Surface Cleanout

Cleanout shall be cast iron ferrule and cast bronze or brass threaded plug with square head assembly.

(x) Valve Box

2.4 Sewer, Storm and Trap Pits

(1) Pits shall have a variable chamber size and depth as indicated on the Drawings. Chamber shall be constructed of reinforced concrete with ductile cast-iron cover.

(2) Casting shall meet the following requirements:

(a) Covers at road and carpark : JIS G5502 FCD500-7 (spheroidal graphic iron casting), Safety load 5,000 kgf.

(b) Other covers : JIS G5501 FC200 (Gray iron casting), Safety load 500 kgf.

(c) Frame : JIS G5501 FC200

(3) Cast iron cover for sewage manholes shall be air tight type.

(4) Each cover shall have molded letterings identifying usage of manholes such as drainage, sewer, electrical, etc.

(5) All covers shall be set at higher elevation at 5mm than surrounding concrete or finishing on which three (3) to four (4) percent slope shall be provided.

3.0 INSTALLATION

3.1 General

Component and accessories of plumbing fixtures shall be installed per manufacturer's instruction and shop drawings as approved.

3.2 Wall Mounted Fixtures

(1) Wall hung fixture shall be provided with back or wall hanger.

(2) Other mounting methods may be applied if approved by the Engineer.

3.3 Floor Mounted Fixtures

Floor mounted fixtures shall be set and secure using anchor bolts and nuts.

3.4 Installation of Fixtures

(1) Rough-ins for carriers, drains and supplies shall be laid out, spaced and aligned for final fixture locations required.

(2) Compression stops shall be required for each supply as specified.

(3) All pipes passing through walls, floors and ceilings in all interior spaces shall be provided with escutcheons.

(4) Traps and vents shall be provided for each fixture whether or not shown.

(5) Rimmed edges shall be set full contact all around with watertight sealant or compound.

(6) Sealed edges where shown or specified shall be set with space for sealant.

(7) Fixtures height unless otherwise shown shall be adjacent to, and accurately aligned with, other fixtures.

(8) Each fixture shall be set square, plumb and level and rigidly secured to support free from movement.

3.5 Sealant Work

(1) Sealant work shall be clear or white, one component, pre-packaged silicone type as approved.

(2) Preparation of surfaces, installation and securing of sealants shall be per manufacturer's instructions.

(3) Sealant joint width shall not be less than 3mm and not more than 6mm.

(4) Sealant depth shall not be less than 6mm.

(5) Finished surfaces shall be smooth and free from pits, strings or other irregularities.

(6) Sealant joints shall be watertight throughout.

4.0 TESTING AND INSPECTION

FIELD TEST AND INSPECTION

General

(1) This provisions are applicable and are to be referred in connection with Series 5000 of this Specification.

(2) Materials, equipment, and the completed installation will be inspected by the Engineer.

(3) All equipment, materials, or work rejected because of defects or nonconformance with the Drawings and the Specification shall be replaced or corrected by the Contractor as directed at no additional cost.

Scope of Testing

(1) Upon completion and prior to acceptance of the installations, the Contractor shall subject the units to operating tests to demonstrate satisfactory functional and operational efficiency.

(2) The Contractor shall furnish all materials, instruments, equipment and test personnel required for tests.

Test Requirements

(1) Each mechanical system shall prove satisfactory and acceptable in accordance with requirements throughout and under the Contract Documents.

(2) In addition to requirements herein, tests shall be concluded as work progresses as required elsewhere under this Specification.

(3) Testing required herein shall be performed in the presence of the Engineer, and schedules duly arranged for in advance in accord with notification requirements.

(4) Sufficiently qualified personnel, time, materials and fuel shall be allotted and provided by the Contractor as necessary to provide and conduct all required tests.

(5) Upon completion of electrical equipment (panel board, motor, control equipment, etc.) the Contractor shall not operate any equipment without the express approval of the Engineer.

Test Programs

(1) Quality and commissioning test shall be carried out and conducted per programs as prepared and issued by the Contractor and approved by the Engineer.

(2) Test programs shall also include such forms as deem necessary by the Engineer, which the Contractor shall utilize and execute accordingly and as applicable to the various kinds of work to be tested.

(3) Tests required shall be completed on schedule for activation of mechanical systems as required in accordance with this Section.

Tests Reports and Records

(1) Forms to be issued by the Engineer shall be devised by the Contractor with appropriate information and data to be recorded.

(2) Within 14 days after completion of testing, one (1) copy of test records and results shall be furnished to the Engineer for review.

(3) Exact indication of site, date, hour, types of instruments used and precision of such instruments shall be recorded; in addition necessary notes shall be registered regarding operations plus observed deficiency. This report shall be signed by the Contractor's representative and by the Engineer and shall serve as a basis for final documentation required under the Contract.

Repetition of Test

(1) If any portion of the system or any piece of equipment fails to pass the tests, the Contractor shall make the necessary repairs or adjustments and the test shall be repeated until satisfactory performance is achieved at the Contractor's expense.

(2) In cases where it may be necessary to perform a partial test and flaws are discovered at a later date such will be corrected by the Contractor at his expense.

Quality Test

(1) Quality testing shall include and consist of all such examinations, measurements and inspections via visual, mechanical, instrumental or other means as is necessary to demonstrate work does in fact meet all quality standards and performance requirements as shown or specified.

(2) At least two (2) pressure gauges shall be used with a total range of the scale not exceeding 130% of the test pressure. Precision shall not be less than 5%.

(3) All piping shall be tested at completion of roughing in before permitting work to be covered or concealed per following schedule. Piping shall show no loss in pressure or visible leaks after a minimum duration of 4 hours at test pressures indicated.

(4) Testing methods shall be as shown below:

System tested	Test pressure	Test using
Soil, waste, drain, vent piping, and storm water headers	Fill with water to top of highest part allow to stand 2 hours; or longer when directed by the Engineer	Water
Water piping: cold water supply and chilled water piping	10 kg/cm² or 150 psi, 2 hours or longer	Water

Demonstration Tests

(1) Demonstration testing shall include and consist of operating systems under various and varying conditions as are necessary to demonstrate work does in fact operate and function as intended under the Contract Documents.

(2) Techniques or methods for quality testing shall be employed as necessary for certain demonstrations.

(3) Demonstration tests shall be distinctly separate from other tests required as specified under the Mechanical Work.

(4) When deemed by the Engineer as practical, feasible and not disruptive to the Contractor's efforts, the Employer's operating personnel shall be permitted to attend such tests or demonstrations as will be helpful to their understanding of work for which they will eventually be responsible.

(5) Operational and functional demonstration tests shall be carried out for all systems required under this Section.

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5.0 DISINFECTION/STERILIZATION OF PIPELINES

5.1 General

(1) Upon completion of the testing as above, the cold water supply pipeline shall be flushed and disinfected to the satisfaction of the Engineer prior to commissioning of the system for general usage.

(2) The costs incurred in disinfection, testing of the water, etc. shall be included in the Contractor's pipe laying rates.

5.2 Disinfection/Sterilization Method

(1) Shall be executed via a pump which shall be connected to valve and service line to water system specifically provided for this purpose.

(2) Service line shall not be less than 25mm diameter and connected to system not more than 50mm from point of system connection to main water supply service.

(3) The pump and service line shall be installed prior to system pressure and leakage tests.

(4) The pump shall be hand operated type rated not less than 7kg/cm², suitable for injecting work required.

5.3 Sterilization Agent

(1) Type: Commercial hydrogen chloride.

(2) Available chlorine content: Not less than 5.25 percent.

(3) The following preparation works needs to be completed before the disinfection/sterilization process commences:

(a) Equipment and fixtures shall be installed and connected, throughout.
(b) Pressure and leakage tests shall be performed and system proven acceptable.
(c) Systems shall be thoroughly flushed, by opening valves until water flow appears clear at each valve.
(d) Systems shall be completely filled with water.
(e) During disinfection, each outlet shall be posted with suitable sign forbidding use of water.

5.4 Sterilization Procedure

(1) Supply valve shall be opened; faucets and bibs shall be opened for uniform trickle flow from each location.

(2) The agent shall be injected slowly and continuously at even and constant rate until orthotolidine test at each and every outlet indicates chlorine residual concentration is not less than 50 parts per million (ppm).

(3) Injecting agent in large doses or surges will not be permitted.

(4) When the above process is completed, the supply valve and all outlets shall be closed and kept closed for a minimum of 24 hours.

(5) Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 10 ppm, of chlorine at the extreme end of the system by the end of the retention period.

(6) The system will not be approved until satisfactory bacteriological results have been obtained.

5.5 Completion

(1) The system shall be flushed with clean water until the residual chlorine is reduced to less than 0.1 ppm.

(2) After completion of disinfection all valves shall be closed tightly.

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

ELECTRICAL WORKS SERIES 6000

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

SERIES 6000

SERIES 6000 – ELECTRICAL WORKS

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GENERAL REQUIREMENTS OF ELECTRICAL WORK

1.0 GENERAL REQUIREMENTS

1.1 The provisions are applicable to some items of Plant and systems and are to be referred to in connection with 6000 Series of the Specification.

1.2 The following provisions are additional to, and are to be read in conjunction with, Series 6000 of the Specification, Drawings and Bill of Quantities

2.0 SCOPE

2.1 This Section shall apply generally to the following Sections:

a. Power Feeder System
b. Lighting and Receptacle System
c. Power Supply
d. Lightning Protection and Grounding System

2.3 The Contractor shall also be responsible for:

(a) Application of electric power and telephone connections, including preparation of all necessary drawings, forms and related documents, payment of all required fees and charges, and coordination with other authorities or persons involved in the procedures. Such coordination and application submittals shall be executed in sufficient time to ensure permanent electric supply will be available to meet the requirements of the Contract.

(b) All permits and fees required for inspection and certification of the Electrical Systems by the proper Government after completion of the work. The Contractor shall prepare all drawings, forms and related documents required by the approving authorities.

3.0 QUALIFICATIONS

3.1 Manufacturers of Electrical Equipment and/or Systems

(1) Shall have been regularly producing equipment or systems of types required for not less than ten (10) years prior to closing date of the Bid.

(2) Shall take full responsibility for all requirements of electrical equipment or systems where specified under respective Sections of the Specification.

(3) Shall be capable of providing immediate emergency service within three (3) official working days after notification by the Employer.

(4) Shall be capable of entering into full service maintenance agreement with the Employer.

(5) Shall be capable of providing well trained and experienced workmen in types of work required, and in direct employment of electrical equipment manufacturer.

3.2 Electrical Subcontractor

(1) Company shall regularly provide types of work required for not less than (10) years prior to closing date of Bid.

(2) Shall take full responsibility for all requirements under the Electrical Work, except as or otherwise specified above and including all necessary coordination of and with manufacturers of electrical equipment and systems.

(3) Shall be capable of providing well trained and experienced workmen in work of types required.

4.0 SUBMITTALS REQUIREMENTS

4.1 General

(1) Submissions are required as specified herein.

(2) Materials and equipment shall not be ordered or fabricated until respective submissions have been approved.

4.2 Material Lists

(1) Shall comprise listing of equipment proposed under Electrical Work, each item identified by reference to item number, schedule and detail as shown on the Drawings or included in this Specification or in the Bills of Quantities.

(2) Each item or system should be accompanied by manufacturer's complete specifications, technical data and installation instructions.

(3) Each specification or technical data sheet shall be annotated as to specific item described, required or proposed. General or multiple-item sheets not so identified shall be rejected.

(4) Equipment identification schedule shall also be provided.

4.3 Shop Drawings

Shall be submitted for review and evaluation of the Engineer.

4.4 Material/Color Samples

Shall be provided for primary materials, finishes or other components as and when requested by the Engineer.

4.5 Certification of Materials

Required from equipment or system manufacturers or from independent testing agencies employed by them indicating compliance with requirements of Specification herein for various items of equipment and system.

4.6 Certification of Installation

(1) Required for all Electrical Work.

(2) Prepared by the Contractor, or by independent testing agencies regularly providing test and inspection work of types required and as retained by the Contractor.

(3) Reports shall be provided inclusive of information and/or data as specified under the electrical testing requirements.

(4) All permits and fees required for Electrical Work shall be obtained by and at the expense of the Contractor. The Contractor shall furnish the Engineer with final certificates of electrical inspection and approval from the proper Government authorities after completion of the work. The Contractor shall prepare all drawings and all forms and documents required by the approving authorities.

4.7 Operation and Maintenance Manuals

Shall be provided by the Contractor

4.8 Training of Employer's Personnel

(1) Local on Site training for operation and maintenance of some of the Electric Systems will be conducted by the Contractor covering the minimum required schedule shown below.

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

5.0 RELATED REQUIREMENTS

5.1 Approvals

(1) Notify the Engineer not less than ten (10) working days in advance for each item of work being prepared for testing or inspection.

(2) Rough-in work shall be inspected and approved by the Engineer prior to being covered, concealed or otherwise made inaccessible.

5.2 Precautions

(1) When using any toxic, noxious or otherwise hazardous material, the Contractor shall follow and comply with precautions of manufacturer.

(2) Safety precautions regarding materials and installations shall be followed at all times to avoid damage or injury caused by fire or accident.

5.3 Protection

(1) The work herein described shall be protected during construction and after completion.

(2) Adjacent construction finishes shall be protected. Should adjacent exposed surfaces become stained or otherwise damaged resulting from the use of materials or operations under this Section they shall be repaired at the Contractor's expense and as directed by the Engineer.

6.0 COORDINATION/CORRELATION REQUIREMENTS

6.1 General

(1) Utility rough-ins, including required tests and other work to be covered up or concealed shall be completed and approved before such is enclosed or otherwise made inaccessible.

(2) Power systems to be provided under any separate contracts shall be tested and approved prior to actual energizing of such power into electrical systems work required under this Section.

(3) Systems under this Section shall be completed, tested and approved to extent necessary to ensure safety prior to utilization of said power sources.

(4) The Contractor shall provide completely coordinated shop, coordination and working drawings for evaluation and approval of the Engineer.

6.2 In Advance of Work under this Section

All work under this Section shall be coordinated with layouts and other requirements for associated work under other Sections and adjustments shall be incorporated as and where necessary for properly coordinated installation.

6.3 In Advance of Work under other Sections

(1) Specific and proper construction or substrate conditions necessary to effect securely anchored or attached work under other Sections shall be ensured by the Contractor.

(2) Layouts, templates and/or instructions shall be provided as necessary for proper preparation of supporting construction.

6.4 Embedded or Concealed Items

All necessary sleeves, inserts, bolts, backing plates or other incidentals embedded in concrete or masonry or attached to and concealed by work under other Sections shall be provided. They shall be supplied complete with layout plans, templates and/or instructions as required.

7.0 CONTRACT DRAWINGS

7.1 Contract Drawings shall be examined as necessary to achieve fully coordinated and proper installations as intended herein.

7.2 Electrical systems layouts indicated on the Drawings are generally diagrammatic and location of openings, outlets and equipment are approximate only. Therefore the exact routings and locations including layouts and positions of conduits, outlets, equipment and other items to be coordinated with architectural and structural elements shall be determined and the necessities of work of other Sections identified.

7.3 The capacity of MCCBs or sizes of cables may have to be modified due to changes in power consumption of the Plant to be installed by the Contractor. Such modification shall be executed after approval from the Engineer. The cost thereof shall be deemed to be included in the Contract Price.

7.4 The Engineer shall be notified of any discrepancies or deviations discovered in the Contract Documents.

8.0 SUPERVISION OF ELECTRICAL WORK

8.1 Full-time services of experienced Professional Electrical Engineers well qualified in directing and overseeing all phases of the various works under this Section shall be furnished.

8.2 Services of manufacturer's representatives or other especially qualified persons as necessary shall be furnished to supervise electrical systems or equipment installations when regular full-time supervisors are not otherwise fully qualified.

9.0 OPERATION BEFORE FINAL ACCEPTANCE

9.1 Should the Employer require that any portion of building, Plant or equipment be operated prior to date of substantial completion, the Contractor shall consent and such operation shall be under supervision and direction of the Contractor.

9.2 These operations so required prior to substantial completion shall not be construed as nor constitute acceptance of work so operated.

10.0 CODES, STANDARDS AND REGULATIONS

Standards for materials, equipment and/or installation, shall comply with the relevant codes, Standards and regulations for electrical works.

11.0 PRODUCT REQUIREMENTS

11.1 Electrical Materials, Assemblies and Systems

(1) Unless or except as shown, specified or approved, manufacturer's first quality line of standard and/or series of factory fabricated items shall be provided as shown or specified.

(2) Comparable materials, assemblies and systems of manufacturers other than as specified may be proposed where differing in minor details only and otherwise compliant with requirements shown or specified, subject to prior approval by the Engineer.

(3) Materials and equipment shown or specified shall be essentially standard catalog products of an approved manufacturer, and variations therefrom shall be only as specified.

(4) Where two (2) or more units of same class, type or kind are required, units shall be products of a single manufacturer. However, component parts of a system need not be products of the same manufacturer.

(5) Where a device or part of a piece of equipment is referred to in singular number, such reference shall apply to as many devices or parts as are needed to complete work required.

(6) Similar mechanical and electrical parts and components should be identical throughout each system and be readily interchangeable.

(7) Electrical equipment of similar type shall be designed, fabricated and supplied by a single manufacturer for all work included in this Section.

(8) Substitution of keyed locks not complying with specified requirements shall not be permitted.

(9) Substantial increase in overall size(s) of pieces of equipment or major components shall not be permitted, unless approved in advance by the Engineer.

11.2 Fabrication/Construction Requirements

(1) All products for work under this Section shall be designed, fabricated and constructed for purposes and uses intended and in accordance with or capable of meeting standards for the electrical work as specified herein.

(2) Compliance shall be substantiated by sufficient and adequate prototype testing or otherwise evidenced by such operational reports and data as may be required by the Engineer to fully demonstrate performance characteristics, operational qualities, reliability, safety and other relevant considerations.

(3) All pull and terminal boxes, panelboards enclosures, including cabinet frames and bodies, fronts, doors and like parts, shall be cleaned, primed, finished with two (2) coats of grey enamel and baked, in accordance with approved manufacturer's standard factory processes.

(4) Unless otherwise specified, materials shall be galvanized, sherardized or otherwise protected by approved standards factory processes.

(5) Special finishes shall be provided where shown or specified.

(6) Requirements under other Sections of the electrical work shall govern material requirements to the extent applicable; .

12.0 EXECUTION REQUIREMENTS

12.1 Prerequisite Conditions

(1) Prior to work commencement the following shall be required:

(a) All provisions shall be reviewed for/from other Sections for requirements affecting this work.

(b) Details of work shall be reviewed with the Engineer, and adjustments incorporated that are deemed necessary and as directed.

(c) Building shall be adequately enclosed and/or protected for interior work.

(d) For electrical systems or other sensitive equipment or components, building shall be entirely enclosed and fully protected.

(2) The work shall not proceed until ancillary work is in proper condition per requirements specified herein and any incorrect construction conditions have been corrected and reinspected.

(3) The Contractor shall ensure all installation work is carried out under the direct active supervision of persons who have adequate technical qualifications and experience, and that sufficient number of trained personnel and adequate facilities are available to perform the installation.

(4) When required by the Engineer the Contractor shall provide competent factory representatives to supervise the installation, start-up, test and adjustment of equipment, and to orient the Employer's personnel in the proper operation and maintenance of the equipment.

12.2 Completion requirements

(1) During construction the Contractor shall:

(a) Remove waste and debris resulting from the work in this Section as work progresses and on completion.

(b) Service and adjust moving or mechanical parts for smooth, quiet and proper operating condition.

(c) Touch-up abraded or damaged prime painting or galvanizing and leave clean and ready for finishing work required.

(2) Upon completion the Contractor shall ensure the following:

(a) Exposed surfaces shall be clean and free from dust, dirt, scratches, dents, broken parts, misaligned or improperly fitted joints, stains, discoloration or other defects or damage.

(b) Installation shall be free from exposed fastenings, unnecessary cuts, holes, blank plates or advertising labels or signs other than as particularly shown, specified or approved.

(c) Exterior or below grade installations shall be watertight throughout and free from leaks or entry of water into or through interior or concealed spaces of the structure.

(d) Each item, unit, or assembly shall be tightly and rigidly secured in place, free from unnecessary movement, squeaks or rattles.

(e) Each item, unit, or assembly shall be set straight, plumb and level, accurately positioned at locations required and adjacent similar units accurately aligned.

(f) Movable or mechanical items or devices shall be serviced and adjusted to operate smoothly, quietly, easily and free from binding, superfluous or unwanted noises.

(g) Electrical devices, assemblies or systems shall be properly connected and grounded and operating in compliance with the performance requirements and tested as specified.

(3) Electrical work not in compliance shall be repaired or replaced as directed or required by the Engineer at the expense of the Contractor.

12.3 Collateral Work Requirements

Collateral work listed below (if applicable) shall be provided and included as part of the work associated with this Section:

(a) Excavation:
(b) Concrete:
(c) Structural steel:
(d) Miscellaneous metal:
(e) Sealant work:
(f) Aluminum work:
(g) Galvanizing requirements:

12.4 Detailed Coordination

(1) Work under this Section further includes coordination of and with work under other Sections, to provide and effect complete and operable systems and equipment throughout the Works as required under the Contract Documents.

(3) Coordination includes, among others, considerations of locations, sizes, capacities and performance characteristics of equipment furnished and installed under other Sections.

(4) Coordination further includes providing adjustments in the electrical work to meet needs of said equipment and cooperation with other subcontractors as may be necessary to make the determination required.

(5) Minor adjustments shall be provided as and where necessary or directed by the Engineer at no additional cost to the Employer.

(6) The Drawings shall be reviewed for necessary openings and access provisions to be provided for the electrical work. The sizes and locations shall be verified that they are adequate and proper and additional openings shall be arranged where and as may be required.

(7) Services that shall be provided under the electrical work shall be verified and adjustments incorporated where and as may be necessary to adequately and properly serve referenced Plant and equipment.

(8) Conduit, cable, wire, service line controls or other items necessary for but otherwise not provided as part of equipment shall be included in scope of work.

(9) Outlets, switches, etc. shall be located for easy and convenient access when work is complete.

(10) The electrical work systems shall be activated as and when necessary for equipment start-up, testing, adjusting and preliminary and demonstration operation. The systems shall be activated sufficiently in advance to permit completion of the above specified operations not later than scheduled preliminary test of the items of equipment.

(11) The electrical work requirements herein are defined in general terms only. The Contractor and manufacturers shall be responsible for all design and fabrication details necessary to provide work and operations as intended under and required by this Specification.

(12) Electrical service characteristics shall be as follows:

400V, 3 phase, 3 wire or 4 wire, 60Hz, AC
230V, 3 phase, 3 wire or 4 wire or single phase 2 wire, 60Hz, AC

(13) All equipment and systems shall be designed and installed free from creating any electromagnetic or other emissions which could cause interference with any communications or signal systems required in the operation of the airport whether installed under this Contract or under other contracts.

12.5 Protective Painting

(1) Protective painting is required for materials, Plant and equipment not otherwise galvanized, prefinished, protected or included for field painting under this Section, and includes all locations, whether exposed or concealed in completed work.

(2) Surfaces to be painted shall be cleaned free from dirt, dust, rust, grease or foreign matter. They shall be thoroughly wiped clean, using suitable solvent where necessary and dried.

(3) Surfaces shall be primed and undercoated with rust inhibitive metal primer.

(4) Finish painting shall be high gloss enameled or stove enameled as appropriate.

(5) For concealed secondary or support surfaces only black asphaltum type paint shall be applied.

(6) Painting for the following shall be two (2) coats, unless otherwise specified:

(a) Galvanized steel and items inaccessible after installation;

(b) Galvanized pipe including valves and other accessories within seven (7) days following installation; and

(c) Hanger rods and devices and other items not galvanized.

12.6 Cutting and Patching

All necessary holes, accesses and supports shall be provided wherever necessary and where prior arrangements therefore have not been otherwise provided, including any and all cutting, removals, sleeves, frames, escutcheons or other accessories, required replacements, repair, patching, cleaning, refinishing and other work as may be required and make good. All work to be approved by the Engineer.

13.0 HANGERS, ANCHORS, ETC.

13.1 General

(1) Types of hangers, anchors, fixing etc. shall be appropriate for materials and conditions encountered and only as shown, specified or approved. The sizes shall be adequate for loads and forces involved.

(2) Power-actuated types in lieu of removable mechanical fastenings shall not be permitted, unless otherwise shown or approved.

(3) Inserts of carbon steel to hold hangers and supports shall be placed prior to concrete pouring on slab, beam and columns, in order to protect reinforcing bars, embedded pipes, etc.

(4) Cutting or welding to structure for support shall be permitted only as and where shown, specified or approved for each specific condition or location.

(5) Supporting piping conduit or equipment by attaching directly to metal shall not be permitted.

(6) Steel items throughout shall be hot-dip galvanized or corrosion resistant painted, plated or treated by approved methods.

13.2 Continuous Supports

(1) Continuous supports shall be manufacturer's standard prefabricated type of C-channel, roll formed from steel strip of thickness not less than 2.5mm, in standard length units for minimum of splices. The type shall be complete with matching splice covers, insert devices suitable for hanger rods, etc. that are required to be supported.

(2) They shall be secured to overhead concrete using unit anchors as specified hereinafter, set through pre-punched holes in C-channel webs, spaced at not over 200mm from each end channel unit and at not more than 600mm centers in between.

13.3 Unit Anchors

(1) Unit anchors shall be manufacturer's standard type of steel insert bolts designed for use in hardened concrete with pre-tested and pre-determined load values and in various types and sizes suitable for varying installation requirements. Each unit shall be selected in accordance with manufacturer's certified load carrying capacity tables as approved.

(2) Each unit shall be selected to safely support work required and when under full load conditions, and as appropriate for strength or conditions of concrete to which attachment is being made.

(3) The selection shall be determined using factor of safety not less than 5 times actual or real load to be supported.

(4) In any and all cases, bolt shank diameter shall not be less than 15mm.

13.4 Other Connections

(a) Heavy items to steel framing

Machine bolts, nuts and washer set through drilled holes.

(b) Light items to steel framing

Machine screws set into drilled and tapped holes or set through drilled holes with nuts and washers.

(c) Light items to sheet metal

Headed fasteners with threads designed for sheet metal work, self-drilling, self-tapping.

(d) Sizes

Appropriate for load to be supported and as approved.

13.5 Attachments not permitted

(a) Wood blocking embedded in concrete.

(b) Wood, fiber, plastic or lead type inserts.

14.0 EQUIPMENT REQUIREMENTS

14.1 Wiring Diagrams

(1) Wiring diagrams are required for all motors and controls and for each electrical system included under Electrical Work. They shall be provided singularly, where practical, or in sets as necessary to clearly portray all relevant connections and interconnections. All sheets shall be in one (1) uniform size.

(2) Complete sets of wiring diagrams shall be included with the Operation and Maintenance Manuals.

(3) In addition, complete sets of all diagrams shall be provided for permanent wall mounting for each type or group of diagrams located in different locations as directed by the Engineer. Each shall be provided with cover of clear plastic in thickness not less than 3.0mm for diagram sizes 400mm x 400mm and larger, 1.5mm for smaller sizes retained in neatly fabricated aluminum frame secured to wall using matching screws.

14.2 Lubrication Requirements

(1) Lubrication facilities shall be provided for all parts involving friction and wear other than where suitably covered or protected by resilient materials or where provided with life-time packing or fittings.

(2) Include all necessary grease fittings, oiling caps or other like facilities as required to maintain equipment properly protected and with all like items essentially identical and serviceable using same lubrication tools throughout.

(3) Locate lubrication facilities where readily visible and easily accessible.

(4) Lubrication tools shall be required as follows:

(a) One (1) complete set for each type of necessary system; and

(b) Set of hand tools of suitable types and adequate sizes, contained in a suitable box or panel.

(5) Removable units securely supported and fastened in place, constructed using wire mesh in steel angle or flat bar frames each mechanically secured into place against accidental removal. Wire mesh shall be woven, galvanized steel wire not less than 1.4 mm, mesh size not larger than 7.0 mm by 7.0 mm.

14.3 Safety Guards

Safety guards shall be provided for all sheaves, couplings and other running equipment which could cause physical injury upon accidental or inadvertent contact.

14.4 Keyed Locks and Switches

(1) Locks and switches required to be keyed shall be masterkeyed to one (1) set or sets for common types of facilities, such as panelboards and for various different locations (i.e. different building).

(2) Exact requirements for keying shall be as directed by the Engineer at later date after commencement of the Works.

15.0 EQUIPMENT IDENTIFICATION REQUIREMENTS

15.1 General

(1) Exposed surfaces of fixtures, Plant and equipment shall be free from shop or factory applied manufacturer's/vendor's labels, insignia, emblems, decals or other like devices.

(2) All items otherwise identified only in compliance with the requirements specified herein.

(3) A complete listing of signs required, giving full text proposed for each item, shall be submitted to the Engineer for approval. Approval must be obtained prior to ordering or fabrication of signs.

15.2 Manufacturer's Identification

(1) Required for each factory fabricated fixture or equipment item, shall be applied so as to be concealed when item is installed and normally closed, readily visible and readable when opened.

(2) Each such label or nameplate may be of standard manufacture, shall be non-corrosive and durable and each permanently affixed.

(3) Labels or nameplate shall state fixture or equipment item type, model number, rating and current characteristics.

15.3 Product Identification Signs

(1) Required for each electrical equipment item, in readily visible locations, each sign shall be installed level and accurately and symmetrical positioned.

(2) Sign size : suitable for equipment
Colors : as indicated by the Engineer
Letters : plain block or gothic style only

15.4 Circuit Directory

(1) Required for each panel containing electrical control or safety devices installed on inside of panel doors.

(2) Each directory shall be correlated with panel as arranged and installed and in typewritten form only.

(3) Each directory shall be protected and retained by suitable frame and clear plastic cover.

16.0 SCOPE OF ELECTRICAL WORK

16.1 Main Distribution Lines

General extent of work is listed below but should not be considered as being complete:

(a) Supply, construction, completion and testing of all distribution boards, main and sub-main circuits.

(b) Supply, installation, completion and testing of all main lines between distribution boards and loads including local switches.

(c) Supply, installation, completion and testing of all branch lines between distribution boards and motor control panels.

(d) Control circuits between motors and control panels.

(e) Grounding of equipment.

16.2 Systems Installation

The detailed scope of installation work is set out in the relevant Section of the Specification.

17.0 CABLES AND WIRES

17.1 General

The requirements hereunder shall be applicable to all electrical and wire materials and installations required for work under this Contract, except as may be additionally specified or otherwise under other Sections.

This shall be in conjunction with the Drawings and Bill of Quantities

17.2 THW Copper wire 14 mm^2
THW Copper wire 22 mm^2
THW Copper wire 50 mm^2
THW Copper wire 60 mm^2
THW Copper wire 250 mm^2

17.3 THWN Copper Wire 3.5 mm^2
THWN Copper Wire 5.5 mm^2
THWN Copper Wire 8 mm^2
THWN Copper Wire 14 mm^2
THWN Copper Wire 22 mm^2

18.0 CABLE AND WIRE - INSTALLATION

18.1 General

(1) Conductors or cables shall not be installed in cable rack, conduits, raceways or cable pits until such system has been completed.

(2) The Contractor shall exercise due care to prevent damage to conductors, insulation or sheathing.

(3) All feeder cables installed in the building shall be continuous from origin to panel or equipment terminations without running splices in intermediate pull or splice boxes except to where tapes and splices are necessary and approved by the Engineer. In such cases they shall be made in approved splice boxes and using suitable connectors.

(4) All cable and wire splices shall be made in pull boxes, junction boxes or handholes.

(5) Conductors of different systems shall be installed as follows:

(a) Conductors for light and power systems of 600 V or less shall be permitted to occupy the same enclosure, without regard to whether individual circuits are insulated for maximum voltage of any conductor within the enclosure;

(b) Excitation, control, relay and ammeter conductors used in connection with any individual motor or starter shall be permitted to occupy the same enclosure as the motor circuit conductors; and

(c) Conductors of signaling or radio systems shall not occupy the same enclosure with conductors of light or power systems.

(6) All cable terminals and splices shall be made secure using solderless pressure-type connectors unless otherwise specified; where solder joints are specified, cable joints shall be mechanically strong before soldering with solder to be carefully applied without use of acid and wrapped with insulating plastic tape in the approved manner.

(7) The Contractor shall furnish and install all hangers, cable cleats and supports required to make a neat and substantial cable installation.

(8) Each cable when completely erected shall have permanently attached to it at each end and at intermediate positions as may be considered necessary by the Engineer, non-corrosive metal plates upon which shall be engraved or stamped, identification number of cable, voltage, rating conductor size and make.

(9) Cable identification numbers shall comply with cable schedules which shall be prepared by the Contractor according to cables as actually installed. These cable schedules shall indicate cable numbers, cable sizes, voltage, number of conductors, conductor size, termination and connections at each and cable route.

(10) Where cable passes through building exterior walls and ground floors, cable holes shall be completely filled using suitable non-flammable and waterproof sealing materials.

18.2 Installation in conduit

(1) No cable or wire shall be installed until inside of conduit has been cleaned.

(2) Sum of cross-sectional area of cables or wires installed in conduit shall be less than 40% of cross-sections are of conduit.

(3) Conductor ends at least 15 mm in length shall be left at each outlet and switch point for splices or for connection of fixture or devices.

(4) All cables and wires shall be installed in good order in pull-boxes, junction boxes, manholes and handholes.

(5) Wires and cables for power and lighting shall be in separate conduit from any wires of cables for communication and signal systems.

18.3 Installation in cable trench

(1) All cables shall be supported in trench using cable rack fixed on the base of the cable trench.

(2) All cables shall be installed in orderly rows.

(3) Where cable passes through metallic covers of cable trench, adequate space shall be provided between cable and cover.

18.4 Installation in metal cable ducts

(1) Cable splices made and insulated by approved methods shall be permitted only at junctions of cable and where accessibility is secured.

(2) The weight of cables shall not directly be loaded to cover of ducts.

(3) Cables/wire identification shall be provided at junctions and other important points along ducts.

(4) Cable protector of PVC or other synthetic resin shall be provided at cable entrances.

(5) Carbon steel divider (1.6mm minimum thickness) shall be provided between ordinary cables/wires and cables for fire alarm and detection systems (excluding heat proofed cables or fire rated cables).

18.5 Installation on cable racks

(1) Cable splices made and insulated by approved methods shall be permitted within a cable rack provided they are accessible and do not project above side rails.

(2) Cable shall be fastened securely to transverse members of cable racks.

(3) Where single conductor cables comprising each phase or neutral of a circuit are connected in parallel, conductor shall be installed in groups consisting of not more than one (1) conductor per phase or neutral, to prevent current inbalance in paralleled conductors due to inductive reactance and single conductor shall be bound in circuit groups to prevent excessive movement due to faulty current magnetic forces.

18.6 Installation in raceways

(1) For splicing cables, joints boxes matching raceways shall be provided.

(2) Cable protection of PVC or other synthetic resin shall be provided at cable entrances.

(3) Cables and wires shall be laid in raceways in good order.

(4) Sum of cross-sectional area of cables and/or wires installed in raceway shall not exceed 20% on internal cross-sectional area of raceways.

19.0 CONDUIT - MATERIALS

19.1 IMC Conduit with coupling & elbow 15mmØx 3m
IMC Conduit with coupling & elbow 20mmØx 3m
IMC Conduit with coupling & elbow 25mmØx 3m
IMC Conduit with coupling & elbow 32mmØx 3m
IMC Conduit with coupling & elbow 40mmØx 3m
IMC Conduit with coupling & elbow 50mmØx 3m
IMC Conduit with coupling & elbow 80mmØx 3m

20.0 CONDUIT INSTALLATION

20.1 General

(1) Conduits shall be installed and supported in a rigid and satisfactory manner.

(2) Where a conduit enters a box or fitting a bushing shall be provided to protect the wire from abrasion, unless design of box or fitting is such as to afford equivalent protection.

(3) Conduit runs between outlet and outlet, fitting and fitting or outlet and fitting, shall not contain more than the equivalent of 4 quarter bends, 360 degrees total, including those bends immediately at outlet or fitting.

(4) All cut ends of conduit shall be reamed to remove rough edges.

(5) Where conduit is threaded in the field, an electrical conduit thread cutting die with a taper shall be used.

(6) Conduit shall be firmly fastened within 0.9 m of each outlet box, junction box, cabinet or fitting and intermediately supported at least every 1.5 m.

(7) Conduits runs which extend through areas of different temperatures or atmospheric conditions or which are installed partially indoors and outdoors shall be arranged in a manner which shall prevent drainage of condensed or trapped moisture into pull boxes, cabinets or enclosures.

(8) Raceways shall be installed at right angles or parallel, to building lines.

(9) Embedded conduits shall be installed as close to the middle of concrete slabs, walls or columns as practical without disturbing reinforcement in accordance with the following:

(a) Outside diameter of embedded conduit shall not exceed 1/3 of the slab thickness and adjacent conduits shall be spaced not closer than 3 diameters centers;

(b) Approved type spacers shall be provided to maintain proper clearance between reinforcement and conduit; and

(c) Conduit shall be secured prior to placing concrete or like materials to prevent movement during placing operation.

(10) During construction conduits shall be plugged to prevent entrance of foreign matter, plugs shall not be removed until ready for cables or wires.

(12) Conduit for future use shall have No. 16 galvanized pull wire, or nylon pull rope minimum 3 mm diameter, 0.5 m minimum extending at each end, coiled and tagged to identify location of opposite end.

(13) All conduits and pipes exposed to the surfaces to receive mortar shall be covered by at least 210 mm wide metal lath. Any conduits and pipes shall not directly receive mortar, unless otherwise specified herein.

(14) The opening of walls for conduits, pipes or cable racks shall be closed in the following manner:

(a) Pipe sleeve in concrete walls

(i) Galvanized steel pipe type: to be fixed prior to concrete pouring. Void between and conduit to be filled by:

waterproofing mortar, polystyrene back-up and polysulfide, sealant (external wall)

– mortar (internal wall)

– waterproofing mortar, polystyrene back-up and polyurethane sealant around entrances on both inside and outside of manhole. End of synthetic resin at cable entrance.

(ii) Galvanized steel sheet type: Galvanized steel sheet: 1.2 mm thick, zinc coating 380 g/m² with galvanized steel anchoring materials. Void filler shall be silicone grey filler, including neoprene gasket and polysulfide sealant all around galvanized steel sheet and cables; 20 mm thick waterproofing mortar all around in opening of wall.

(b) Opening through CHB wall

Void between conduit and wall to be filled by:

mortar (internal wall)

waterproofing mortar, polystyrene back-up and polysulfide sealant (external wall)

(c) Fiber reinforced cement board covers on slabs and fire rated walls:

Fiber reinforced cement board shall be calcium silicate board JIS A 5430, 25 mm minimum thickness; void filler shall be rockwool to JIS A 9504, 200 kg/m³ or more; sealant shall be all around cables and fiber reinforced cement board, and shall be heat resistant; 20mm thick mortar finish to opening of wall.

Manner of Installation as applicable and in reference with the Project Bill of Quantities

20.1 Installation of Flexible Metal Conduit

Any run of conduit for concealed raceway between outlet and outlet, fixture and fixture or outlet and fixture shall not contain more than equivalent of 4 quarter bends, 360 degrees total.

20.2 Installation of Steel Pipe Conduit

(1) Shall be installed where shown, spacing not less than as shown, all joints shall be made up using couplings only as approved, each joint tight and secure.

(2) Trench bottoms shall be formed with curved transitions at slope changes to avoid over-stressing conduit or joints.

20.3 Installation of Polyvinyl Chloride Conduit

(1) Bends of conduit shall be so made that conduit shall not be damaged and the internal diameter of conduit shall not be effectively reduced.

(2) Field bends shall be made only using bending equipment intended for the purposes and with radius of curve of inner edge of bends not less than six (6) times nominal diameter of conduit.

(3) All joints between lengths of conduit and between conduit and couplings, fittings and boxes shall be made by a method approved for the purpose.

21.0 WIRING DEVICES

21.1 Switches

(1) Shall conform to JIS C 8304 or equivalent.

(2) Contacts and finger switches shall stop at “on” and “off” positions.

(3) Switches shall not arc in switching operation

(4) General lighting switches shall be of the 15 amperes AC rating suitable for both inductive and fluorescent lighting loads. All switches shall be fixed to an adjustable grid plate, complete with earthing termination.

(5) Installation generally shall be as follows:

(a) All switches boxes or switch banks shall be installed vertically.

(b) The center of cover plate shall generally align to the level at 1.30 m to 1.37 m above finished floor level. Level and location of switch boxes on tile finished wall be set along tile joints of tile center.

(c) Splices of conductors 5.5 mm² or smaller shall be provided with an insulated pressure type connector or equivalent.

21.2 Socket Outlets

(1) Shall conform to JIS C 8303 or equivalent

(2) Plugs shall be easily inserted and removed and shall have good electrical contact.

(3) All general purpose receptacles shall be rated 15 amperes, 250V, 2 pole, 3-wire, parallel slot, grounding type. Locking type and other special purpose receptacle outlets, where applicable, shall be indicated on the Drawings.

(4) Locking type receptacles shall be such that plug is inserted and turned clockwise to insert plug prongs to make electrical contact.

(5) Receptacle outlets connected with the emergency generator supply shall be identified separately from other receptacles connected with the normal power.

(6) All outlets on exposed conduit work shall be cast alloy conduit fittings of approved manufacturer.

(7) All outlets on concealed conduit work shall be provided with hot galvanized pressed steel outlet boxes of standard make. These boxes shall be in all cases standard and where such boxes are not available on the market, special boxes shall be secured by the Contractor at his own expense.

(8) All utility boxes intended for outlet devices shall be especially designed to receive the particular type of device to be mounted and should be deep enough to accept and fit the total number of conductors and devices required as per Drawings, but in no case, depth shall not be less than 24mm.

(9) In case of fixtures, their outlet fittings shall be provided with suitable supports of size and kind required by the fixture to be hung. Fixture studs if required shall be 98mm diameter.

(10) Installation generally shall be as follows:

(a) The center of cover plates shall generally align to the level at 300 mm above finished floor level. Level and locations of convenience outlets at kitchen, kitchenette and toilet shall be set after coordination among layout of furniture, sanitary fixtures, tile joint, etc.

(b) Splices of conductors 5.5 mm² or smaller shall be provided with an insulated pressure type connector or equivalent. Splices in conductors 8 mm² or larger shall be made using solderless connectors and covered with an insulation material equivalent to the conductor insulation.

(c) Plug slot direction of convenience outlets shall be set vertical at any location.

(d) The direction, quality and general appearances of cover plates shall be unified after coordination on this matter among all systems.

(e) Colors of cover plates for normal power outlets and emergency power supported outlets, telephone outlets shall be significantly different as approved by the Engineer, in order to secure easy identification.

21.3 Waterproof switches and socket outlet

(1) Shall conform to JIS C 8304 and C 8303 or equivalent.

(2) Surface-mounted shall be cast non-corrosive metal housing specifically constructed to house exterior switches and plugs, complete with all gaskets and screw-on cover plates.

(3) Terminals of switches and receptacles shall be recessed into switch body not less than 3 mm with head recesses filled using non-hygroscopic sealing compound after connection are made.

(4) 4 mm Minimum clearance shall be maintained between box and terminal face of switch or receptacle.

(5) Insulation material shall be provided to the box, exposed to weather shall be porcelain, urea resin moldings, phenol resin moldings or other approved weather-proof types.

(6) Gaskets shall be neoprene or other approved synthetic rubber, closed-cell type only.

21.4 Cover plates

(1) For interior, shall be white bronze or stainless steel, satin or brushed finished, or plastic with smooth surface plain plates without markings.

(2) For exterior, shall be non-corrosive metal castings, with cover plate for switches with “on” and “off” markings cast into face.

21.5 Marking

On body of switch and back box shall be indelibly marked with the information of rated current, rated voltage and name of manufacturer.

21.6 Plugs and receptacle

Unless otherwise specified in other Section(s) plugs and receptacles to be installed shall follow the following requirements.

(a) Pole arrangement shall be of two (2) flat poles (face to face) and one (1) grounding between and below poles, like shown on Fig. 2 (1) of JIS C 8303.

(b) Performance on following shall comply with the requirements of JIS C 8303.

- Retaining force
- Temperature rise
- Contact resistant
- Make and break
- Insulation resistance
- Dielectric withstand voltage
- Resistance to heat
- Strength of terminal
- strength of board fixing part
- strength of enclosure
- strength of cord anchorage
- strength of cord outlet
- performance of screwless terminal
- endurance to ammonia gas
- tensile load
- waterproof

21.7 Wiring Box

(1) Wiring boxes shall include all outlets back boxes, switch back boxes and pull boxes used in buildings.

(2) Metal back boxes for outlets and switches shall meet the requirements of JIS C 8336 or equivalent.

(3) Pull box sizes shall be determined by location and number of wires, cables and raceways involved and direction of intersections.

(4) Boxes for mounting lighting shall not be less than 100 mm square (or octagonal), except that smaller boxes may be installed as required by fixture configurations, as approved by Engineer.

(5) Metal pull boxes shall comply with following:

(a) Welded constructions, of carbon steel at 1.6 mm thick or more or of stainless steel at 1.2 mm thick or more.

(b) Carbon steel, unless otherwise galvanized meeting requirements of JIS C 8359 #8.3, shall be anti-rust paint coated (non-organic zinc powder coating or equivalent) with phosphating.

(c) At least one (1) cable holder shall be provided with box if longer edges length of the box is more than 600 mm.

(d) Cover shall be divided into two (2) and opening of box shall have back reinforcement of angular steel section, in case the length of longer edge of cover is more than 800 mm.

(e) Boxes shall have approved type of grounding terminal.

(6) External metal pull boxes shall comply with items (a) to (e) above and further comply with:

(a) Weatherproof with drip hole

(b) Neoprene or equivalent gasket

(c) Stainless screws

(7) Metal pull boxes for raceways shall be as per raceways manufacturer's standard and in general shall be as follows:

(a) Shall be of the cast-metal hub type as follows:

(i) when located in normally wet locations

(ii) when installed exposed up to 2m above interior floors and walkways

(iii) when surface mounted on outside of exterior surfaces

(iv) when installed in hazardous areas

(b) Boxes in other locations shall be galvanized sheet steel or code-gauge aluminum

(c) Each box shall have the volume required by code for the number of conductors enclosed in the box

(d) Boxes for mounting lighting shall not be less than 100mm square (or octagonal), except that smaller boxes may be installed as required by fixture configurations, as approved.

(e) Gaskets shall be provided for cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces.

(f) Boxes and supports shall be fastened with machine screws or welded stubs on steelwork.

(g) In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support.

(h) Sheet metal boxes shall be supported directly from the structure or by bar hangers. Where bar hangers are used, the bar shall be attached to raceways

on opposite sides of the box and the raceway shall be supported with an approved type of fastener not more than 600 mm from the box.

(i) Boxes shall be furnished with a common pull box.

(j) The feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

(8) PVC back boxes for outlets may be used for low voltage system only. PVC pull boxes shall comply with the following:

(a) Length of longer edge: shall not exceed 600 mm

(b) Wall thickness: shall not be less than 3 mm

(9) Installation requirements are as follows:

(a) Unless otherwise specified, maximum number of conductors, excluding number of fixture wires, permitted in a standard box shall be per PEC.

(b) Requirements above apply where no fittings or devices, (i.e. fixture studs, cable clamps, switches, or receptacles), are contained within a box, where no grounding conductors comprise a part of wiring within a box and otherwise, it shall comply with the following requirements:

(i) Where one (1) or more fixture studs or cable clamps are contained in a box, the number of conductors shall be one (1) less than as tabulated;

(ii) An additional deduction of one (1) conductor shall be made for each strap containing one (1) or more devices, and a further deduction of one (1) conductor shall be made for one (1) or more grounding conductors entering a box; and

(iii) A conductor running through box shall be counted as one (1) conductor, and each conductor originating outside of box and terminating inside box counted as one (1) conductor.

(c) Pull-boxes shall comply with the following requirement:

In straight pulls, the length of the box shall not be less than 8 times nominal diameter of largest conduit to be connected thereto; and

(d) All boxes and metallic conduits shall be bonded or grounded together.

(e) In damp or wet locations, boxes shall be so placed and constructed so as to prevent moisture from entering or accumulating within the box. Boxes installed in wet locations shall be specifically approved for the purpose.

(f) Boxes used to enclose flush devices shall be completely enclosed on back and sides, and shall provide substantial support for wiring devices.

(g) Screws for support of boxes shall not be used for attachment of devices.

(h) All pull boxes shall be set flush with finished surface on which mounted.

(i) Outlet, switch and concrete boxes mounted in wall or ceilings of concrete, tile, or other noncombustible materials, shall be so installed that front edges of or covers will not recess below finished surface more than 6 mm.

(j) In walls and ceilings constructed of wood or other combustible materials, box covers shall be flush with finished surfaces.

(k) Boxes shall be securely and rigidly fastened to surface upon which they are mounted, or securely and rigidly embedded in concrete or masonry and shall be supported from a structural member of building either directly or by using a substantial and approved metal braces.

(l) In pull boxes or junction boxes having any dimension over 1.8 m, all conductors shall be cabled or racked in an approved manner.

22.0 ELECTRODE SWITCHES

22.1 General

(1) These shall be used for opening and closing of electrical circuits with variation of water level inside water tanks.

(2) Switches shall consist of rod or strip electrode, electrode supports and relays.

(3) Voltage shall not exceed 24 V.

(4) Electrodes shall be stainless steel.

22.2 Installation of Anchorage to Structures

(1) Each cabinet, panel, pole or other individual piece of equipment or device shall be securely anchored to structure walls or floors, as applicable, using adequate and sufficient means to prevent dislodgment or overturning due to seismic forces (earthquake).

(2) Anchors shall be installed only through main frame of cabinets or panels.

22.3 Installation of Panels or Cabinets on Walls

(1) Each unit shall be set square, plumb and level at heights required, securely anchored to structure as specified.

(2) Surface mounted units shall be set with backs tight against and fully closing with wall surfaces.

(3) Recessed units shall be set with face frames tight against and fully adjacent to wall surfaces.

23.0 GROUNDING

23.1 System Requirements

(1) Grounding systems shall be classified into three (3) as listed below:

(a) Grounding for equipment, metal conduits, steel pipes and special wireways: Enclosures, casing and metallic bases of all electric equipment, metal conduits, steel pipes, special wireways and sheathing of cable ends shall be grounded with grounding resistance maximum (5) ohms.

(b) Grounding for transformer:

(i) Instrument enclosure and secondary circuits of transformer shall be grounded separate from the grounding for equipment and lightning protection system.

(ii) Grounding resistance for the transformer shall be determined based on the formula listed below:

$$R = 150/I \text{ (Ohm)}$$

where R : Grounding resistance
I : Current of the secondary circuit of the transformer (Ampere)

(iii) Grounding conductor shall be PVC insulated wire (IV) and the size shall be determined based on the capacity of the transformer as shown below:

Capacity of Transformer	Size of the Conductor
10 kVA or less	Not less than 5.5 mm²
20 kVA or less	Not less than 8 mm²
40 kVA or less	Not less than 14 mm²
75 kVA or less	Not less than 22 mm²
125 kVA or less	Not less than 38 mm²
200 kVA or less	Not less than 60 mm²
250 kVA or less	Not less than 100 mm²
1000 kVA or less	Not less than 200 mm²

(c) Grounding for lightning protection.

(2) Grounding resistance shall be below the value mentioned above. However, in case less value of grounding resistance is required to assure performance of the Plant to be installed by the Contractor, the grounding system shall be so installed by the Contractor. Cost thereof shall be deemed to be included in the Contract Price.

(3) Installation requirements shall be as follows:

(a) Grounding for lightning, transformer and equipment grounding system shall be separated from each other.

(b) Conductors shall be securely fastened to structure at intervals not exceeding 1.5 m.

(c) Point of connection of grounding conductor to interior metal raceways shall be as neat as practical to source of supply.

(d) Connection of conductor to a grounding electrode shall be made at a point and in a manner that will assure a permanent and effective ground.

(e) Conductors and bonding jumpers shall be connected by pressure connectors, clamp, or other approved means. Connection devices or fittings that depend on solder shall not be permitted.

(f) Where more than one (1) equipment grounding conductor of a branch circuit enters a box, all such conductors shall have good electrical contact with each other and shall be arranged such that disconnection or removal or any receptacle, fixture, or other device fed from the box will not interfere with or interrupt grounding continuity.

(g) Connection shall be made between equipment grounding conductors and metal boxes using grounding screws, and which shall be used for no other purpose, or by using approved grounding devices.

(h) Equipment grounding conductors brought into a nonmetallic outlet box shall be arranged that a connection can be made to any fitting or device in that box requiring grounding.

(i) Three (3) test terminal wells with concrete cover for each grounding system shall be installed at appropriate locations in the electrical room suitable for testing. The distance between the grounding electrode for each grounding system shall be more than five (5) meter apart.

(j) Not more than one (1) conductor shall be connected to an electrode by a single clamp or fitting, unless such clamp or fitting is approved for multiple connections.

(k) Where damage occurs, clamps and fittings shall be enclosed with a protect covering approved by the Engineer.

(l) Paint, lacquer and other nonconductive coatings on equipment to be grounded shall be removed from contact surface to assure good electrical continuity.

24.0 ELECTRICAL TEST REQUIREMENTS

24.1 General

(1) The provisions of **Section 1145** are applicable and are to be referred in connection with 6000 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 6000 series of this Specification.

(3) Materials, equipment, and the completed installation will be inspected by the Engineer.

(4) All equipment, materials, or work rejected because of defects or nonconformance with the Drawings and the Specification shall be replaced or corrected by the Contractor as directed at no additional cost.

24.2 Scope of Testing

(1) Upon completion and prior to acceptance of the installations, the Contractor shall subject the units to operating tests to demonstrate satisfactory functional and operational efficiency.

(2) The Contractor shall furnish all materials, instruments, equipment and test personnel required for tests.

24.3 Test Requirements

(1) Each electrical system shall prove satisfactory and acceptable in accordance with requirements throughout and under the Contract Documents.

(2) In addition to requirements herein, tests shall be concluded as work progresses as required elsewhere under this Specification.

(3) Testing required herein shall be performed in the presence of the Engineer, and schedules duly arranged for in advance in accord with notification requirements.

(4) Sufficiently qualified personnel, time, materials and fuel shall be allotted and provided by the Contractor as necessary to provide and conduct all required tests.

(5) Upon completion of electrical equipment (panel board, motor, control equipment, etc.) the Contractor shall not operate any equipment without the express approval of the Engineer.

24.4 Test Programs

(1) Quality and commissioning test shall be carried out and conducted per programs as prepared and issued by the Contractor and approved by the Engineer.

(2) Test programs shall also include such forms as deem necessary by the Engineer, which the Contractor shall utilize and execute accordingly and as applicable to the various kinds of work to be tested.

(3) Tests required shall be completed on schedule for activation of electrical systems as required in accordance with this Section.

24.5 Tests Reports and Records

(1) Forms to be issued by the Engineer shall be devised by the Contractor with appropriate information and data to be recorded.

(2) Within 14 days after completion of testing, one (1) copy of test records and results shall be furnished to the Engineer for review.

(3) Exact indication of site, date, hour, types of instruments used and precision of such instruments shall be recorded; in addition necessary notes shall be registered regarding operations plus observed deficiency. This report shall be signed by the Contractor's representative and by the Engineer and shall serve as a basis for final documentation required under the Contract.

24.6 Repetition of Test

(1) If any portion of the system or any piece of equipment fails to pass the tests, the Contractor shall make the necessary repairs or adjustments and the test shall be repeated until satisfactory performance is achieved at the Contractor's expense.

(2) In cases where it may be necessary to perform a partial test and flaws are discovered at a later date such will be corrected by the Contractor at his expense.

24.7 Quality Test

Quality testing shall include and consist of all such examinations, measurements, inspections, by visual, mechanical, instrumental or other means, as is necessary to show and prove that work so tested does in fact meet all quality standards and performance requirements as shown or specified.

24.8 Measurement of Grounding Resistance

(1) Grounding resistance of all grounding electrodes and grounding terminals shall be measured using a transistor earth tester.

(2) Grounding resistance shall be less than values stipulated in this Specification, or in accordance with PEC when not so specified, or manufacturer's recommendation.

24.9 Insulation Resistance Tests

(1) Insulation resistance between ground and high tension busbars, high tension cable conductors and ground, and high tension cable conductors shall be measured using 1,000 V meggar meter.

(2) Insulation resistance between all low tension and ground, all branches and ground, and conductors of feeder/branches shall be measured using 500 V meggar meter.

(3) All measured values of high tension circuits shall be not less than 100 meg. ohm, and of others low tension shall be not less than 0.2 meg. ohms.

24.10 Dielectric Strength Test (Not applicable for low voltage cable below 600V)

All high tension equipment, busbars and cables shall be tested by withstanding voltages as specified under various Specification Sections and before they are energized.

24.11 Relay Test

(1) Characteristics of all relays shall be tested.

(2) All relays shall be adjusted and set to assure adequate characteristics for respective system.

24.12 Demonstration Tests

(1) Demonstration test requirements shall include and consist of operating systems under various and varying condition as is necessary to show and prove that work so tested does in fact operate and function as intended under these Contract Documents.

(2) Techniques or methods for quality testing shall be employed as necessary for certain demonstrations.

(3) Demonstration tests shall be distinctly separate from other tests required as specified under the Electrical Work.

(4) When deemed by the Engineer as practical, feasible and not disruptive to the Contractor's efforts, the Employer's operating personnel shall be permitted to attend such tests or demonstrations as will be helpful to their understanding of work for which they will be eventually responsible.

(5) Operational and functional demonstration tests are required for electrical equipment, individually and separately as installed, and each and every system required under this Section.

25.0 MEASUREMENT AND RATES

25.1 Measurement

Work under this Section shall be for Series 6000 and shall generally be measured according to the item classification and units contained in the Bills of Quantities (BOQ).

25.2 Rate

(1) The rates and lump sums shall be full compensation for all plant, materials, labor, equipment, transport, temporary works, establishment charges, overheads, profit and taxes required to complete the work described in this Section and the following Sections of the 6000 Series of the Specification and/or shown on the Drawings.

(2) The rates and lump sums shall further include, if not itemized separately in the BOQ, for the Sections of the 6000 series:

(a) Contractor's design (where applicable)

(b) Spare parts

(d) Testing and commissioning

(e) Maintenance tools and special tools

(f) Protection

(g) All permits and fees required from Government authorities for inspection/certification.

POWER FEEDER SYSTEM

1.0 SCOPE OF WORKS

1.1 The scope of works includes the provision of a 400V/230V Low Voltage (LV) Distribution System to all buildings comprising, but not limited to, the following:

(a) All normal Distribution Panels (DP), normal Lighting Panel (LP) and normal Enclosed Circuit Breaker (ECB) complete with all the necessary electrical components and accessories.

(b) Feeder cables fed from the emergency power supply, from (emergency) LV Switchboards (ELVSB) to each EDP, and from EDP to each ELP and ECB. (BY OTHERS)

(c) Feeder cables fed from the normal power supply from (normal) Main Distribution Panel (MDP) to each DP, and from DP to each LP and CB.

(d) All feeder cables, branch circuits and interconnecting wiring for all electrical, mechanical, fire, BMS, FIDS, Security and CCTV, Master Electric Clock, Cable TV, PABX, Public Address, Signage, Elevators, Escalators, Boarding Bridges, Baggage Handling Systems, and Airconditioning Equipment, etc.

(e) All floor ducts, conduits, junction boxes and accessories from the panelboard to general use receptacle outlets.

(f) Associated grounding systems for the LV systems.

(g) All wire ways, cable trays and necessary wiring accessories for the LV wiring systems.

1.2 The scope of work includes the provision of all labor, materials and equipment necessary for the complete execution of all the Electrical Systems as shown on Electrical Drawings. Scope of work shall include but is not limited to, the following principal items of works:

(a) The provision and installation of cable trays, cable ladder and conduits when not included in other sections.

(b) The provision and installation of all circuit breakers, disconnect switches and other protective devices when not included in other sections.

(c) Painting of all exposed electrical conduits, enclosures and equipment.

(d) Execution of all terminations for Electrical Systems.

(e) Complete testing of Electrical Systems and Equipment.

(f) All work, materials, equipment, fittings, supports, etc. which are necessary for the completion of the works shall be included in this scope of work.

(g) Full coordination with all electrical trades.

2.0 CABLES AND WIRES - MATERIALS

2.1 Generally

All main power supply (400V and 230V) shall use multi-core cable routed into cable trays, cable ladder, or underground conduits.

2.2 Main cables

(1) All cables from main low voltage switchboards (400V and 230 V) located in each electrical room, to the distribution panels, shall be considered as the “Main Cables”.

(2) All these cables will be multi-core XLPE type (except where otherwise specified)

(3) All main cables will follow the PEC, NEC or equivalent standard for type and size.

2.3 Secondary Cables and Wire

(1) The cables to be considered as "Secondary Cable and Wires" shall be the cables from distribution panels to final load.

(2) When possible these secondary cables and wires shall be of the same type as the main cables (XLPE multi-core cables)

(3) When wires will be used for secondary connection (only), the wires shall be in accordance with the following:

(a) All wires shall be copper, soft-drawn and annealed, shall be of 99% conductivity, shall be smooth and true of cylindrical form and variation shall be within 1% of the actual size called for.

(b) All wires and cables shall comply with the requirement of the Underwriters Laboratories, the A.S.T.M., I.C.E.A. and other relevant Standards as they apply to the particular usage.

(c) All wires and cables shall be as manufactured from a reputable and approved manufacturer.

(d) Wires and cables for power and lighting system shall be plastic insulated for 600 volts working pressure type "THHN" type unless otherwise noted on plans or specified.

(e) All wires 8 mm sq. or larger shall be stranded copper.

(f) Control leads for motors shall be of Type "TW" unless otherwise noted on the plans.

(g) For lighting and power systems no wire smaller than 3.5 mm sq. shall be used, except for control leads or otherwise specified.

(h) Color Coding

Shall be provided for all service, feeder, branch, control and signaling circuit conductors. Color shall be green for grounding conductors, and black for neutrals. The color of the underground conductors in different voltage systems shall be as follows:

(i) 230 volt, 1-phase : Phase A – Red
Phase B – Yellow

(ii) 400 volt, 3-phase : Phase A – Red
Phase B – Yellow
Phase C – Blue

(iii) The grounded conductors should be only of yellow/green type.

(i) Splices and Termination Components

Connectors for wires 5.5 mm^2 and smaller shall be insulated pressure-type or twist lock splicing connector. Solderless terminal lugs shall be provided on stranded conductors.

2.4 Control Cables

(1) All control cable shall be as PEC, NEC or equivalent standard. Control cable will be rigid copper type with minimum size of 1.0 mm^2, PVC or XLPE insulation. They shall be of the control type with a standard number of cores of 12, 19, 27 or 37.

(2) The instrumental cable type can be used as well if of the following type:

(a) collectively screened
(b) no armour

(3) The collectively screened instrument cable type shall be used when electromagnetic influences are present, or to ease installation.

(4) The instrument cable type shall include only the following standard number or pairs 5, 10, 30 or 50.

2.5 Cable Marking and Splices

(1) The Contractor shall develop a cable numbering list to be submitted to the Engineer for approval.

(2) All main and control cables will be labeled at both ends with clear indication of the cable number in accordance with the developed cable list.

(3) Conductor identification shall be provided within each enclosure where a tap, splice or termination is made. For conductors 16 mm^2 and smaller, color coding shall be factory applied color impregnated insulation. For conductors 22 mm^2 and larger, color coding shall be by plastic-coated self-sticking markers, colored nylon cable ties and plates, or heat-shrink type sleeves. Control circuit terminations shall be identified.

(4) Splices shall be made in accessible locations; splices in conductors 5.5mm^2 and smaller shall be made with an insulated pressure type connector, splices in conductor 8 mm^2

and larger shall be made with a solderless connector and covered with an insulation material equivalent to the conductor insulation.

3.0 CABLE AND WIRES - INSTALLATION

3.1 Main Cable Routing

(1) All main cables shall be routed by use of cable trays or cable ladder when installed horizontally or vertically in an open area.

(2) No intermediate metallic conduit shall be used for horizontal and vertical routing of main cables, in an open area.

(3) Intermediate metallic conduit may be used for concrete embedded installation or special use when required.

3.2 Secondary Cables and Wires Routing

(1) Secondary cables and wire shall use cable trays or ladder.

(2) Where this is not possible the routing has to be made in accordance with the following:

(a) Conduits in general shall be Intermediate Metallic Conduit (IMC) with an interior coating.

(b) Polyvinyl-chloride conduit (PVC) shall be heavy wall, schedule 40, with factory made bends, couplings and fittings.

(c) No conduits shall be used in any system smaller than 20mm (3/4 inch) diameter electric trade size, nor shall have more than four (4) 90 degree bends in any one run and where necessary, pull boxes shall be provided as directed.

(d) No wire shall be pulled into any conduit until the conduit system is completed in all details, in the case of concealed work until all rough plastering masonry has been completed, and in the case of exposed work until the conduit work has been completed in every detail.

(e) The ends of all conduits shall be tightly plugged to avoid entrance of plaster, dust and moisture while the construction of building is in progress. All conduits shall be reamed to remove all burrs.

(f) All pipes and fittings on exposed work shall be IMC and be secured by means of metal clips, which shall be held in place by means of machine screws. When running over concrete surface, the screws shall be held in place by means of expansion sleeves. All pipes on exposed work shall be run at right angels to and parallel with the surroundings walls. No diagonal runs shall be allowed and all bends and offsets shall be avoided as much as possible. Where necessary conduit fittings shall be used. Conduits in all cases, shall be run perfectly

straight and true, satisfactory to the Engineer. Conduits shall be supported at 1.50 meter intervals maximum.

(g) No splicing of wires shall be made inside the conduit run from equipment to box or from one box to another box. Splicing shall be done only in boxes.

3.3 Insulated Bushings

Bushings shall be made in such way to protect cables and wires as well as allowing easy maintenance.

4.0 PANEL AND CABINETS

4.1 Except when specified, all panels and cabinets shall be of the surface mounted type.

4.2 Standard panels and cabinets, as much as possible, shall be used and assembled on Site. All panels shall be dead front construction, furnished with trims for mounting as required. Cabinets shall be of code gauge steel with gutters at least 100mm wide and wider if necessary. The trim for all panels shall be finished in industrial gray enamel over a coat of rust inhibitor.

4.3 Panelboard main bus work shall be ampacity rated to equal or exceed overcurrent protective device immediately ahead of it. All buswork shall be properly secured to withstand available short circuit forces at the location.

4.4 Distribution panels shall be equipped with two poles and three poles air circuit breakers of sizes, voltage ratings and interrupting capacity as called for on the Drawings.

4.5 Panelboard buses: copper bus bars shall be supported on bases independent of the circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. A separate ground bus marked with a green stripe along its front shall be provided and bonded to the steel cabinet for connecting grounding conductors.

4.6 Mounting heights: panelboards, circuit breakers and disconnecting switches shall be mounted so the height of the operating handle at its highest position shall not exceed 1.8 m from the floor.

5.0 INDIVIDUAL BREAKERS AND SWITCHES

5.1 General

(1) Individual circuit breakers, safety switches and disconnect switches shall be provided where indicated on the Drawings.

(2) Voltage ratings shall be suitable in each case of service application.

(3) Enclosures shall be General Purpose.

(4) Unless otherwise specified, minimum interrupting level for 240 volts circuit breakers shall be 10 KA.

5.2 Operation type

(1) Circuit breakers shall consist of a quick-make, quick-break type entirely trip-free operating mechanism with contact, arch-interrupter, and thermal magnetic trip unit for each pole, all enclosed in a molded-phenolic case.

(2) The thermal-magnetic trip unit shall provide time-delayed overload protection in case of overload or short circuit current in any one pole.

(3) Circuit breaker shall be trip indicating, with the tripped position of breaker handle midway between "ON" and "OFF" positions.

5.3 Residual Current Circuit Breaker (RCCB)

(1) Shall be pole 250 volts maximum, 60 Hz, rated at 25 amperes with adjustable ground fault current sensitivity.

(2) RCCB shall provide protection against ground fault (earth-leakage) current.

(3) It shall stay independent in operation using a core balance current transformer for differential current sensing and tripping.

(4) RCCB shall have complete mounting box and accessories.

(5) RCCB shall be of approved manufacture.

6.0 DISCONNECT MEANS

6.1 Disconnect means shall be provided as indicated on the Drawings at motor locations. Disconnect switches shall be fusible or non-fusible as required and of sizes as indicated on the Drawings.

6.2 Disconnects shall be KW rated, of sufficient capacity to carry the continuous current of the load it controls and of the correct voltage rating.

6.3 Air or gas circuit breakers shall be used where feeder and motor protective means require. Circuit breaker shall be provided at each motor location where it is not within the sight of respective control starter, unless indicated otherwise on the Drawings. All circuit breakers shall be totally enclosed.

LIGHTING AND RECEPTACLE SYSTEM

1.0 SCOPE OF WORKS

1.1 The scope of works for the lighting & receptacle system consists of design, (where applicable) manufacture, supply and installation, testing and commissioning of the complete Lighting & Receptacle System.

1.2 The scope of works for the lighting system is as follows:

(a) All lighting fixtures and accessories for interior use including those lighting fixtures mounted on the exterior surfaces of the building and shall be of LED Type.
(b) All lamps, lighting switches, lighting control systems and wiring accessories.

(c) All essential / emergency lighting, exit signs, directional and information lighted signs and security lighting system.

1.3 The works to be executed under the power receptacle system are:

(a) General receptacle outlets installed at various area of the airport complex, which includes indoor and outdoor types, flush mounted or surface mounted.

(b) Installation of conduit, wireways, trunking and other accessories.

2.0 DESIGN CRITERIA

2.1 The system is designed in accordance with the following conditions:

(a)	Operating ambient temperature	:	10°C to 40°C
(b)	Enclosure	:	0° to 60°C
(c)	Operating ambient humidity	:	+ 50% to 99% RH
(d)	Operating voltage for all luminaries	:	shall be 230 volts at 60 Hz

2.2 The lighting design general requirements for the interior and exterior lighting system in the entire complex and other facilities are designed in accordance with the applicable requirements of the latest edition of PEC Part 1 and Part 2, NFPA 101, IES, UL & other internationally accepted Standards and the following requirements:

(a) Ambient lighting design shall use the following:

(i) Actual lumen output shall be 85% of the specified lamps' initial lumens and a power factor correction to at least 0.9.

(ii) Maintenance factor of 0.85 for down lights and 0.65 for up-lights

(b) Emergency illumination shall be provided throughout the airport complex in the event of normal lighting failure.

(c) Where paneled ceilings/ ceiling tiles shall be erected, particular care shall be taken in setting out to ensure that the luminaries are symmetrically disposed in relation to the ceiling panels; except where otherwise specified the centers of luminaries shall coincide with the centers of the ceiling panels.

3.0 LIGHTING CONTROL

3.1 In large public areas the lighting control system shall be directly homerun to panel board via Switch bank in designated area.

3.2 Areas such as offices, private shops, specific technical room/areas and other non-public areas shall be directly controlled through local switches as usual.

4.0 SUBMITTALS

4.1 Shop Drawings

(1) Shop Drawings shall clearly indicate the Document number of fitting details used as reference in the development of the shop drawings.

(2) Shop drawings shall be complete submissions for approval and maintenance and, where applicable, shall include the wiring diagram, scale plans, and details showing the method of installation of lampholders, lamps, reflectors, transformers and secondary feeds.

(3) Where applicable, field dimensions shall be verified and included on shop drawings showing exact locations of lampholders, and lamp shapes and lengths.

(4) The Contractor shall coordinate all his lighting fitting drawings with the Drawings and details of the Architectural, Structural, and Electrical, Mechanical, and other related trades to assure conformance with the Engineer's requirements.

4.3 Samples

(1) After shop drawing review, and prior to release for ordering, the Contractor shall furnish one sample of each fitting on the fitting schedule Drawings for which sample requirement is noted. These should be a working model of the luminaries to test the performance and show the workmanship and finishes.

(2) Samples are not returnable, nor included in quantities listed for a project. Approved samples shall be kept on Site for reference.

(3) Samples must be actual working unit of materials to be supplied.

4.4 Other Submittals

The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each type of special light fitting, photo-electric lighting controls, a recommended maintenance manual including:

(a) Tools required

(b) Types of cleaners to be used

(c) Replacement parts identification lists

5.0 PRODUCTS

5.1 General Requirements

(1) LED lamps with ratings as indicated in the plans/drawings shall have a maximum value of harmonic complying with the relevant JIS. Power factor correction shall be provided and this shall be not less than 0.95 lagging unless otherwise indicated.

(2) Emergency light fitting shall comply with the current PEC.

(3) All light fittings shall be supported independently of ductwork or piping.

(4) All sheet metal work shall be free from tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion after assembly.

(5) Housings shall be so constructed that all electrical components are easily accessible and replaceable preferably without removing fittings from their mountings, or disassembly of adjacent construction.

(6) All castings shall be exact replicas of the approved patterns and shall be free of sandpits, blemishes, scales and rust, and shall be smoothly finished. Tolerance shall be provided for any shrinkage of the metal castings in order that the finished castings will accurately fit in their designated locations.

(7) All lamp sockets in light fitting shall be suitable for the indicated lamps and shall be set so that lamp is positioned in optically correct relation to all lighting fitting components. If adjustable socket positions are provided, socket should be preset in factory for lamp specified. If different socket positions are specified for same fitting, sockets shall be preset for each type, where practical and cartons marked accordingly.

(8) All fittings shall be completely wired at the factory.

(9) Outdoor fittings: fittings for use outdoors or in areas designated as damp locations shall be suitably gasketed to prevent the entrance of moisture. Approved wire mesh screen shall be provided for ventilation openings. All dissimilar metal materials shall be separated by a non-conductive material to prevent galvanic action.

(10) For steel and aluminum fittings, all screws, bolts, nuts and other fastenings shall be cadmium or equivalent plated. For stainless steel fittings, all fastenings shall be stainless steel. For bronze fittings, all fastenings shall be stainless steel or bronze.

(11) Welding shall be done with electrodes and/or methods recommended by the manufacturers of the metals being welded. Welds shall be continuous, except where spot welding is specifically permitted. Welds exposed to view shall be ground flush and dressed smooth. All welds on or behind surfaces which will be exposed to view shall be done so that finished surface will be free of imperfections such as pits, runs, splatter, cracks, warping, dimpling, depressions or other forms of distortion or discoloration. Weld spatter and welding oxides shall be removed from all welded surfaces.

(12) Mechanical: All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that swinging or other normal motion will not cause them to drop out.

(13) Lampholders shall comply with the table below. Other types shall be used only where indicated.

Table 6200.1 Lampholders

LAMP TYPE	**RATING WATTS**	**LAMPHOLDERS**
Fluorescent (T5 & T8 – LED Tube)	16-32	Bi-pin
HID	Up to 150 200 Above 200	Bayonet B22d Edison Screw E27 Edison Screw E40

(14) Fluorescent lamp holders shall be white urea plastic; contacts spring-loaded-silver-plated phosphor bronze.

(15) High intensity discharge lampholders shall be porcelain; screw shell: nickel-plated brass, pre-lubricated with silicone compound; contact: spring-loaded silver-plated phosphor bronze.

(16) White finishes: Minimum of 85% reflectance.

(17) All lamps shall be of the LED type and rating as indicated in the plans and applicable to all lighting fixtures

(18) Furnish and install all LED lamps.

(19) All LED lamps of a given type shall preferably be supplied by the same manufacturer.

(20) Fluorescent light fittings shall be as follows:

(a) General construction and materials: housing end plates, socket bridges, reflectors, wiring channels and ballast covers shall be die formed of not less than 0.9 mm thick cold rolled steel, unless specified otherwise.

(b) Construct fittings so that ballast may be serviced or replaced preferably without removal of fitting housing.

(c) Ballasts must be the manufacturer's best sound rating, and the sound rating indicated on the ballast. Ballasts found by the Engineer to be unduly noisy shall be replaced without charge prior to acceptance of the job. Ballasts shall be high power factor, high efficiency, low loss type.

(d) Relative light output: (percentage of light emitted with reference tube and ballast) shall be not less than 95%.

(e) Electrical characteristics: ballasts shall be designed for single frequency operation, 60 Hz. nominal, and shall operate at the nominal voltages indicated on label, 230 volt.

(f) Outdoor ballasts shall be suitable for operation and starting at 10°C minimum.

(g) Ballast shall bear a manufacturer's label that has been certified.

5.2 Exit Signs

(1) Self contained and maintained and non-maintained type Exit signs shall be constructed with removable gear tray that is independent of housing to facilitate ease of installation, maintenance and replacement of lamps. Housing shall be galvanized steel with epoxy powder coating, except in external application, which shall use polycarbonate IP54 or IP65 enclosure, as appropriate for the location. Exit signs shall comply with most recent PEC, IEC 598-2-22 and other applicable international Standards.

(2) Exit signs shall have the following features:

(a)	Face plate	:	single face or double face with or without directional signs
(b)	Lamp	:	1 x 9W LED lamp
(c)	Mains Supply	:	230 volt, 60Hz

(d) Charge monitor : red L.E.D. 5mm diameter

(e) Diffuser : fire retardant acrylic

5.3 Lighting Switches

(1) Lighting switches shall be rated 15 amperes, 230 volts, and 60Hz and shall be selected by the Architect for final color appearance. Except for weatherproof, all lighting switches shall be toggle, quiet type; and spring operated.

(2) Lighting switches shall be:

(a) Single-gang switch (one single pole switch in one cover plate).

(b) Two-gang switches (two –single pole switches in one cover plate).

(c) Three-gang switch (three-single pole switches in one cover plate).

(d) Three way switch (one switch in one cover plate, for switching of lamps in two or more locations).

(e) Four way switch (one switch in one cover plate, for switching of lamps in three or more locations, wired together with three way switches).

6.0 INTERFACE WORKS

6.1 Mechanical & Electrical Rooms

Mounting height and location of light fitting shall be coordinated to clear mechanical, electrical and plumbing equipment and to illuminate adequately meters, gauges and equipment.

6.3 Interface with the Flight Information Display System (FIDS)

6.4 The Contractor shall coordinate and be responsible for ascertaining the location of all outlets or receptacles. Outlets or receptacles incorrectly located shall be relocated at the Contractor's expense.

LIGHTNING PROTECTION AND GROUNDING SYSTEM

1.0 SCOPE OF WORKS

1.1 General

The scope of works in this Section consists of the design, manufacture, supply and installation, testing and commissioning of complete Lightning Protection and Grounding Systems.

1.2 Lightning Protection

(1) The installation of Lightning Protection System shall ensure that the whole airport complex complete with all its passengers, operational personnel, equipment, and building structural will be protected from the danger of direct or indirect lightning strikes. This is to ensure that no personal injury, property damage nor disruption is caused to the continuous operation of Davao airport due to the effects of Lightning.

(2) An air terminal network shall be designed for the airport complex. The air terminal shall be located at strategic points around the complex and at sufficient height to effectively screen the building structure from lightning.

(3) Down conductors shall be connected to all the air terminals to convey the lightning discharge to earth without danger of side flashing.

(4) Performance recording equipment shall be provided to serve as lightning event counter.

(5) Grounding system connecting to the down conductors strike shall safely disperse the discharge current.

1.3 Grounding System

Grounding System shall be mainly composed of three independent grounding system, as described below:

(a) Building Grounding System

(i) All Medium Voltage (MV) Systems grounding consisting of grounding of all MV panels, switchgears, cabling in all MV substations.

(ii) All LV 460/230V grounding for all normal and emergency main switchboards, distribution boards, lighting panel and enclosed circuit breaker.

(iii) All grounding of trunkings, cable trays, cable ladders, conduits, junction boxes, lighting fittings, general receptacle outlets, small equipment installed in the complex and other facilities.

(iv) All grounding for Standby Generating Systems and their related electrical equipment.

(v) All grounding for the Telephone System

(vi) All computer systems grounding.

(vii) All communications equipment grounding.

(viii) All equipment grounding of metal enclosed equipment.

(ix) The installation work shall include all the necessary materials and accessories needed for the whole installation such as::

- ground rods or electrodes
- exothermic weld kits, connecting clamps, and bonds
- grounding cables and conductors
- ground bars and disconnecting links
- ground bar terminals including test terminals
- ground wells or pits

(x) The installation of the grounding systems to the related systems such as MV, LV, Transformers, Generators, UPS, Telephone, and computer systems shall be designed and installed to protect life and equipment against dangerous voltage potentials due to earth leakage currents.

(b) Grounding for Transformers

A separate grounding system for the transformer's secondary neutral circuit will be provided.

(c) Aircraft Grounding System

A separate grounding system network shall be provided at the Apron area which includes "grounding plug" system dedicated to the grounding of aircraft when in parking position.

2..0 SYSTEM DESCRIPTION

2.1 Lightning Protection System

(1) The Lightning Protection System shall be based on the latest international Standards known as the Collection Volume Method.

(2) This lightning protection system shall generally consist of three essential components:

(a) Air Terminals located on the roof level of the complex to protect the entire complex basing on the "collection volume" method with these terminals designed as early streamer emission type to create an early initiation of the upward connecting leader.

(b) Down conductors that are connected to these air terminals to discharge to ground safely without danger of side flashing. These down conductors shall either be of high voltage purpose designed screened cables or copper strips of adequate size suitable to discharge the current down to ground.

(c) Grounding system needed to safely disperse the discharge current received from the air terminals down to the down conductors and then into the ground below.

2.2 Grounding System

(1) The basic grounding components of Building Grounding Systems shall be comprised of all the items as follows:

(a) Ground cabling or ground conductors connecting to

(i) All metalwork of all wiring systems (other than current carrying conductors) including conduits, floor ducts, raceways, wireways, cable trays, busducts and boxes.

(ii) Exposed metalwork of all electrical equipment such as MV and LV Panels, receptacle outlets, lighting points, switch points grounding terminals.

(iii) Grounding terminals of all distribution boards, lighting panels and enclosed circuit breakers.

(iv) Grounding of neutral of generator sets.

(b) Ground bars and disconnecting links

From the ground bars and/or disconnecting links, grounding leads shall be connected to ground rods.

(c) Ground bar terminal on insulated supports

Ground bar terminal including test terminal pit with concrete cover shall be installed in the following areas:

(i) Three (3) test terminal pits of the electrical room, ground floor, of the PTB.

(ii) Three (3) test terminal pits at the Power House.

(2) Transformer Grounding System shall be as follows:

(a) All secondary neutral system of all transformers shall be grounded independently from all other transformers.

(b) Transformer neutral grounding system shall be separate from all other grounding system, e.g. Building Grounding System and Lightning Protection Grounding System.

(c) All other exposed non-current-carrying metal parts of transformer installations, including secondary circuits of current and potential instrument transformer shall be connected to the Building Grounding System.

(3) Aircraft Grounding System shall be as follows:

(a) The system shall be provided with a dedicated (and inter-connected) 100mm^2 bare copper wire grounding network that will connect all grounding plugs.

(b) The installation of the earthing plugs will be carried out during the concrete work of the Apron area.

3.0 DESIGN CRITERIA

3.1 System Requirements

(1) Lightning Protection System shall be designed in accordance with the following criteria:

(a) The system shall be of the Collection Volume Method type with air terminals designed as early streamer emission type to create an early initiation of the upward connecting leader.

(b) Each roof of the complex shall be installed with designed and calculated number of air terminals, mechanical supports, down conductors and a grounding system suitable for the protection of the airport complex.

(c) Performance recording equipment and a grounding system shall be installed to record and discharge the lightning strikes down to the earth every time.

(d) The system shall be required to operate without failure continuously for 24 hours a day, 365 days a year.

(e) The design of the different components shall be traceable to field research, laboratory testing, statistical levels of the lightning events.

(f) The grounding resistance shall not exceed 5 ohms.

(g) The whole system shall be designed with direct coordination with the architectural works to ensure that the aesthetic criteria are met.

(h) Lightning Protection System's ground wells shall not be connected to any other Grounding System.

(2) The grounding system for all systems shall be designed to the following criteria:

(a) Protective conductor in each power supply cable

(b) Equal potential bonding of all exposed metal parts of current carrying equipment

(c) Lowest electrical resistance (in ohms)

(d) Good corrosion resistance

(e) Able to carry the high current repeatedly

(f) Reliable life span of at least 30 years

(3) Ground resistance measurements for individual systems shall be as follows:
(a) MV Systems – not exceeding 5 ohms

(b) Transformers – not exceeding 5 ohms

(c) LV Systems – not exceeding 5 ohms

(d) Lighting Systems – not exceeding 5 ohms

(e) Telephone Systems – not exceeding 5 ohms

(f) Computer System – not exceeding 5 ohms

(4) All individual grounding for MV System, LV Systems, Standby Generating System, computer system, and all communication systems shall be inter-linked to the Common Building Perimeter ground as shown on the Drawings.

3.2 Technical Requirements

(1) The lightning protection system shall include components as follows:

(a) Air termination(s)

(b) Mechanical support(s)

(c) Down-conductors(s)

(d) Lightning counter(s)

(e) Grounding system.

(f) Ground wells or pits

(2) The Lightning Protection System shall be designed in accordance with the following requirements:

(a) Air Termination

(i) The air termination shall be of the early streamer emission type that responds dynamically to the appearance of a lightning down-leader by creating free electrons and photo-ionization between a spherical or pointed surface and a grounded central finial.

(ii) Arcing is not to be continuous and shall only occur during the progress of the lightning leader. Arcing shall not occur solely due to electro-static

field when a thunderstorm is overhead, except when there is leader activity in the region.

(iii) The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.

(iv) The air termination shall be non-radioactive and require no special licensing.

(v) The external shape of the terminal shall be such as to significantly reduce the build up of sharp point corona discharge under static field thunderstorm conditions.

(vi) The air termination shall not be dependent upon batteries or external power supplies for any part of its operation. It shall have no moving parts. The materials of the air termination shall be non-corroding in normal atmosphere. The center grounded finial shall be made of electrical grade non-ferrous material.

(vii) The air termination shall be insulated from the protected structure under all conditions.

(viii) The size of the collection volume and attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

(ix) The air termination shall be mounted a minimum of 10 meters from the ground.

(x) The air termination shall be installed strictly to the manufacturer's instructions with the approval from the Engineer. It shall not be installed in corrosive environments or atmospheres.

(b) Air Termination Support

(i) The support shall consist of either a minimum of 1.2 meters of termination insulating fiberglass cylindrical tube or copper rod.

(ii) The down-conductor shall either pass through the center of the tube or be clamped rigidly to the copper rod.

(iii) The support shall be securely bolted to other mast materials with guy wires used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities. The support arrangement shall have sufficient rigidity to ensure that the maximum deflection of the termination under such extreme wind conditions shall not exceed 100mm. The support arrangement shall

have a first natural frequency of oscillation occurring at a wind speed at least two times the maximum design wind speed for the region.

(c) Down-conductor

(i) The down-conductor shall either consist of a plastic filler, copper conductor, inner insulation, outer copper conductor, outer insulation and conductive sheath all concentrically arranged, or adequate size of copper strips.

(ii) The main copper conductor shall be made of electrical grade copper of minimum cross sectional area of 50mm^2 or as specified by the manufacturer of the lightning protection system.

(iii) In the final 3m to the ground and where it is exposed to human contact, the down-conductor shall be placed in a protective PVC pipe of 3mm minimum wall thickness so as to avoid mechanical damage and increase human safety.

(iv) The main copper conductor shall be capable of direct crimp press to the base of the air termination.

(v) The down-conductor shall be installed in accordance with the manufacturer's instructions and shall not be subject to bends of less than 0.5 meters radius.

(vi) The down-conductor shall be secured to the structure by approved metallic fastenings at least every 2 meters.

(d) Lightning Counter

(i) Every protection system shall be supplied with a lightning counter.

(ii) The lightning counter shall have an electronically controlled mechanical register that is activated on registration for every discharge at the point of measurement over 1500A peak current.

(iii) The lightning counter shall be water resistant, robust and easy to install. It shall have a concentric hole between 52 and 60mm diameter through which the down-conductor or earth stake is placed.

(iv) The lightning counter shall be installed to the manufacturer's instructions in a readily accessible manner so that readings can be taken at regular intervals.

(e) Grounding

(i) The grounding system shall not exceed 5 ohms static impedance except with prior approval by the Engineer of the lightning protection system.

(ii) Grounding will be done by copper wire or tape buried not more than 750mm deep, by deep drive copper clad steel earth rods especially designed for electrical grounding or a combination of these. In all cases the grounding system shall be electrically connected to the center ground rod that is securely connected to the down-conductor system.

(iii) Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building and to arriving services is required. However, the resistance must be measured and the 5 ohms maximum figure achieved before such bonding is done.

(iv) Electrically conductive, non-soluble Ground Enhancing Compound may be used to help achieve low ground resistance, provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

(v) All ground electrodes shall be installed and protected by ground well with concrete cover.

(3) The grounding system shall be designed in accordance with the following requirements:

(a) Lighting fixtures, receptacle outlets and fixed wiring to appliances shall be grounded by an earth conductor forming part of the respective sub-circuit cabling, with a separate earth conductor for each sub-circuit.

(b) Metallic pipes, ducts or brackets in the vicinity of metallic enclosures containing electrical supplies shall be grounded to the enclosure ground.

(c) Grounding shall be in accordance with the requirement of the latest edition of PEC.

(d) The ground connection of all 2 pole, 3 wire grounding receptacle outlets, lighting fixtures, lighting columns and poles, metal parts of all switchgear, distribution boards, metal conduits and all other items of metalwork, that are likely to become 'live' in the event of the electrical installation becoming defective, shall be effectively bonded to ground by means of copper ground-continuity conductors (aluminum conductors shall not be permitted) of sizes as per PEC requirements.

(e) Ground continuity conductors and grounding leads shall be of high conductivity copper (aluminium ground conductors shall not be permitted), continuous throughout their whole lengths and without joints, except by means of approved mechanical clamps. Where connections are made at switchgear and such items

of electrical equipment, the conductors shall terminate in soldered or compression-type sockets.

(f) The electrical resistance of any ground continuity conductor or grounding lead measured from its connection with the main ground electrode system of a building to any other position in the complete installation in the building shall not exceed five (5) ohms.

(g) The main grounding lead of the installation shall be taken from as directly as possible without looping into any accessory or equipment, to the ground electrodes. Such grounding leads shall be mechanically protected by means of conduit or similar means, which shall be surface-run on walls and buried in the ground, at a depth of not less than 450mm below finished ground level.

(h) For each ground rod system, rods shall comprise 20 mm diameter, 3000 mm long, extendable type, copper/steel-cored rods (copperweld or approved equivalent make), or hard-drawn copper rods of approved manufacturer driven into the ground at intervals of at least at every 50 meters. The ground electrodes shall be driven into the ground by means of an electric or pneumatic hammer or similar type. Every connection clamp shall be provided with a concrete inspection chamber and cover. Each and every cover shall be clearly marked and identified the ground electrode system they belong to.

(i) The number of ground rods to be driven into the ground for each ground rod's system will entirely depend on the soil conditions in the vicinity where the electrodes are installed. The Contractor shall therefore provide a sufficient number of ground rods to obtain the above-mentioned requirement and no claims for additional ground rods to meet these requirements shall be allowed. The Contractor may, at his own discretion, increase the length of ground rods to obtain the required ground resistance value.

(j) Interconnecting ground-continuity conductors between the rods shall comprise cables buried in the ground, to a depth of not less than 450mm below finished ground level. Such conductors shall be of sizes to suit the main grounding leads to each rod system, in which case, the ground-continuity conductors between rods shall be in accordance with the requirements of PEC. In the case of the ground rod system for the switchboards and other intake positions requiring rod systems, interconnecting conductors between ground electrode and the main grounding leads may comprise a 25 x 3mm cross-section, high conductivity copper tape (or equivalent Bare Copper Wire, BCW, size), enclosed in conduit and buried in the ground to a depth of 450mm below finished ground level.

(k) Independent ground rods shall be installed for testing the groundings resistance.

(4) All necessary materials, accessories, cables, copper tape, earth electrodes and other relevant items to complete with electrical grounding requirement of the Works shall be supplied and installed by the Contractor.

(5) The Contractor shall provide the necessary number of ground points and inter connections to obtain a resistance as specified . Complete test results shall be recorded and certified by the Engineer.

(6) The complete installation or any part thereof shall be tested both and witnessed by the Engineer. The grounding resistance of each system shall not exceed the following value:

(a) For lightning ground resistance, max 5 ohms.

(b) For all other ground resistance, max 5 ohms each

4.0 INTERFACING WORKS

4.1 Lightning Protection System

No major interface.

4.2 Ground System

(1) The interfaces between the grounding system and all installations for which they are intended are located in the equipment rooms of:

(a) MV equipment in all MV Substations

(b) LV equipment in all LV Substations

(c) Transformers in Transformer Rooms

(d) Riser cores in Buildings General

(e) Generators in Generator Rooms

(f) All communication equipment room, control and operation rooms in the complex.

(g) Apron area

(2) All the grounding systems terminate on ground bar terminals or ground terminal boards installed at the appropriate rooms in an appropriate position. Other Sections will cover all the interconnection between all equipment and the ground terminal bar respectively.

5.0 POWER SUPPLY

5.1 MATERIAL REQUIREMENTS

POWER TRANSFORMER, PADMOUNT, OIL COOLED 3ø 2000KVA 13.8/14.4Kv PRIMARY VOLTAGE, 400/230 VOLTS SECONDARY VOLTAGE

HIGH VOLTAGE SWITCHGEAR (HVSG), 15KV, 100A, OUTDOOR TYPE

GENERATOR SET, 3ø 350KVA 400/230VOLTS, 60HERTZ, STANDBY DUTY, SILENT TYPE

GENERATOR SYNCRONIZING PANEL FOR 6-350KVA 3PHASE 400/230VOLTS WYE 60HERTZ STANDBY-DUTY GENERATOR HOSTS, 2000KVA POWER HANDLING CAPABILITY

PRIMARY METERING; 3SETS-POTENTIAL TRANSFORMERS 15KV/230V; 3SETS-MV CURRENT TRANSFORMERS; 3Ø DEMAND METER & OTHERS

LOW VOLTAGE SWITCHGEAR; MAIN BREAKERS: 2-4P3000AT/AF 120KAIC AUTO-SWITCHING (COMPARTMENTS 1 & 2); BRANCHES: 2-4P1000AT/AF 100KAIC (COMPARTMENT 3 & 4); 1-4P400AT/AF 65KAIC (COMPARTMENT 5);2-4P350AT/400AF 65KAIC (COMPARTMENT 5); NEMA 3R ENCLOSURE COMPLETE WITH METERINGS, INDICATOR LAMPS, GROUNDING BUS

LOW VOLTAGE SWITCHBOARD (LVSB), SEE PLSND A& SPECS OR SEE BELOW, COMP1: MDP. COMP2: WCPHP. COMP3: AHUP, COMP4: SPACE, COMP5: SPACE; NEMA 3R ENCLOSURE COMPLETE WITH METERINGS, INDICATOR LAMPS, GROUNDING BUS

MV CONCRETE PEDESTAL SERVICE ENTRY; 13.8KV, 3Ø WITH 4-100MM DIA. PVC & OTHERS

POWER CABLE AND TERMINATION KIT (XLPE CABLE; 15kV, SINGLE CORE, 100MM² - 630 METERS AND 4 SETS HIGH VOLTAGE TERMINATION KIT; 4P)

THW COPPER WIRE 250MM² 99.99% COPPER
THW COPPER WIRE 50MM² 99.99% COPPER

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

TELECOMMUNICATION - SERIES 7000

TECHNICAL SPECIFICATIONS FOR TELECOMMUNICATION WORKS

SERIES 7000

Telecom System-GENERAL DESIGN REQUIREMENTS
Section 7200-01 – ACCESS CONTROL SYSTEM (ACS)

Section 7200-02 – CABLE TV SYSTEM (CATV)

Section 7200-03 – CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)

Section 7200-04 – FIRE DETECTION AND ALARM SYSTEM (FDAS)

Section 7200-05 – FLIGHT INFORMATION DESIGN SYSTEM (FIDS)

Section 7200-06 – LOCAL AREA NETWORK (LAN)

Section 7200-07 – MASTER CLOCK SYSTEM (MCS)

Section 7200-08 – PUBLIC ADDRESS SYSTEM (PA)

Section 7200-09 – STRUCTURED CABLING SYSTEM (SCS)

Section 7200-10 – TELEPHONY SYSTEM (PABX)

Section 7200-11 – WIRELESS FIDELITY SYSTEM (WIFI)

Section 7200-12 – UNINTERRUTIBLE POWER SUPPLY (UPS)

SERIES 7000- TELECOMMUNICATION WORKS

Telecom System - GENERAL DESIGN REQUIREMENTS

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TERMINOLOGY AND ABBREVIATION

TERMINOLOGY

END-USER - Davao International Airport Authority (DIAA)

PMO - Civil Aviation Authority of the Philippines (CAAP)

EPC/CONTRACTOR - Company to whom the EPC Contract purchase order is issued to

PROJECT - Davao International Airport –Expansion of Passenger Terminal Building

ABBREVIATION

ACS	Access Control System
CAD	Computer Aided Design
CATV	Cable Television
CCTV	Closed Circuit Television
CPU	Central Processing Unit
DIA	Davao International Airport
DOLE	Department of Labor and Employment
DOTr	Department of Transportation
EOL	End of Life
FAA	Federal Aviation Administration
FDAS	Fire Detection and Alarm System
FIDS	Flight Information Display System
HVAC	Heating, Ventilation and Air Conditioning
Hz	Hertz
ICAO	International Civil Aviation Organization
IP	Internet Protocol or Ingress Protection
LAN	Local Area Network
MCB	Miniature Circuit Breaker
MCS	Master Clock System
PA	Public Address
PABX	Private Automatic Branch Exchange
PDF	Portable Document Format
PoE	Power over Ethernet
PTB	Passenger Terminal Building
RU	Rack Unit
SAT	Site Acceptance Test
SCS	Structured Cabling System
TCP/IP	Transmission Control Protocol / Internet Protocol
UPS	Uninterruptible Power Supply
VAC	Voltage Alternating Current
DRL	Document Register List
WiFi	Wireless Fidelity

A. Description

The General Design Requirements document provides the overall design requirements and specifications of the Telecom Systems including its associated peripherals and equipment for the DIA Terminal Building Expansion Project.

This document must be read in conjunction with all the twelve (12) Telecom Systems':

1. Technical Design Specifications
2. Bill of Quantities
3. Schematic Diagrams
4. Equipment Layout Diagrams

General Requirements

The awarded supplier shall provide the Telecom Systems' material selection, manufacture, supply, installation, system configuration, testing, packaging/shipping/delivery, documentation, training and commissioning of the Telecom Systems for this PROJECT.

The Telecom Systems shall be designed based on the requirements and specifications of the PROJECT.

The Telecom Systems shall be IP-based and shall be provided in all areas under the PROJECT scope.

The Telecom Systems shall be software controlled, easily configured and allow for future expansion. Where possible, The Telecom Systems shall use a single software and hardware platform.

The Telecom Systems shall interface and integrate with other systems as described in the individual Telecom System's Technical Design Specifications.

The Telecom System's equipment, peripherals and field equipment shall be Commercial-Off-The-Shelf products and proven to function well in international airports. These shall be the latest hardware models available in the market with the latest firmware, software and update as of commissioning date. Software updates and patches shall be made available and free of charge during the warranty period. Prototype or unproven equipment or materials shall not be considered nor installed in this PROJECT. No equipment shall be installed that are nearing its end-of-life or end-of-support. The manufacturer of all supplied equipment shall have an authorized Philippine distributor/reseller or branch with local support and services.

The Telecom Systems to be supplied and delivered in this PROJECT shall have a minimum of 10% equipped spare capacity (for hardware and software) of its initial configuration.

The approved supplier shall coordinate with all disciplines involved for the interfacing, installation, aesthetics and finishes of the new PTB.

APPLICABLE STANDARDS

The VENDOR shall show and demonstrate that the systems' equipment complies with the relevant standards and that the development, design, implementation and installation of the Telecom systems are in accordance and consistent with the codes and standards, Philippine laws, National and International airport standards, project standards, specifications, industry accepted practices and best engineering practices:

- Department of Transportation (DOTr)
- Civil Aviation Authority of the Philippines (CAAP) Manual of Standards for Aerodrome

- International Civil Aviation Organization (ICAO)
- Federal Aviation Administration (FAA) Standard and Recommended Practices
- International Air Transport Association (IATA) Airport Design Manual
- National Electrical Code (NEC) applicable standards
- Philippine Electrical and Electronics code
- Fire Code of the Philippines
- National Building Code of the Philippines
- National Fire Protection Association
- Underwriters Laboratories
- BICSI – Telecommunications Distribution Methods Manual
- BS 5839 – Fire detection and fire alarm systems for buildings
- BS 6259 – Code of practice for the design, planning, installation, testing and maintenance of sound systems.
- BS 6701 – Telecommunications equipment and telecommunications cabling – Specification for installation. Operation and maintenance.
- BS 6840 – Sound system equipment – Methods for specifying and measuring.
- EIA/TIA-568 – Commercial Building Telecommunications Cabling Standard Set
- EIA/TIA-569 – Telecommunications Pathways and Spaces
- IEC 60297-3 – Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482.6mm (19inch), Basic dimensions of the front panels, subracks, chassis, racks and cabinets.
- IEC 60529 - Degree of protection provided by mechanical casings and electrical enclosures against intrusion, dust, accidental contact and water.
- IEC 61000 – Electromagnetic Compatibility (EMC)
- IEEE 802 – Physical and data link layers of the Open Systems Interconnection (OSI).
- ISO/IEC 11801 – Information Technology – Generic cabling for customer premises
- ISO/IEC 14443 – Identification cards – Contactless integrated circuit cards
- ITU-T G.711 – Pulse code modulation (PCM) of voice frequencies
- ITU-T G.8010 – Architecture of Ethernet Layer Networks
- ITU-T Q.23 – Technical features of push-button telephone sets
- TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

In case of conflicts of the above standards or the specifications herein, the most stringent shall apply.

OPERATIONS AND MAINTENANCE

The Telecom Systems shall have a high reliability, high availability and shall be resilient since these will operate 24hrs a day, 7days a week.

The Telecom Systems target operational life shall not be less than ten (10) years after PROJECT acceptance. Hardware and software spare parts support shall be provided by the awarded supplier. End of life (EOL), end of support or discontinuation notifications by the manufacturers shall be provided to the END-USER at least two (2) years in advance of the projected EOL.

The telecom systems shall have the ability to go to a fully operational status from a shutdown status. In cases where an anomaly, incident, issue or problem occurs on a telecom system that causes it to shutdown or reboot, the system shall be able to recover immediately, back online and be fully operational without any human intervention or remote assistance. Failure of a component shall not cause a Telecom System to shutdown or degrade and shall maintain normal operation for the rest.

Maintenance and repair of Telecom Systems' components shall be possible without interrupting the normal operation.

The Telecom Systems shall have an ease-of-use operation and GUI-based terminals or workstations. The workstations shall be of good quality from reputable brands with the latest operating systems, software and firmware required by the telecom system. The workstations must be configured with the proper and extra capacities, fast processing times, good quality video/screen, etc.

The Telecom Systems and the workstations shall have minimum of three (3) hierarchical password levels based on the credentials of each user of role-based control for administration and operations wherein these are logged into the system and may be retrieved for audit trails.

Where possible, limit the workstations to a maximum of three (3) for all the Telecom Systems in such a way that the administration/monitoring terminals or workstations of the various Telecom Systems may share the hardware resources. For example, terminals using a web browser interface may share with other terminals using the same method. Terminals with less extensive software applications may be loaded and shared with other workstations. The awarded supplier shall verify and confirm the possibility of implementing such setup.

SOFTWARE AND SUPPORT LICENSES

The awarded supplier shall ensure that the software, device, equipment and component licenses required to complete, configure, commission, operate and maintain the Telecom Systems are included in the supply. Where the licenses are not perpetual, the awarded supplier shall supply said licenses for three (3) years to commence upon PROJECT acceptance.

It shall be the responsibility of the END-USER to continue with the subscription of these licenses with the manufacturer or through the help of the awarded supplier. The licenses are an important factor for the continuance of the Telecom Systems' operation and performance.

EQUIPMENT/TELECOM CABINET

All equipment cabinet or racks shall conform to the following specifications:

- 42RU (Height) x 600mm (Width) x 1000mm (Depth) SES Cabinet
- Four (4) adjustable 19-inch vertical mounting posts type C with RU markings.
- One (1) Top panel with 100mm x 300mm cable entry opening (with cover and screws).
- One (1) Roof fan tray with fans. Number of fans and airflow for each cabinet shall be determined from the Heat Dissipation Report.
- Fans shall be controlled by a thermostat where inside temperature may be set variably.
- One (1) Fully perforated front door with swing-handle key lock and quick release hinges.
- One (1) Fully perforated double rear door with swing-handle key lock and quick release hinges.
- Two (2) Snap on side panels with locks.
- Bottom part shall have removable plates with brush or grommets to allow cable entry.
- Four (4) transit castor wheels fitted with levelling feet.
- Baying kits shall be provided for systems that require two (2) or more cabinets.
- Finished in RAL 9005 black, powder coated.
- Load rating of 1,000kg static.
- Shall support the weight of a fully loaded cabinet with equipment, cables and accessories.
- Complete with the necessary:

- Cable managers
- Din-rails
- Miniature circuit breakers (MCB) for each equipment. This shall be mounted on the top portion of the vertical mounts with encasement (40 to 42RU). Circuit breaker ratings shall vary depending on the requirement of the equipment installed in the equipment cabinet.
- Isolated earth bonding copper strip where all rack mounted equipment, cabinet metal parts, doors, panels, rails, etc. shall be grounded using green/yellow earth cables. An M10 nut shall be used to connect to the main bonding copper strip within the Telecom Room.
- Another isolated instrument earth bar shall be provided for cable screens of the field cables if necessary.
- Grommet or brush to be fitted on the bottom cable entries (to avoid entry of vermin).
- Power, signal and field terminal blocks mounted on din-rails.
- Cantilever shelves for non-19inch rack-mountable equipment.
- One (1) Service outlet - 220VAC, 5A universal type
- Bolts, nuts, screws and other accessories needed to complete the Telecom Cabinet.

Aside from the standards mentioned in the previous sections, the internal wiring within the equipment cabinet shall comply with the following:

- Ensure that the cable sizes selected are suitable for the supplied power and specific signal.
- Use of ferrules and appropriate terminal lugs for each stranded cable end.
- Use shrinkable tubes to cover metal parts of the lugs or pins.
- No cable joints are allowed for any type of cable.
- Ensure that power and ground cables are routed on opposite sides with respect to the signal cables.
- Put covers and warning labels for the power terminals.
- Proper cable dressing secured with cable ties.

Each equipment cabinet shall incorporate a 20% spare space capacity (9RU) to provide space for future expansion.

All Telecom Systems' equipment cabinets shall be installed in the G/F Telecom Room of the new PTB. The equipment cabinets shall be of the same brand, model and size to maintain uniformity, design, standard, color and specifications.

SITE ENVIRONMENT CONDITIONS

All Telecom Systems equipment and materials shall be suitable for continuous operations under the conditions specified in this document, its equipment specifications and datasheets.
Equipment and materials located outdoors shall be suitable for continuous operation in direct sunlight or shall be supplied with a protection or hood accordingly.

Indoor conditions (Air-conditioned environment):

Temperature : 23^{o}C ± 3^{o}C

Humidity : 60%

In the event of air-conditioning system failure, the Telecom Systems shall continuously operate under the following conditions:

Temperature : 33°C ± 3°C

Humidity : 65%

Outdoor conditions:

Maximum solar temperature : 50°C

Maximum shaded temperature : 40°C

Minimum solar temperature : 30°C

Minimum shaded temperature : 25°C

Minimum degree of protection against ingress of solids and liquids for outdoor equipment shall be IP65. For indoor it shall be IP22.

The above temperature and humidity values shall be confirmed with the EPC before the implementation and before placement of the Telecom System orders.

Aside from the foregoing, all Telecom Systems equipment shall be carefully selected to have a degree of protection suitable for the installation and conditions like noise, vibration, seismic activity, electromagnetic interferences, lightning, wind, etc.

INCOMING POWER SUPPLY

The available commercial power at the Telecom Room shall be 220VAC ± 10%, 60Hz ± 5%, single-phase. The awarded supplier shall incorporate into their design and supply the power supply systems for the conversion of the main incoming supply to operate the Telecom Systems.

The awarded supplier shall provide a Power Consumption and Heat Dissipation Report for each Telecom System to be able to determine the total load requirement. This shall be used to size up the electrical components for the Telecom Room including sizing up the cables, circuit breakers, UPS, battery autonomy and generator capacities. The heat dissipation report shall determine the HVAC requirement of the G/F Telecom Room at the new PTB.

During a commercial power outage, a supplied UPS shall provide a temporary power for all the Telecom Systems inside the Telecom Room of the new PTB. This shall last for 10minutes of which, a generator shall then supply the needed power of the Telecom Systems.

Where necessary, the awarded supplier shall provide and install separate UPS for field equipment located outside the Telecom Room such as the video wall of CCTV System, etc.

EQUIPMENT TAGGING AND LABELING

All Telecom System equipment, peripherals, accessories and cables shall be tagged or labelled accordingly and shall provide a tagging procedure and shall coordinate this with the EPC, END-USER and other system suppliers/VENDORS for uniformity and consistency in this PROJECT.

TOOLS AND TEST EQUIPMENT

The awarded supplier shall be equipped with the necessary tools, proprietary tools, test equipment and consumables to perform the tasks needed in the installation, configuration, commissioning and tests of all items, materials, equipment and cables as required to complete the Telecom Systems.

SPARE PARTS AND SPECIAL TOOLS

The awarded supplier shall provide the recommended spares to cover the day-to-day operation of the END-USER. These spares are used for breakdown maintenance, preventive maintenance, inspection, replacements, etc. The awarded supplier shall include this in the submission of its bid including its cost as separate line items.

The awarded supplier shall provide the test equipment, special or proprietary tools required by the END-USER's personnel to perform routine inspections, tests and maintenance and shall include this in the submission of its bid including its cost as separate line items.

Include the software tools that are necessary and important to the END-USER in operating, maintaining, upgrading the telecom systems. These shall be loaded into the Telecom System's workstation or management terminals and separately provided in a USB thumbdrive.

INSPECTION AND TESTS

The awarded supplier shall provide all the tests required at the END-USER's site, in order to guarantee the complete and functional Telecom Systems. During all the tests, the awarded supplier shall have the necessary spare parts to replace a malfunctioning equipment or accessory in order not to hamper or delay the tests.

SITE ACCEPTANCE TEST (SAT)

The Telecom System equipment, peripherals, accessories, field equipment, cables, cabinets and other necessary items shall be identified and tested whereby results are recorded in the awarded supplier's Site Acceptance Test (SAT) Procedures document. The records shall include expected results or values, test results and measurements that are carried out. The SAT Procedure shall be developed by the awarded supplier and submitted to the EPC and END-USER for approval prior to conducting the actual SAT. The SAT shall only commence after the awarded supplier has successfully installed, tested and commissioned the Telecom Systems and with an approved schedule by all parties concerned.

The SAT shall include, but not limited to the following:

- Verification and recording of test equipment
- Equipment visual inspection and recording of equipment data
- Equipment checks against project specifications and datasheets
- Telecom Cabinet power, bonding and grounding checks and thermostat test
- Documents and drawings check according to the system design and implementation
- Telecom System components, equipment, peripheral, accessories and field devices' functional, operational, performance, interfacing and integration tests.

The SAT shall be carried out by the VENDOR and witnessed by EPC, END-USER and other relevant agencies in accordance with a previously approved SAT Procedure by the EPC and END-USER.

During the SAT, all functions shall be fully tested. All items and materials shall be inspected and tested at their installed locations.

Where applicable, Integration Tests shall be performed with other systems to which the systems are integrated and interfaced to.

Upon successful completion of the SAT, the EPC and END-USER shall sign the SAT Report as concurrence that the SAT has been conducted. The SAT Report shall be submitted to EPC and END-USER at the day of the SAT.

PUNCHLIST

A punch list of failed, unsatisfactory, incomplete, faulty or damaged items, materials, equipment, cable or accessory, which are unable to meet the required specifications, shall be listed under a Punchlist during the SAT. This list shall be compiled by the VENDOR, witnessed by the EPC and END-USER.

The awarded supplier shall resolve and complete all punch list items and inform the EPC and END-USER when all specifications are met and all punch lists are resolved and cleared. The EPC and END-USER shall then return to witness the re-testing.

Full acceptance shall not be granted until this Punch list is satisfactorily completed, accepted, approved and signed to the satisfaction of the EPC and END-USER.

WARRANTY

The awarded supplier and/or manufacturer shall provide a three (3) year warranty to take effect upon acceptance of all hardware, software, items, materials, components, peripherals and accessories for all telecom systems included in this PROJECT. Warranty for services and workmanship shall also be for three (3) years after commissioning and acceptance and shall consider other activities that will merit an extension of the warranty to more than three (3) years like: delivery, installation, setup, configuration and commissioning.

Supplier and manufacturer technical and commercial support shall continue until the projected Project Life of ten (10) years.

DOCUMENTATION

The PROJECT shall require the awarded supplier to submit the below list of documents and drawings in the English language:

1. Bill of Materials
2. System Design Specifications
3. Equipment Datasheets
4. Cable Schedule (for systems with field cabling)
5. Power Consumption and Heat Dissipation Report (per equipment cabinet)
6. Site Acceptance Test Procedure
7. IP Address List (if applicable)
8. Link Budget Calculation Report (for LAN System with FO cable)
9. Sound Coverage Study (for PA System)
10. CCTV Camera Coverage Study (CCTV System)
11. WiFi Heatmap Report (for WiFi System)
12. Equipment Certificates & Type Approval Certificates (if applicable)
13. Installation, Operation and Maintenance Manual
14. Training programs, modules and manuals
15. Block Diagram

16. Cable Runway, Cable Structure Details and Cable Riser Diagrams (for SCS)
17. Dimensional and Mounting Details Diagram
18. General Arrangement Diagram or Rack/Cabinet arrangement
19. Equipment Layout Diagram
20. Wiring and Interconnection Diagram

The foregoing documents and drawings shall be subject to the approval of the EPC and END-USER where no equipment or item shall be ordered, supplied or delivered without their approval on the documents and diagrams or drawings.

Document and drawing/diagram templates shall be first submitted to the EPC and END-USER for approval. EPC and END-USER shall send their comments, instructions or changes and shall be incorporated by the VENDOR before the actual submission of design documents and drawings.

The first submission of documents and drawings shall be submitted as "Issued for Review" under a Revision A, whereby the EPC and END-USER shall comment, raise queries, change or instruct the awarded supplier accordingly based on their design inputs and submissions.

The awarded supplier shall incorporate the comments, queries, changes or instructions and shall re-submit them as "Issued for Approval" under a Revision B. These re-submissions and revisions shall go on until the EPC and END-USER are satisfied with the Telecom Systems' design.

Once no comments, queries, changes or instructions are given, the awarded supplier may re-submit the documents and drawings as "Issued for Construction" Revision 0 (zero) where "no comments" are written on the revision page and no revision clouds on the drawings. Once approved, the VENDOR may order, supply and deliver the Telecom Systems.

Documents shall include a revision history page where all comments are listed, detailed and answered while changes in the drawings shall have revision clouds and a revision sheet.

After the Site Acceptance Test is conducted, all comments, changes, instructions and punchlist clearances shall be incorporated into the documents and drawings for final As-Built documentation submission. The documents and drawings shall be rolled-up, issued and submitted for "As-Built" under Revision 1 (one).

The awarded supplier shall have a dossier of all the documents and diagrams/drawings submitted and shall maintain a Document Register List (DRL) to keep track of all submissions and shall be shared with the EPC and the END-USER for their reference.

Documents shall be submitted in Adobe PDF formats, while spreadsheets shall be submitted in both Adobe PDF and MS Excel formats. All drawings shall be submitted in both CAD and Adobe PDF files.

TRAINING

The awarded supplier shall provide theoretical and practical trainings for the END-USER personnel in Davao City. Training shall be provided by qualified personnel of the awarded supplier or Manufacturer.

Training program and materials shall be in the English language and submitted to the END-USER before the training date. Training shall include sufficient hands-on sessions on the configuration and maintenance of the supplied Telecom Systems.

PACKAGING AND SHIPPING

The awarded supplier shall handle and bear the cost for packaging, shipping and delivery of the complete Telecom systems to the END-USER site. All equipment shall be packed and weather protected for shipment wherein loose parts shall be boxed. All equipment must be complete and identified with an itemized packing list.

OCCUPATIONAL SAFETY AND HEALTH STANDARDS

All involved parties in the PROJECT must comply to the Occupational Safety and Health Standards set forth by the Department of Labor and Employment (DOLE) Philippines. This shall ensure that every workingman is protected against the dangers of injury, sickness or death through safe and healthful working conditions to assure the conservation of valuable manpower resources and the prevention of loss or damage to lives and proper

SERIES 7000- TELECOMMUNICATION WORKS

Section 7200-01 – ACCESS CONTROL SYSTEM (ACS)

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ABBREVIATION

ACS	Access Control System
AC	Access Controller
BoM	Bill of Materials
CCTV	Closed Circuit Television
EPC	Engineering Procurement Construction
FIDS	Flight Information Display system
IP	Internet Protocol
LAN	Local Area Network
LD	Layout Diagram
MCS	Master Clock System
Mhz	Mega Hertz
NTP	Network Time Protocol
PoE	Power over Ethernet
PTB	Passenger Terminal Building
SCS	Structured Cabling System
SD	Schematic Diagram
SW	Software
TCP/IP	Transmission Control Protocol / Internet Protocol
TDS	Technical Design Specifications
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
VMS	Video Management System
WDR	Wide Dynamic Range

B. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the Access Control System (ACS) and its components, peripherals, accessories, ancillaries, field devices and associated items for the ACS System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements
b. ACS System – Bill of Quantities
c. ACS System – Schematic Diagram
d. ACS System – Equipment Layout Diagram

The ACS System shall include, but not limited to the following:

- Access Controller
- Face Recognition Biometric Device
- Card Reader
- Mifare Access Card
- Push to Exit Button
- Emergency Break Glass
- Electromagnetic lock
- Card Issuer
- Card Printer
- ACS Server
- System administration and workstation for management and maintenance (workstation may be shared with other Telecom Systems)
- Latest software and firmware
- Cables, roughing-ins and connectors
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the Access Control System.

The main SYSTEM and its associated peripherals shall be installed in the G/F Telecom Room of the new Passenger Terminal Building (PTB).

The ACS Controlled Doors shall be distributed at the following areas:

- Telecom Room
- Immigration Offices
- Customs Office
- Airport Manager Office
- Baggage Breakdown Area
- Baggage Make Up Area
- Corridors Entry/Exit Points
- Airline Offices
- Service Entry/Exit Doors

- Bus Gate
- Elevator Lobby
- Passenger Bridge
- Boarding Gates
- Holding Room
- Emergency Exit Doors
- Command & Control Room
- Security Office

GENERAL DESIGN REQUIREMENT

The ACS System is designed based on the minimum requirements and specifications of the PROJECT.

The ACS System shall be an integrated configuration, controlling normal access to the listed controlled areas, offices and entry points at each location.

The system shall be IP networked deployed on modern state of the art Operating System enabled server running ACS SW application. The Access Control System server shall be a rack-mounted server with the latest specification. The software shall be able to control individual and specified controlled door location, to log statistics, to restrict access to unauthorized personnel and to include database management for personnel inventory and control. The system shall be software configurable to send alarm messages to selected location.

The ACS Workstation or terminal connected to the network at the new PTB shall provide system control and monitoring, event logging, database maintenance and database backup and configuration update, information retrieval and card enrollment information. The workstation shall comprise a PC with keyboard, mouse, LCD display, card enrollment station and badge printer.

The Card enrollment station shall produce a unique Access/ID badges to each airport personnel and stakeholders.

The ACS system server at Telecom Room shall share equal information from all the controlled areas, provided with ACS under this scope. Full system functionality must be maintained with or without the ACS Workstation connected.

The Card Readers shall be designed such that upon presentation of an ACS access card, unique card identification data is transmitted to the associated Access Controller. The system shall read the data, identify the person, issue authorisation and instruct the ACU to unlock the associated door locking mechanism.

The installation of field control measure such as Face Recognition, Proximity Cards Readers, Push-to Exit Buttons and electromagnetic locks shall be closely coordinated with the Building Works Doors and frames and shall be fabricated to receive the components and wiring of the ACS without the need for excessive on site dismantling, cutting or drilling.

For the controlled doors, in the event of alarm, the CCTV System will display the location of the camera from which the alarm signal is taking place.

The interface between the Access Control Unit (ACU) related to the concern door and the local Fire Alarm Control Panel (FACP) shall be part of the Fire Alarm and Detection System. The operation of the Controlled Emergency Exit Doors shall be of the highest level in terms of Fire Safety, The Contractor shall ensure the proper coordination between both Systems.

The system shall have an appropriate interface with the Fire Detection and Alarm System (FDAS) allowing the FDAS to override the security system under Fail Safe mode during emergency situations. ACS shall immediately return to its normal operation if the situation is in clear situation.

The ACS System shall be scalable in order to accommodate the existing quantity of existing controlled doors at the existing Passenger Terminal Building (PTB). In the event that the existing PTB's ACS System be included or added into the new ACS System (in the future), then this shall only entail additional Access Controller units and devices without any replacements of any major component.

The ACS System shall interface directly with other systems, such as the LAN, SCS, CCTV and FDAS Systems, as described herein.

TECHNICAL DESIGN CRITERIA

The ACS System shall consist of the Server, Access Controllers, Face Recognition, Card Readers, push-to-exit button, Emergency Exit Bar, Electromagnetic Locks, card printer, management and monitoring terminal, software, interfaces and telecom cabinet.

The ACS System shall include all other necessary components and peripherals to complete a functional ACS System.

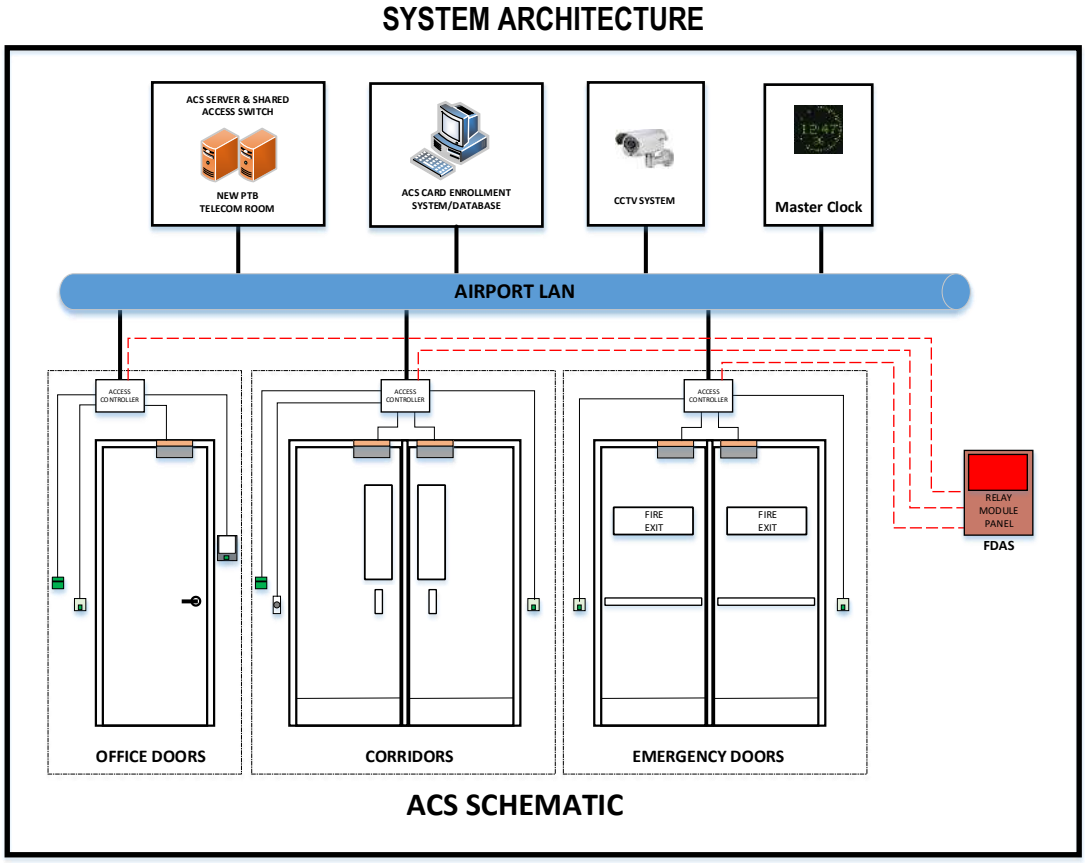

Figure 1: ACS System Architecture

ACCESS CONTROLLER

Access Controllers are installed in the selected door locations with the extended feature of 2 to 3 independent controlled doors for each controller in the new Passenger Terminal Building. The controller shall provide access to and from of the specific room by controlling the magnetic door locks and confirming badge IDs and Face Recognition device with the Access Control System Server's database.

The controller and the face recognition device shall be linked via CAT6 UTP copper cable to information outlets located at each door requiring security access control. An attempt to access a door will result in a signal being sent from the card reader and from the face recognition device to the Access Controller, which in-turn will confirm with the remote Main Access Control Server database if the ID badge is allowed access. Once confirmation has been received from the Access Control System Server, the Access Controller shall then disengage the respective magnetic door lock to allow access.

The Access Controller shall have the ability to accept volt free contact closure either open or closed as alarm states from other systems; e.g. window switch and to provide volt free relay contact outputs to control other devices that shall be determined in the detailed design.

All Access Controllers shall be connected back to the Access Control System Server. This connection shall allow the Access Controllers to query the Access Control System Server database for confirmation of identification access rights.

The Access Controller shall have the following as a minimum:

- 32-bit high-speed processor
- Supports TCP/IP communication, and ISAPI protocol. The communication data is specially encrypted to relieve the concern of privacy leak
- User-centered design. Supports adding various user types: normal user, visitor, and user in blocklist
- Supports up to 100,000 cards (including 97,000 non visitor cards and 3,000 visitor cards) and 300,000 card presenting records
- Supports multi-door interlock function, anti-passback function, multiple authentications function, open door with first card function, super card and super password function, M1 card encryption, online upgrade function and remote control of the doors
- Supports tampering alarm for the card reader, alarm for door not secured, force opening door alarm, alarm for door opening timeout, duress card and code alarm, blocklist alarm and alarm for illegal card swiping attempts reaching the limit
- Short circuit and open circuit attempts alarm
- IP address conflict detection
- Cross-controller anti-passback function
- Supports RS-485, OSDP, and Wiegand protocol for accessing card reader. Wiegand interface supports W26, W34 and is compatible with the third-party card reader with Wiegand interface

● Shall come with a 12Vdc power supply unit with battery to ensure that operation of the security systems will be unaffected by loss of power supply for up to 8 hours. In the case of total incoming power supply interruption, door locks shall be released to open automatically. This PSU shall also provide power to the other ACS door devices.

FACE RECOGNITION BIOMETRIC DEVICE

The Face Recognition Biometric device provides entry to the selected locations or areas in the New PTB. The face recognition device shall be linked via 5pr stranded copper cable to junction boxes located at each door requiring security access control. Face detection is performed by the camera which transmits the detection alarm and the position of the face in the picture. Another option for authorizing access is by using an access card. The server performs accurate diagnosis on the basis of comparing the enrolled photo against the person accessing the Face Recognition biometric device that makes a face qualification. Once the same face parameters are matched the doors will open. An attempt to access the door without face authorization shall not be granted entry. It shall also come with the function of detecting a person wearing a mask or not.
The Face Recognition shall have the following as a minimum:

- 7 inch LCD touch screen, 2 mega pixel wide angle lens
- Maximum of 6000 faces
- Supports TCP/IP
- Supports Weigand and RS485 protocols
- IP65

CARD READER

The card reader shall support access using cards for individual personnel or issued for a room entry by the authorized personnel. Card readers shall be suitable for the environment, either in weather protected or non-weather protected locations.

Card readers shall be interfaced with their associated local controller via 5 pairs stranded copper conductor cable. The reader/access equipment shall be powered from a 12-volt dc source with status and power LED indicator, generated internally within the local access controller panel.

The card reader shall have the following as a minimum:

- Reads Mifare Card,
- Supports RS485 and Wiegand (W26/W34) protocol,
- Tamper-proof alarm
- IP 65

ELECTROMAGNETIC LOCK

Electrically operated Electromagnetic Lock assemblies shall be provided by the VENDOR for all controlled doors. Electromagnetic Locks will serve as the main locks to all controlled doors in the ACS System.

Electromagnetic Locks shall be interfaced with their associated local controller via 2pair stranded copper conductor cable.

The electromagnetic lock shall have the following as a minimum:

- Single-door and Double-door Magnetic Lock
- 280kg Linear Thrust,
- 12 VDC
- LZ Steel bracket
- Suitable for wooden door, glass door, metal door and fire proof door, aluminum framed doors, aluminum doors.

PUSH-TO-EXIT BUTTON

The Push-to-Exit Button shall serve as door opener from inside the area or room. Its function is to disable the power source from the electromagnetic lock for a certain time to allow the person to get outside of a certain area or room. Push-to-Exit Button shall be interfaced with their associated local controller via 2pair stranded copper conductor cable.

The push-to-exit button shall have the following as a minimum:

- Aluminium alloy panel, metal button;
- 3A@36Vdc Maximum Current Rating
- NO/NC/COM Output Contact

EMERGENCY BREAK GLASS

The Emergency Break Glass is another way of opening a controlled door from inside the room. This is normally used during emergencies when immediate egress are needed or when the card reader is not operating or not functioning well. Emergency Break Glass shall be interfaced with their associated local controller via 2pair stranded copper conductor cable.

The Emergency Exit Bar shall have the following as a minimum:

- 3 A @ 36 VDC Max power supply
- NO/NC/COM Contact Output
- Green color

ACCESS CARDS

Access Cards shall be made of robust plastic and conform to the dimensions stated in ISO 7810, (width= 85.725mm, length= 55.245mm).

CONTRACTOR shall provide an initial batch of 500 cards together with the equipment to enable permanent and temporary cards to be produced as and when required.

The Access card shall have the following as a minimum:

- Mifare 1 Contactless Smart card, Frequency: 13.56vMHz.
- Dimension: 85mm x 54mm x 0.8mm

CARD issuer

The Card issuer device is a non-touch IC card enrollment station. It can be connected to PC or other device with USB interface. It supports ISO 14443 Type A/B and ISO 7816 standard. Reading frequencies are 13.56 MHz and 125 KHz.

The Access card shall have the following as a minimum:

- Plug-and-play USB with no-driver technology;
- Supports Mifare card, EM card Standard IC card
- 2 SAM card slots for encryption using

CARD printer

The Card printer is an electronic desktop printer with single card feeders which print and personalize PVC cards with a minimum resolution of 300dpi in color. It should have a memory of 64MB RAM and supports Microsoft Windows 10, Mac OS and Linux. The card printer should accept card thickness 0.38mm and 1.0mm.

The card printer shall have the following as a minimum:

- Supports various card types: Mifare card and EM card
- 300, 600. & 1200dpi Printing Resolution
- Dual Side Color Printing
- USB Ethernet interface
- 24Vdc operating voltage comes with power supply

SYSTEM ADMINISTRATION AND WORKSTATION

The Access Control System (ACS) shall be managed by an administration workstation and shall be responsible for the configuration, monitoring, diagnostics and troubleshooting the Access Control System.

The ACS workstation shall come with its software or access to the ACS System interface. It shall be capable of configuring all the controlled doors, normally open or close state.

The ACS workstation shall present the logs, events and faults in the system in real-time.

The Access Control System shall have access rights management where the administrator shall assign levels of access for various users. The workstations shall have minimum of three (3) hierarchical password levels based on the credentials of each user of role-based control for administration and operations wherein these are logged into the system and may be retrieved for audit trails.

The minimum required specifications of the Access Control System workstation shall be:

- Workstation shall be of a reputable manufacturer
- Minimum Intel Core i7 processor
- Minimum 16GB RAM
- Minimum 1TB HDD
- Minimum 256GB SSD
- Minimum 1GB video/graphic card
- Minimum 24” LED monitor, full HD

- HDMI and VGA ports
- At least 4 USB ports
- Keyboard, mouse and speakers
- Latest operating system with license
- ACS administration terminal may be shared with other telecom systems

CABLING

The Access Control System shall be associated with the Structured Cabling System through patch cord from the access controller. Each Access controller location shall have specific patch cord on its assigned information outlet onward to the switch of LAN System. It shall have a specific port assignment in the Telecom Cabinet in the Telecom Room.

In conjunction with the field devices, the card reader, and face recognition biometric device shall have 5 pair stranded cables to interconnect with the Access Controller. The Push to exit button, Emergency Pull Bar and Electromagnetic locks shall have a 2 pairs stranded cables which are all terminated in the Access Controllers. Cable passes through an individual conduit to protect from tampering and altering the devices.

The Terminating box is where an extension of power, accessible card reader, input and output interface of the Access Controller capable of controlling 2 to 4 doors are terminated. The termination box consist of 12Vdc power interface, 2 to 8 card reader interfaces, Alarm Inputs, door contacts, exit buttons, case inputs and tamper alarms.

Each Terminating box has distinct door functions connected to Access Controller.

The ACS Controllers shall also be wired to the FDAS using a 5-pair stranded cable. This shall be the interface between the two (2) systems whereby each access controller is wired to the FDAS relay modules located in the 2/F Command and Control Room.

The ACS door devices shall have its own cabling infrastructure independent of the SCS, FDAS and PA System. The awarded supplier shall supply and install all the necessary cables, roughing-ins, EMT pipes and accessories, utility and junction boxes, flexible metal conduits, clamps, accessories and ancillaries to complete the ACS devices' cabling infrastructure.

The awarded supplier shall determine the appropriate cable core size in order to keep the resistance and the voltage drop to a minimum.

INTERFACING AND INTEGRATION

The ACS System shall have features and functions built into it to integrate and interface with the subsequent systems. The awarded supplier shall ensure installation and implementation of all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

CCTV SYSTEM

The ACS System shall be interfaced with the CCTV System providing a high-level type of integration. This shall allow cameras to be configured to show, display or pop-up onto the monitors during an alarm triggered by the ACS devices or as when required by the ACS.

ACS alarm or events shall trigger the CCTV System whereby the latter shall have its video footages played back instantly. PTZ cameras shall be configured to receive ACS alarms or events and shall be able to pan, tilt and zoom or preset its position in the location of the ACS event. Fixed cameras and PTZ shall push the camera views to the monitoring workstation and video wall upon an ACS event or alarm.

FDAS SYSTEM

The system will provide integrations with Fire Detection systems allowing the doors to open in case of Fire emergencies. The interface will be based on relay contact (for automatic door release). Following are few important functions that are expected out this interface.

1. The system will be interfaced with the FDAS system through the use of fire alarm system relay modules. All Emergency Exits monitored or not will be compliant with NFPA Standards and therefore be "Fail Safe" wired,

2. In case of an emergency exit control by the ACS system, the FDAS has priority over Security. When zone in alarm has been detected all security that are used as safety accesses will automatically unlock,

3. Dry contact from fire alarm will be hardwired up to the Access Controller. Sequence of operation will be coordinated with FDAS and in compliance with the NFPA standards,

4. The FDAS will also report the zone in alarm to the ACS system,

5. In case of confirmed fire, the FDAS will send an order to the ACS controlled doors located at egress paths in the affected zone to unlock them.

STRUCTURED CABLING SYSTEM

The ACS System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure to the LAN System onwards to the main ACS System. The SCS shall use CAT6 UTP cables for this purpose with Information Outlets (IO) for terminating the Access Controllers cable to the RJ45 keystones with UTP patch cords.

MASTER CLOCK SYSTEM

The ACS System shall be interfaced with the Master Clock System for its time synchronization via Network Time Protocol (NTP) over Ethernet. The Master Clock shall be under the scope of the Master Clock System.

SERIES 7000- TELECOMMUNICATION WORKS

Section 7200-02 – CABLE TV SYSTEM (CATV)

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ABBREVIATION

CATV	Cable TV
FIDS	Flight Information Display System
GUI	Graphical User Interface
HD	High Definition
HDMI	High-Definition Multimedia Interface
IP	Internet Protocol
ISBD-T	Integrated Services Digital Broadcasting – Terrestrial
LAN	Local Area Network
LCD	Liquid Crystal Display
LD	Layout Diagram
LED	Light Emitting Diode
MCS	Master Clock System
NTP	Network Time Protocol
PoE	Power over Ethernet
PTB	Passenger Terminal Building
SCS	Structured Cabling System
SD	Schematic Diagram or Software Defined
SDI	Serial Digital Interface
STB	Set Top Box
TDS	Technical Design Specifications
TV	Television
UHD	Ultra-High Definition
URL	Uniform Resource Locator
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
VESA	Flat Display Mounting Interface defined by Video Electronics Standard Association

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the CATV System and its components, peripherals, accessories, ancillaries and associated items for the CATV System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. CATV System – Bill of Quantities

c. CATV System – Schematic Diagram

d. CATV System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- Encoders
- Decoders
- Set Top Box
- Smart UHD TV
- System Administration
- Latest software and firmware
- Telecom cabinet and wiring (may be shared with other Telecom Systems)
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the CCTV System.

The main CATV System and its associated peripherals shall be installed in the G/F Telecom Room of the new Passenger Terminal Building (PTB).

The CATV TV shall be distributed at the following areas:

- Information/Tourist Counter
- Arrival Hall
- Pre-Departure Lounge
- VIP Lounge
- Passenger Lounge

GENERAL DESIGN REQUIREMENT

The CATV System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new CATV System shall be provided in all areas under the scope described herein, for the purposes of providing a video content for passengers' entertainment and informational viewing.

The CATV system is an IP-based system that shall have the ability to deliver the following:

- Ability to deliver digital television, video, audio, text and graphics.
- Ability to distribute content through the IP network at new PTB.
- Ability to provide content using the standard IP systems.
- Ability to also support encryption of the content thereby preventing unauthorized distribution or access.
- Ability to provide an IP decoder at each TV which can be controlled from a remote location.

Display TV shall utilize the Structured Cabling System (SCS) and LAN System as connection from the head-end located at the G/F Telecom Room. The LAN PoE switches and the SCS UTP cables shall be the interface connections between the head-end and decoders of the display TVs.

The CATV System shall be software controlled, easily configured and allow for future expansion.

It shall be scalable in order to accommodate the additional display TV as needed (in the future). In the event that the existing PTB's CATV System be included or added into the new CATV System (in the future), then this shall only entail additional modules without any replacements of any major component.

TECHNICAL DESIGN CRITERIA

The IP Television System is the prime entertainment system in the new PTB and the design is made for broadcast of local CATV, advertisement and information on display screens. The source feed for entertainment live channels are from local cable TV service provider and the same stream will be connected through encoders for broadcasting to the display screens.

The Set Tob Box (STB) shall be the source input of video to the encoders coming from the cable TV provider, media players, info graphics and advertisements in various media formats. STB is the information appliance device that generally contains a TV-tuner input and output to the encoder, turning the source signal into content in a form that can then be displayed on the television screen or other display device. They are used in cable television, satellite television, and over-the-air television systems as well as other uses.

The Video Encoder converts analog or digital video to another digital video format for delivery to a decoder. The encoder receives the simultaneous steaming video signal from headend equipment and converts it to IP. The video encoders come in modular type and shall have a HDMI input and output as an uncompressed digital video signal coming from Set Tob Box (STB). The encoder shelf shall support up to 16 channels of plug-in encoders and shall have dual power adapters.

The Video Decoder is the hardware device that converts an encoded digital stream into audio, video, closed captions, and subtitles that can be displayed on a television. They receive encoded video input signals that conform to standard formats such as NTSC or PAL. The decoder shall be installed at the back of the television with a VESA mount and shall be connected using the HDMI interface.

A Standard 55" Smart UHD TV shall be used as the display screen for the video, audio, graphical or text information content. These TVs are located in waiting areas of passengers in the new PTB and Information/Tourist counters for their convenience.

The CATV System shall include all other necessary components and peripherals to complete a functional CATV System.

SYSTEM ARCHITECTURE

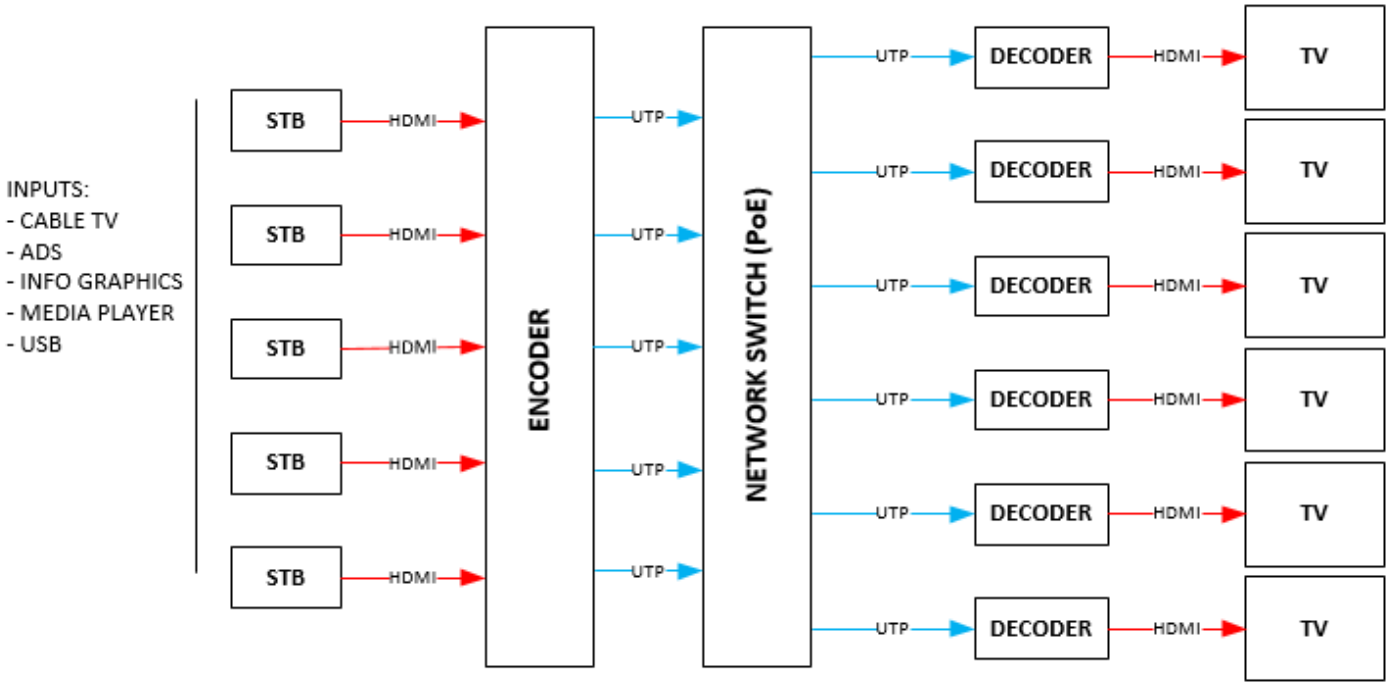

Figure 2: CATV System Architecture

SET TOP BOX

The Set Tob Box (STB) is the device to receive and decode digital television or receives video format from another source such as media player and USB stored media files.

- Fully SD/HD ISDB-T compliant
- Support Full HD 1080p
- Support SD/HD MPEG2 and MPEG4 AVC H.264
- USB 2.0 for PVR, TIMESHIFT, software upgrade and media files playback
- Support aspect ratio 16:9, 4:3, Pan&Scan, letter box
- Auto and manually scan all available TV and radio channels using digital broadcast.

The awarded supplier shall ensure the necessary quantity and appropriate STB based on the final CATV System design and quantity of services. This shall be determined after the design has been firmed up and before the implementation.

ENCODER

The encoder shelf shall have a capacity of up to 16 encoder modules to provide the scalability during expansion of the new CATV system. The encoder shall convert the video into encrypted signal via the IP and LAN network.

ENCODER SHELF

The rack mount shelf is a plug-in structure, which can replace and mix plug-in cards easily, combining 1-16 channels and multi-interface, encoding/decoding mixed solutions. It is equipped with dual power adapters.

- Input power: 100 – 230 VAC
- 1-16 slots
- Hot swappable power supply
- Used to mount the encoder modules

ENCODER MODULE

The Encoder module shall convert the input video/audio into encrypted signal via the LAN network.

- HDMI encoding modules
- HDMI video input and video loop
- HDMI embedded or 3,5mm analog audio
- 100M RJ45 Ethernet port
- Up to 1080P 60Hz video resolution
- Video resolution, H.264;
- Audio AAC/G.711
- Stream protocols, SRT/RTP/RTSP/RTMP/TS-UDP/HLS
- Encoding latency, <67ms
- Web based management method

The awarded supplier shall provide the mounting bracket to mount the decoder to the back of the TV including its accessories and ancillaries and shall ensure the necessary quantity and appropriate encoder module based on the final CATV System design and quantity of services prior to implementation.

DECODER

The decoder will convert back the encrypted signal to video format.

- H.264 decoding with resolution up to1080P, 60Hz
- Support the most main protocols, including RTMP/HLS /TS over UDP/SRT/RTP/RTSP
- Decoding latency is less than 200ms in the typical network environment.
- 100M RJ45 Ethernet port

- Video Output, 1*3G-SDI + 1*DVI-I; 1*/2*/4*1000M RJ 45 Ethernet (compatible with HDMI1.4/ DVI 1.0/VGA)
- Input media protocols, SRT/TS over/ UDP/ RTMP/HLS/RTP/ RTSP
- Video decoding, H.264
- Audio decoding, AAC/G.711
- Decoding ability, 1CH 1080p60
- Web based management method
- PoE powered or 12VDC, 1A

The awarded supplier shall provide the mounting bracket to mount the decoder to the back of the TV including its accessories and ancillaries and shall ensure the necessary quantity and appropriate encoder module based on the final CATV System design and quantity of services prior to implementation.

IP TELEVISION

Display screen shall use a standard 55" UHD TV.

- Built-In ISBD-T Receiver
- Resolution: 3840x2160 p
- 60 Hz Vivid motion
- Supports USB Device JPEG, MP3, MKV
- Supports HDMI, Global TV System: PAL/NTSC
- Supports Ethernet connection, RJ45
- CCS technology, Crystal Clear Panel, Color Enhancing Imaging
- 6mins Response Time
- VIDAA U Operating System
- TV browser, Anyview cast, Netflix, Youtube, Prime Video
- Input Power: 100-230VAC

The awarded supplier shall ensure the necessary quantity and appropriate size of TV screen based on the final CATV System design and quantity of switches together with the services prior to implementation. And shall provide the VESA mounts, pole ceiling or floor mounts if necessary, mounting brackets, accessories and ancillaries.

INTERFACING AND INTEGRATION

The CATV System shall have features and functions built into it to integrate and interface with the subsequent systems.

The awarded supplier shall install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

STRUCTURED CABLING SYSTEM

The CATV System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure for the decoder to connect to the LAN System. The SCS shall use CAT6 UTP cables for this purpose with Information Outlets (IO).

LAN SYSTEM

The CATV System shall use the LAN network to connect all the encoders and decoders using the server and access switches respectively. Moreover, the decoders shall use the PoE switch to provide power and connectivity over the LAN network.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-03 – CLOSED CIRCUIT TELEVISION SYSTEM (CCTV)

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ACCESS CONTROL SYSTEM 48

ABBREVIATION

ACS	Access Control System
API	Application Programming Interface
BoM	Bill of Materials
CCTV	Closed Circuit Television
DNR	Digital Noise Reduction
DORI	Detection, Observation, Recognition, Identification
DP	Display Port
DVI	Digital Visual Interface
EIS	Electronic Image Stabilization
FOV	Field of View
fps	Frame per second
HD	High Definition
HDD	Hard Disk Drive
HDMI	High Definition Multimedia Interface
IP	Internet Protocol or Ingress Protection
IR	Infrared
LAN	Local Area Network
LCD	Liquid Crystal Display
LD	Layout Diagram
Mbps	Mega bit per second
MCS	Master Clock System
mK	milli Kelvin
MJPEG	Motion JPEG – Joint Photographic Experts Group
MP	MegaPixel
NAS	Network Attached Storage
NTP	Network Time Protocol
NTSC	National Television System Committee
NVR	Network Video Recorder
ONVIF	Open Network Video Interface Forum
PAL	Phase Alternating Line
PoE	Power over Ethernet
ppm	pixels per meter
PTB	Passenger Terminal Building
PTZ	Pan, tilt and zoom
QoS	Quality of Service
RAID	Redundant Array of Independent Disks
RAM	Random Access Memory
SAN	Storage Area Network
SATA	Serial Advanced Technology Attachment
SCS	Structured Cabling System

SD	Schematic Diagram or Secure Digital
TCP/IP	Transmission Control Protocol / Internet Protocol
TDS	Technical Design Specifications
TV	Television
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
VCA	Video Content Analysis
VGA	Video Graphics Array
VLAN	Virtual Local Area Network
VMS	Video Management System
WDR	Wide Dynamic Range

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the CCTV System and its components, peripherals, accessories, ancillaries, field devices and associated items for the CCTV System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

UICI-DIA-GEN-TDS-001 - Telecom System-General Design Requirements

UICI-DIA-CCTV-BOM-001 - CCTV System – Bill of Materials

UICI-DIA-CCTV-SD-001 - CCTV System – Schematic Diagram

UICI-DIA-CCTV-LD-001 - CCTV System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- CCTV NVR
- CCTV Storage
- CCTV Video Analytics and Video Management System
- CCTV camera sets with SD cards
- Video wall, decoder, TVs, workstation and CCTV keyboard
- Monitoring workstation with CCTV keyboard + joystick
- System administration and workstation for management and maintenance(may be shared with other Telecom Systems)
- Latest software and firmware
- Telecom cabinet and wiring (may be shared with other Telecom Systems)
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the CCTV System.

The main CCTV System and its associated peripherals shall be installed in the G/F Telecom Room of the new Passenger Terminal Building (PTB). The Video wall, monitoring workstations and administration workstation shall be distributed accordingly.

The CCTV cameras shall be distributed at the following areas:

- Lobbies
- Check-in lobby/counters
- Public spaces
- Arrival areas
- Departure areas
- Immigration areas
- Baggage claim/handling areas
- Passenger lounges
- Gate lounges

- Hallways or corridors
- Entrance and PTB sides
- Airside corridor
- Selected rooms

GENERAL DESIGN REQUIREMENT

The CCTV System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new CCTV System shall be provided in all areas under the scope described herein, for the purpose of the surveillance, forensic review, monitoring and recording video for the critical and vital areas/facility, security, safety, people movement and personnel location.

The CCTV System shall monitor, operate, control and manage all the CCTV cameras and other interfaces.

For all the areas being monitored by the CCTV System - the CCTV System shall provide real-time live video, video playback to review video footages, monitor critical areas as mentioned in this document and video analytics to provide notification and alerts based on the required scenarios and events.

The CCTV System shall accommodate the CCTV camera types – fixed dome and bullet, temperature screening, PTZ, 3rd-party cameras and shall be distributed at areas mentioned herein.

The CCTV cameras and its associated peripherals shall be located in a manner that facilitates easy access for routine operation and maintenance.

The CCTV System shall be software controlled, easily configured and allow for future expansion. The CCTV System shall be a single software and hardware platform for playback, storage, analytics and management.

The CCTV System shall be scalable in order to accommodate the existing quantity of cameras at the old Passenger Terminal Building (PTB). In the event that the old PTB's CCTV System be included or added into the new CCTV System (in the future), then this shall only entail additional modules or servers without any replacements of any major component.

The CCTV System shall interface directly with other systems, such as the LAN, SCS, Access Control and Master Clock Systems, as described herein.

TECHNICAL DESIGN CRITERIA

A new CCTV System shall consist of the NVR and storage, VMS server, LAN switches and backbone network (under the LAN System), management and monitoring terminals, software, video analytics, video wall, cameras, interfaces and telecom cabinet.

The CCTV System shall include all other necessary components and peripherals to complete a functional CCTV System.

SYSTEM ARCHITECTURE

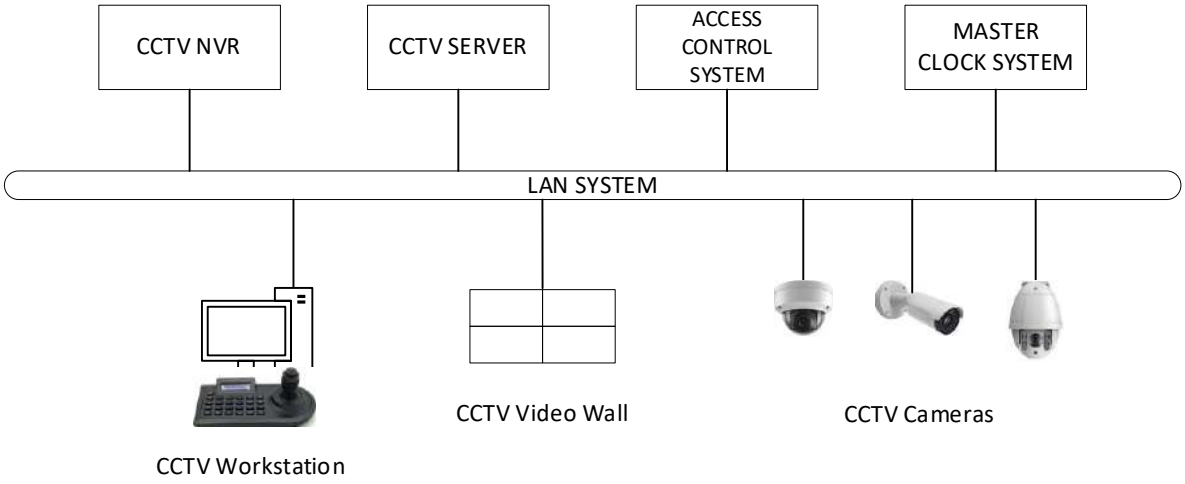

Figure 3: CCTV System Architecture

The new CCTV System shall be IP-based and shall support both PAL and NTSC formats and standards. The cameras shall be the front-end while the NVR, video management system, storage and recordings shall form the back-end section of the CCTV System.

The CCTV System shall support multicast and unicast network topologies with both centralized and distributed architectures.

NETWORK VIDEO RECORDER (NVR)

The NVR shall be properly designed for the required capacity plus a 10% spare port capacity for future camera installation. It must accept cameras with high resolution in full HD formats. Live views, playbacks and recordings shall be in full HD in relation with the cameras selected.

The CCTV System's NVR shall have the minimum requirements:

- Rack mount type
- Minimum 64-channels (including 10% spare)
- Allow real-time monitoring, PTZ control and video recording
- High quality HD video up to full screen display without pixelation, blurriness, unclear video or motion
- Selectable frame rate up to maximum 30fps for all cameras on both live view and recording
- Support up to 12MP video input
- Support bandwidth of minimum 400Mbps (incoming/outgoing)
- Output resolution of 4K and 1080p
- Capable of supporting redundancy
- Support ONVIF
- Support decoding formats H.265, H.265+, H.264, H.264+, MPEG4
- Audio decoding format: G.711ulaw, G.711alaw, G.722, G.726, MP2L2
- Video playback types shall include instant, event, tag, log or external file
- Shall provide 20-ch, 1080p independent playback

- Support picture capture and playback
- Support digital zoom on live view and playback
- Playback at 8x without skipping and up to 256x for fast review
- Support pre-record and post-record for alarms or events
- Support searching and playing back record files by channel number, recording type, start time, end time, etc.
- Support reverse playback for multiple channels
- Support more than 48 split-screen in live view on its local monitor interface
- Capable up to 16 SATA hard disks and 1 eSATA disk
- Supports 8 network disks (NAS/IP SAN)
- Self-adaptive 10/100/1000 Mbps network interfaces
- Support multiple address and network fault tolerance modes
- Support TCP/IP, DHCP, IPv4, IPv6, DNS, DDNS, NTP, RTSP, SADP, SMTP, SNMP, NFS, iSCSI, ISUP, UPnP, HTTP, HTTPS
- Shall have smooth streaming technology
- Shall have Network Protocol QoS (NPQ) to automatically adjust live view and playback bitrate according to network bandwidth conditions
- Support Automatic Network Replenishment (ANR) feature that enables an IP camera to save the recording files in its local storage (SD Card) during network failures, then syncs the files to the NVR upon network restoration.
- Support remote keyboard and PTZ operations
- Smart playback
- Event searching and playback
- Alarm for video loss, motion detection, tampering, abnormal signal, video input/output standard mismatch, illegal login, network disconnected, IP conflicts, abnormal record/capture, HDD error, and HDD full, etc.
- Support VCA detection alarm
- VCA for human search, vehicle search, people counting and heat mapping
- Connectable to a thermal network camera
- Alarm triggers full screen monitoring, PTZ linkage, audio alarm, notifying surveillance center, sending email and alarm output
- Configurable account credentials – usernames, passwords and verification

STORAGE AND RECORDING

The awarded supplier shall calculate the required storage capacity or size to accommodate all the cameras' recordings for a retention of 90days, continuous and alarm-based recording plus a 10% spare capacity for future expansion. Once the hard drives are full, the oldest recorded footage shall be overwritten by the new footage with a minimum of 90days stored at all times.

The CCTV System's video recording shall be configurable either continuous, automatic, by schedule, by video analytics, trigger or via an alarm event or alarm-based recording. In most CCTV cameras, this shall be continuous recording. It shall record all CCTV cameras simultaneously.

The storage shall have a minimum of the following:

- Up to 10 TB storage capacity per HDD
- Supports S.M.A.R.T. and bad sector detection
- Supports HDD group management
- Supports HDD standby function

- HDD property: redundancy, read-only, read/write (R/W).
- HDD quota management - different capacities may be assigned to channels
- Support RAID 0, 1, 5, 10, global hot spare HDD
- Supports disk clone to the eSATA disk.
- Supports 2 mini SAS interfaces.

The CCTV System shall be able to transfer images and video clips/footages into a CD, DVD, flash drive or USB thumb drive. Ensure that all electronically stored recordings are suitable for use as evidence in legal proceedings.

VIDEO ANALYTICS

The CCTV System shall perform the tasks of real-time event detection, post event analysis and extraction of data. This shall reduce manpower costs while increasing the effectiveness of the END-USER's operations.

The video analytics shall be able to provide, but not limited to, the following:

- Motion detection
- Line crossing
- Intrusion detection, unauthorized movement in restricted areas
- Face recognition, capture and picture comparison
    - The video analytics shall detect human faces, capture its faces and trigger an alarm. The system shall be able to handle 24-channels of 4MP face recognition cameras.
    - The video analytics shall analyze and recognize face pictures captured by the cameras. The system shall search the target person by face picture. The system shall be able to handle 48-channels of face picture comparison alarms.
    - The system shall support 64 face picture libraries with a total of 500,000 pictures.
- Left baggage
- Object missing
- Scene change detection
- Object and person tracking (for the PTZ)
- Camera Tamper detection
- No video alert
- Temperature screening and measurement
- Region area detection and exiting
- Use of AI technology

Reduction of false alarms by efficiently recognizing trees, branches, shadow, light, vehicles, animals, etc.

All these events shall support notifications, triggers, email, captures, warnings and alarm outputs. The analytics shall be configurable that allows it to be displayed or pop-up on the video wall or monitoring workstations.

VIDEO MANAGEMENT SYSTEM

The CCTV System shall come with a Video Management System (VMS) or software platform for managing the entire CCTV System. This shall also be a common platform for the Access Control System (ACS) that will be elaborated on the integration section with ACS.

The VMS shall provide for the configuration, analytics and statistics of the CCTV System. It shall be an open platform with a unified architecture to permit integration with 3rd party hardware and systems. All of its applications shall be interactively integrated with informative dashboards and interactive E-maps.

The VMS shall have a minimum of the following:

- Server hardware appropriately designed for the CCTV VMS Software
- Scalable
- Open architecture with OpenAPI interfaces
- Data encryption
- Device configuration and maintenance
- Reports and statistics
- Interactive E-maps – multi-layered to display devices across the new PTB
- Health status monitoring
- Video Content Analysis (VCA) with search capabilities
- Quick and convenient search and playback
- Alarm detection, event and linkages
    - Physical hardware
    - Function and states of the devices
    - External events
    - Internal events
    - Analytics
- Minimum of 2,000 managed devices
- Minimum of 5,000 cameras
- Minimum of 15 thermal cameras
- Minimum of 10,000 event and alarm rules – rule system to facilitate automation of different devices
- Minimum Face comparison of 500,000 pictures
- Minimum 32 decoding devices
- Minimum 32 video / smart walls
- Tiered management rights – system logging, audit trail
- Multicast support, sending one video stream to multiple clients
- Configuration data backup and restore
- Exporting video to various formats
- Client application
    - Centralized management
    - Live and playback modes
    - Configuration
    - Alarm management
    - System monitor
    - System administration

CCTV IP CAMERAS

The CCTV cameras shall be of high quality, IP-based, capable of day and night viewing under very low light conditions. Lens and focal lengths shall be selected based on the required field of view (FOV) of the camera installation.

The CCTV cameras shall use the Identification level of the DORI (Detection, Observation, Recognition, Identification) standard at a 10m distance from the camera. For example: Using a 4MP camera with a resolution of 2592 x 1520 (16:9) and a camera lens of 6mm, this will give a 259ppm which is higher than the standard of

250ppm. For this requirement, the camera resolution and the lens must be selected carefully based on the FOV of the camera installation. In some areas where required, the camera resolution may be higher than 4MP. VENDOR shall specify the DORI standard for each CCTV camera model selected.

The CCTV cameras shall have a 32GB SD card fitted in them to provide for emergency storage. This feature allows edge level recording for the cameras to store video footages during network or communication loss between the cameras and the NVR. Once communication is restored, the cameras shall be able to transmit the same to the NVR.

All supplied CCTV Cameras for this PROJECT shall incorporate the following as minimum requirements:

- Power over Ethernet (PoE)
- Minimum of 4MP
- Varied lens focal lengths from 2.8mm to 12mm or greater. Choosing the appropriate focal lengths is mandatory and special attention must be taken on the field of view of each camera installation.
- WDR ≥120dB
- SNR ≥50dB
- Network protocols: TCP/IP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, NTP, SMTP, IGMP, 802.1x, QoS, IPv6, UDP, PPPoE, SSL/TLS
- ONVIF compliant
- Digital zoom minimum of 10x
- Minimum illumination to achieve full colour shall be 0.01lux
- Minimum illumination for black and white shall be 0.0005lux or 0lux with IR
- IR or supplemental light up to 20m minimum
- Automatic iris or fixed depending on the installation with manual override.
- Superimposed text for purposes of identification, camera locations, data and time stamps. The text information shall be available on both live views and recordings.
- Support three (3) simultaneous video streams
- Audio, compression G.711/G.726
- Built-in microphone with noise filtering (to be selected and determined during implementation)
- Minimum IP66 camera housing
- 3-axis adjustment
- Cable tails with sealed connectors for LAN interface, power (if needed)
- Interface to the LAN and SCS using RJ45
- VENDOR shall provide the necessary mountings for installations where poles, pendants, wallmounts or brackets are required.
- IP66 Junction box to secure the cable tail and UTP patch cord

The cameras shall either be mounted on the ceiling, wall or pole depending on the location of the camera installation.

For outdoor installations, the CCTV camera's housing must be suitable for the environment. The housing must be capable of withstanding prolonged direct exposure to solar radiation, strong winds and rain.

The CCTV cameras shall be:

1. Fixed camera, dome
2. Fixed camera, bullet
3. Varifocal camera, dome
4. Pan Tilt Zoom camera, 25x zoom and 42x zoom
5. Temperature screening thermal and optical camera

FIXED DOME AND FIXED BULLET CAMERA

The fixed cameras shall either be dome or bullet types depending on the location of their installations. The fixed dome cameras shall primarily be chosen for ceiling mounting while the fixed bullet cameras shall be wall mounted. Focal length selection must be appropriate for the location of the installation considering its field of view. Dome and bullet cameras for the new PTB shall be installed indoors. All features and functionalities for the dome and bullet cameras shall adhere to the previous section on CCTV IP Cameras.

VARIFOCAL CAMERA

The Varifocal Dome Cameras are required to be installed in the Immigration areas – Arrival and Departure areas. This camera type shall have the Facial Recognition feature on its software and licenses. These shall capture the passengers' faces and compare them with a database of photos to verify and check the identity of the passenger amongst a list of persons with interest or concern by the government agencies.

Aside from the general requirements of a CCTV IP camera in the previous section, the varifocal camera shall have a minimum of the following:

- Face Capture/Recognition feature
- Motorized varifocal lens
- WDR ≥140dB
- Focal length – 2.8mm to 12mm
- DORI – Identification at 6m to 12m minimum
- Basic and smart video analytics

TEMPERATURE SCREENING THERMAL CAMERA

The Temperature Screening Cameras are required to be installed in the Quarantine Area of the Arrival section and the X-Ray machines at the Pre-Check in Lobby (the locations shall be confirmed during the implementation). This camera type shall measure the temperature of a passenger whereby temperature range shall be between 30ºC and 45ºC (final temperature range shall be determined during the implementation).

This camera type shall have both a thermal module and an optical module. The thermal module shall be responsible for measuring the skin temperature and thermal image of a person and reflect it back to a CCTV workstation that shall be placed nearby. An alarm shall be setup to alert the operator of a person's high temperature or that is beyond the temperature range set. This shall be monitored daily by the Airport's staff to ensure that all persons entering the DIA are screened of their temperatures and shall isolated if need be. The temperature screening cameras shall be mounted on a tripod.

These cameras must be installed and setup properly in the right environment to effectively scan a person. It should not measure people at the same time but must queue for best results. The person handling the thermal imaging must be properly trained by the awarded supplier.

Aside from the general requirements of a CCTV IP camera in the previous section, the temperature screening camera shall have the following as a minimum:

- Detect elevated skin temperature with accuracy and in real time
- Temperature range of 30ºC to 45ºC

- High temperature alarm
- Thermal module:
  - Focus distance about 0.2m
  - Focal length of 2.8mm to 4mm
  - Response waveband of 8μm to 14μm
  - NETD is <40mK, @25ºC

- Optical Module:
  - 4MP resolution
  - Focal length of 4mm
  - WDR ≥120dB
- Picture in picture showing partial image of thermal view on a full screen of an optical view
- Bi-Spectrum image fusion
- IR up to 40m
- Temperature accuracy of 0.5ºC
- Alarm

PAN, TILT AND ZOOM (PTZ) CAMERA

These cameras shall be setup within the new PTB to be able to monitor various areas with the ability to pan and tilt to the direction of concern and be able to zoom in or out for better clarity of view. They may either be ceiling or wall mounted depending upon the location of the camera installation.

Two (2) types of PTZ cameras shall be installed in the new PTB: PTZ cameras with 25x zoom and one with 42x zoom.

Aside from the general requirements of a CCTV IP camera in the previous section, the PTZ cameras shall have the following as a minimum:

- PoE+ maximum
- Focal length of 4.8mm to 120mm for a working distance of up to 1000m minimum (for the 25x zoom PTZ camera)
- Focal length of 6mm to 252mm for a working distance of up to 1500m minimum (for the 42x zoom PTZ camera)
- Pan and tilt motor mechanism
- Lens with motorized auto focus
- Optical zoom with 25x and Digital zoom of 16x (for the 25x zoom PTZ camera)
- Optical zoom with 42x and Digital zoom of 16x (for the 42x zoom PTZ camera)
- Pan range of 360º endless
- Tilt range of -15º to 90º
- Adjustable PTZ speeds (for the 25x zoom PTZ camera)
- Pan speed at 0.1º/s to 210º/s (for the 42x zoom PTZ camera)
- Tilt speed at 0.1º/s to 150º/s (for the 42x zoom PTZ camera)
- Shall have 300 presets
- Shall have 8 patrols with 32 presets for each patrol
- Shall have park feature
- Shall have 4 pattern scans with recording of 10mins per scan
- Capable of calling presets, pattern scan, patrol scan, auto scan, tilt scan, random scan, panorama scan and frame scan.
- Capable of multiple scheduled tasks like scans, presets, park, etc.

- Shall have power-off memory to restore PTZ positions during a power interruption.
- Basic and smart video analytics
- With Electronic Image Stabilization (EIS) function
- With de-fog feature
- PTZ zoom of a defined area/space

The awarded supplier shall ensure that the bracket and mounting harness of the PTZ camera are sturdy and strong enough not to make vibrations that may cause movements or vibrations during its pan and tilt actions.

The awarded supplier shall supply the power supplies or PoE injectors in cases where the VENDOR supplied PTZ cameras require additional power over and above the power from the PoE LAN switches.

VIDEO WALL

The video wall, decoder, monitoring workstation and CCTV keyboard shall be able to monitor and view all CCTV cameras simultaneously without delay or latency issues. These shall enable the selection and control of any camera on the system whereby selection and control shall be software based to allow for flexibility. These shall be capable of supporting the display of high-resolution video images and graphical displays.

The video wall shall be equipped with large LCD monitors and shall be installed in a wall within the 2/F Command and Control Room of the new PTB. The video wall shall be able to display all CCTV cameras of the PROJECT and to consider also displaying the existing CCTV Cameras' views with an additional of 10% as spare capacity for future requirements.

The following are the requirements for the video wall TVs:

- Four (4) 55" LCD monitors
- Decoder
- CCTV keyboard
- CCTV workstation

The 55" LCD monitors shall display the camera footages with the following minimum requirements:

- Active display area: minimum 1209mm (H) x 680mm (V)
- Direct-lit backlight
- Pixel pitch at 0.63mm
- Physical Seam maximum at 3.5mm
- Brightness at 500cd/m^2
- Color Depth shall be 8-bit, 16.7M
- Contrast Ratio shall be 1200:1
- Resolution: 1920x1080 @ 60Hz
- Bezel width: 2.3mm for top/left and 1.2mm for bottom/right
- Viewing angle: minimum 178º horizontal and 178º vertical
- Input - VGA, HDMI, DVI, DP, USB
- Output – HDMI
- Control – RS232

The awarded supplier shall design, engineer, supply and install a sturdy structural hardware to install the video wall monitors. This shall also include the power and signal wiring ducts and power outlets required.

The decoder shall decode the video streams onto the video wall with the following minimum characteristics:

- 16x HDMI ports with 4K and 1080p resolution
- 128-channels at 1080p or 80-channels at 3MP
- Up to 36 split screens

The CCTV keyboard shall be used to select and control cameras across the PROJECT. It shall have the following minimum requirements:

- Screen
- 4-axis joystick
- Ethernet, USB, serial ports

The monitoring workstation shall be equipped with the CPU, monitor, keyboard, mouse and CCTV keyboard to be able to view, monitor and control the CCTV cameras including, but not limited to, the PTZ camera controls.

The monitoring workstation software shall be easy to use and GUI-based. It shall allow to display sequentially the output from a selected number of CCTV cameras and operate in a split screen format. The CCTV System and the workstations shall have minimum of three (3) hierarchical password levels based on the credentials of each user of role-based control for administration and operations wherein these are logged into the system and may be retrieved for audit trails.

A standalone UPS of about 2kVA shall be provided for the video wall setup. The UPS shall be under the UPS System included in this Telecom Package. This shall provide for the emergency power during commercial power outages while waiting for the emergency generator to continue supplying power to the new PTB.

SYSTEM ADMINISTRATION AND WORKSTATIONS

The CCTV System shall be managed by a CCTV administration workstation and shall be responsible for the configuration, monitoring, diagnostics and troubleshooting the CCTV system.

The CCTV System shall have access rights management where the administrator shall assign levels of access for various users. The workstations shall have minimum of three (3) hierarchical password levels based on the credentials of each user of role-based control for administration and operations wherein these are logged into the system and may be retrieved for audit trails.

CCTV workstations shall be required for the following offices:

- 2/F Telecom Room – CCTV Administration workstation
- G/F Immigration Office – CCTV monitoring workstation equipped with CCTV keyboard, to monitor the varifocal and PTZ cameras at the Immigration Sections – arrival and departure areas. This comes with a standalone UPS of about 1kVA for emergency power during power outages.
- 2/F Command and Control Room – CCTV monitoring workstation equipped with CCTV keyboard and video wall to monitor and control all CCTV cameras.
- G/F Arrival and Pre-check in lobbies – 2x CCTV monitoring workstation in conjunction with the temperature screening cameras only.

The monitoring workstation and CCTV keyboard shall be able to select a camera or a number of cameras for viewing, or recording outputs of cameras or a sequence of cameras. The workstation shall be able to record onto its own hard disk or external USB thumb drive picture images or video footages of any selected camera.

Minimum required specifications of the CCTV monitoring workstations and administration workstations:

- Workstation shall be of a reputable manufacturer
- Minimum Intel Core i7 or i9 processor, dependent on the required simultaneous camera views with high resolution quality output
- Minimum 16GB RAM or higher, dependent on the required simultaneous camera views
- Minimum 1TB HDD
- Minimum 256GB SSD
- Minimum 1GB video/graphic card or higher, dependent on the required simultaneous camera views
- Minimum 24" LED monitor, full HD or 4K or bigger
- HDMI and VGA ports
- At least 4 USB ports
- Keyboard and mouse
- Latest operating system software with license

Note that the specifications mentioned above are minimum requirements whereby the awarded supplier shall configure the workstation for the minimum required simultaneous camera views with high resolution quality output, quick response of shifting camera views with none or very minimal latency/delays.

CCTV OPERATIONS

The CCTV System Operations shall be monitored and controlled from the 2/F Command and Control Room of the Security Office of the new PTB, where the CCTV video wall is installed.

The Immigration Office at the G/F of the new PTB shall have its own CCTV workstation with CCTV Keyboard to monitor the operations at both Arrival and Departure Immigration Booths. There shall be a minimum of eight (8) varifocal cameras with motorized lens for this purpose and two (2) PTZ cameras.

CCTV CAMERA COVERAGE STUDY

The VENDOR shall develop a CCTV Camera Coverage Study Report to depict the cameras' field of view, the camera locations and camera types. This shall enable the END-USER to review and confirm if the cameras' coverage is properly aligned and that cameras are correctly chosen for its purpose. This shall be developed and approved before the implementation.

TRAFFIC CALCULATION

The awarded supplier shall develop a report on the calculation of the required bandwidth capacity to accommodate all the CCTV cameras' live view and recordings streams. This shall be broken down per LAN Switch and per location up to the LAN core switch. This calculation shall help the awarded supplier determine if the LAN System is able to handle the load and bandwidth including that of other systems that shall use the LAN System as its transport or infrastructure.

CABLING

The CCTV camera shall incorporate a cable tail where it meets the structured cabling system (SCS). The camera's cable tail shall be equipped with grommets, seals and gaskets to seal the UTP patch cord and the cable tail terminations.

The CCTV cameras shall be equipped with individual junction boxes to secure the connectors of the camera's cable tail and the Structured Cabling System UTP patch cord. The junction boxes shall be mounted and secured with bolts inside the ceilings hidden from the public's eye or as part of the camera's base unit itself. The junction boxes shall be weather-proof, IP66, whereby holes shall be sealed with silicon to prevent further ingress. From the cable tail, a patch cord shall connect to the Information Outlet (IO) of the SCS onwards to the LAN Switch.

For outdoor installation, particularly on the Rooftop, a PTZ camera shall be installed whereby the VENDOR has to ensure a proper cabling infrastructure. The SCS UTP cable shall be placed in a conduit and terminated into a IP66 junction box with cable or conduit gland to prevent further ingress. The camera cable tail shall be placed inside that junction box, where both shall meet. VENDOR shall ensure that all components must be suitable for outdoor installations. All connections, conduits, adaptors, etc. must be properly sealed.

INTERFACING AND INTEGRATION

The CCTV System shall have features and functions built into it to integrate and interface with the subsequent systems.

The awarded supplier shall design, engineer, supply, install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

MASTER CLOCK SYSTEM

The CCTV System shall be interfaced with the Network Time Protocol (NTP) Server for its time synchronization over ethernet. The NTP shall be under the scope of the Master Clock System.

LAN SYSTEM

The CCTV System shall be supported by the LAN System as its transport for all the CCTV System components. The LAN and PoE Switches required by the CCTV System shall be under the scope of the LAN System. The LAN System shall be able to provide the requirements of the CCTV System including its field cameras.

The CCTV field cameras shall be connected to the nearest or most suitable LAN switch within the area and subsequently to the server switch of the LAN System to where the CCTV NVR, Storage and VMS are connected to. Other CCTV field devices such as the video wall, monitoring and administration workstations shall also be connected to the LAN switches.

In cases where the field UTP cables from the LAN Switch to the field CCTV camera exceed 90 meters, a FO transceiver or media converter shall be installed by the awarded supplier together with the power cables. Extra care must be taken in measuring the length of the UTP cables.

The CCTV cameras shall be terminated on minimum 10/100Base-TX ports of the LAN Switch.

The awarded supplier shall ensure that the CCTV System shall have its own VLAN configured within this PROJECT. The awarded supplier shall ensure that the bandwidths are properly allocated considering that the PROJECT has other Telecom Systems that will use the LAN System as its backbone for transporting its own data.

STRUCTURED CABLING SYSTEM

The CCTV System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure to the LAN System onwards to the main CCTV System. The SCS shall use CAT6 UTP cables for this purpose with Information Outlets (IO) for terminating the camera cable tails to the RJ45 keystones with UTP patch cords.

ACCESS CONTROL SYSTEM

The CCTV System shall be interfaced with the Access Control System (ACS) providing a high-level type of integration. This shall allow cameras to be configured to show, display or pop-up onto the monitors during a trigger by the ACS devices or as when required by the ACS.

ACS alarm or events shall trigger the CCTV System whereby the latter shall have its video footages played back instantly. PTZ cameras shall be configured to receive ACS alarms or events and shall be able to pan, tilt and zoom or preset its position in the location of the ACS event. Fixed cameras and PTZ shall push the camera views to the monitoring workstation and video wall upon an ACS event or alarm.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-04 – FIRE DETECTION AND ALARM SYSTEM (FDAS)

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ABBREVIATION

ACS	Access Control System
BoM	Bill of Materials
DC	Direct Current
DCP	Digital Communication Protocol
EOL	End Of Line
FACP	Fire Alarm Control Panel
FDAS	Fire Detection and Alarm System
LED	Light Emitting Diode
NAC	Notification Appliance Circuit
NFPA 72	National Fire Protection Association - Alarm Code
PAS	Public Address System
PTB	Passenger Terminal Building
SCS	Structured Cabling System
SD	Schematic Diagram
SLC	Signalling Line Circuit
TDS	Technical Design Specifications
UL	Underwriters' Laboratory

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the Fire Detection & Alarm System and its components, peripherals, accessories, ancillaries, field devices and associated items for the Fire Detection & Alarm System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. Fire Detection & Alarm System – Bill of Quantities

c. Fire Detection & Alarm System – Schematic Diagram

d. Fire Detection & Alarm System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- Fire Alarm Control Panel (FACP)
- Smoke Detector
- Heat Detector
- Annunciator
- Manual Call Point
- Horn-Strobe
- Relay Module
- Peripherals, accessories, cables, roughing-ins, connectors, ancillaries, and other related works and supplies necessary to complete the installation of the Fire Detection & Alarm System.

The main Fire Detection & Alarm System and its associated peripherals shall be installed in the G/F Command & Control Room of the new Passenger Terminal Building (PTB).

The smoke detectors, heat detectors, annunciator, horn-strobe and manual call points shall be distributed at the following areas:

- Lobbies
- Check-in lobby/counters
- Public spaces
- Arrival areas
- Departure areas
- Immigration areas
- Offices
- Rooms
- Toilets
- Baggage claim/handling areas
- Gate lounges
- Passenger lounges
- Hallways or corridors
- Airside corridor

- Electrical room
- Mechanical room
- AHU rooms
- Fan room

GENERAL DESIGN REQUIREMENT

The Fire Detection & Alarm System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new Fire Detection & Alarm System shall be provided in all areas under the scope described herein, for the purposes of monitoring excessive smoke and heat which can result to fire within the new Passenger Terminal Building (PTB).

The FACP or fire alarm control panel shall be located at the Command and Control Room, a controlled location wherein a 24x7 personnel is on-duty to centrally monitor the panel in case of any alarm detection.

The Fire Detection & Alarm System shall provide the function to detect, alert, monitor and control the initiating devices and indicating appliances.

Initiating devices are the part of the alarm system which detects smoke or a fire. These devices include smoke detectors, heat detectors, and manual pull stations. Indicating appliances are the part of the system that sounds the alarm and alerts occupants to the fire hazard such as using horn and strobes. Detection of smoke and heat to inform passenger and airport personnel during situations that require verification of alarm and to act accordingly if false alarm or verified alarm to partially or fully evacuate the new PTB. A response time to verify the alarm is set in the FACP (in seconds) either to reset the alarm (false alarm) or to confirm the detection of smoke or heat in a certain location. Subsequently, the annunciators will also display the location of a detected alarm to assist the responding team. Upon confirmation of alarm or exceeding the time limit of a detected alarm, the FACP will send a signal to the horn-strobe alerting the area of such visual flashing strobe and horn sound. At the same time when integrated, the FACP shall trigger the ACS and PA systems to open the controlled doors and initiates a voice emergency announcement respectively. Alarms can be cleared or reset upon during completion of emergency procedures.

Moreover, the FDAS operation shall be defined by its fire safety plan to be provided by DIA during the commissioning of the system.

The FDAS system will cover the ground and second floor of the New PTB and shall have 2 zones connected to FACP. Each zone shall consist of the initiating and indicating devices. The specific location of these devices may vary aesthetically according to its interior design but making sure the standard spacing (i.e. NFPA 72) of detectors shall be complied.

The Fire Detection & Alarm System shall interface directly with other systems, such as the Paging System and Access Control System as described herein.

TECHNICAL DESIGN CRITERIA

A new Fire Detection & Alarm System shall consist of Fire Alarm Controller with backup batteries, smoke detectors, heat detectors, annunciators, manual call points, horn-strobe and relay modules.

The Fire Detection & Alarm System shall include all other necessary components and peripherals to complete a functional Fire Detection & Alarm System.

SYSTEM ARCHITECTURE

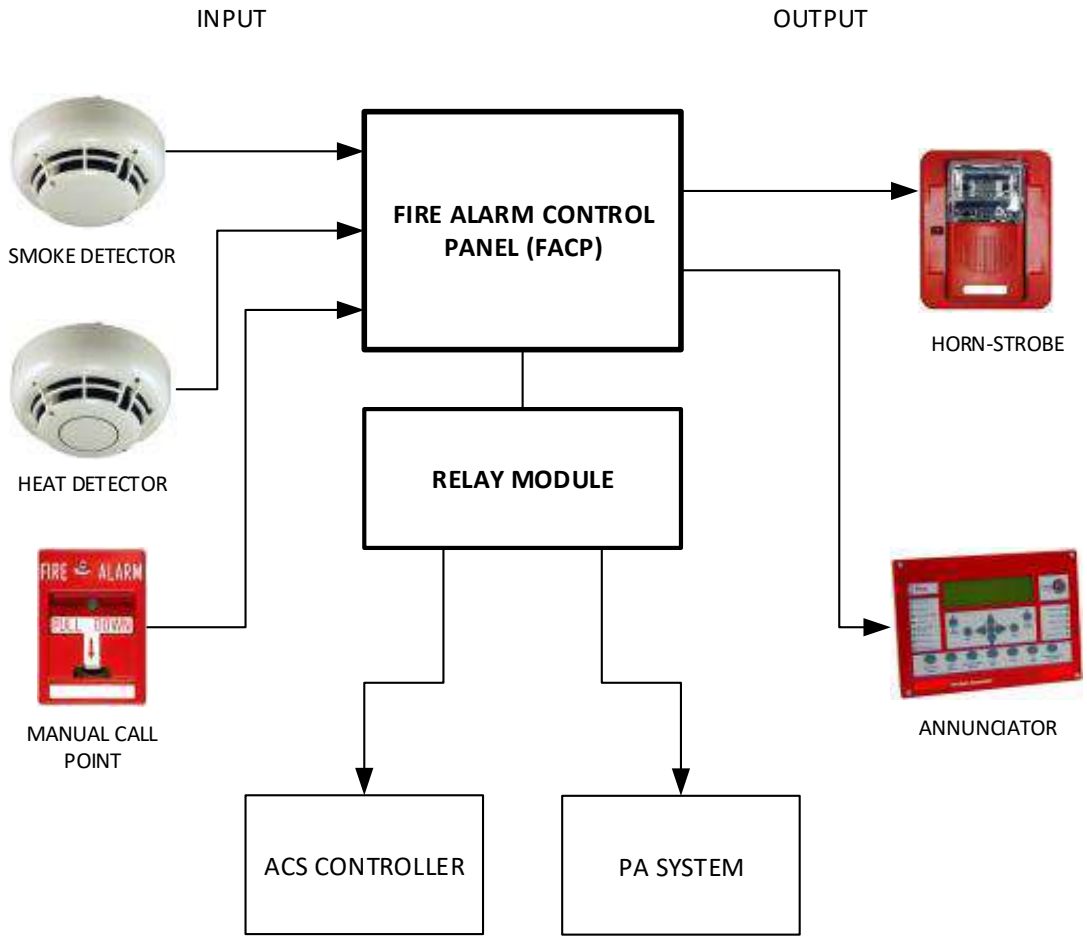

Figure 4: Fire Detection & Alarm System Architecture

FIRE ALARM CONTROL PANEL (FACP)

The fire alarm control panel is the user interface and central monitoring and controlling element of the system. It shall have a display revealing the current state (alarm or no alarm) of the fire alarm system and a touch pad, which allows onsite personnel to program, troubleshoot, silence, and reset the system.

The fire alarm panel monitors and shall have a supervisory functions over all the system's initiating devices, indicating appliances, all related field wiring, circuit cards and internal wiring.

It is also via the fire alarm panel that a signal shall sent out to a relay module in the event of a triggered alarm so that a system such as Paging and Access Control can be integrated.

Technical Specifications:

- Wired loops: 2 to 8 loops
- Power supply voltage: 120 V AC or 240 V AC
- Backup battery: 2 x 12VDC, 5.25A, 28AH @20hr
- Power supply rating at 24V DC 5.25 A (charges up to 60 Ah)
- Display Full color 800 x 480 LCD with resistive touch screen and automatic backlight dimming
- Software zones - 2,000
- Software groups - 5,000
- Cause and Effects - 5,000
- Event log 10,000 events, 1 second resolution. Filterable and printable
- Detection loop current - 400 milliamps each
- Programmable Relay Outputs - 5; 30 VDC 1 Amp
- Programmable Inputs - 3; designed to be activated by voltage-free contacts
- NAC Synchronization - Internal Support of System Sensor, Wheelock, Gentex and Amseco protocols
- Powder coated metal enclosure

SMOKE DETECTOR

The Smoke Detector shall be an addressable sensor particularly suited to detecting optically dense smoke typical of fires involving materials such as soft furnishings, plastic, foam or other similar materials which tend to smoulder and produce large visible smoke particles. It is designed to allow fast response to flaming fires as well as smouldering fires while preventing false alarms.

The detection chamber shall consist of a light-emitting diode (LED) and photodiode arrangement.

Smoke sensor spacing shall be in compliance with NFPA 72. For smooth ceilings and in the absence of specific performance-based design criteria, the distance between smoke sensors shall not exceed a nominal spacing of 9.1m or all points on the ceiling shall have a sensor within a distance equal to or less than 0.7 times the nominal 9.1m spacing. Sensors shall be located within a distance of one-half the nominal spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.

Technical Specifications:

- Low profile - only 2.00" high, including base
- Addressable device
- Automatic compensation for sensor contamination
- Built-in fire test feature
- Uses the noise-immune Digital Communication Protocol (DCP)

- Two built-in power/alarm LEDs
- Programmable non-polling LEDs
- Non-directional smoke chamber
- Vandal resistant security locking feature
- Operating Voltage 24 - 41 VDC
- Transmission Method: DCP - Digital Communication Protocol
- Maximum Humidity: 95% RH Non-Condensing
- Ambient Operating Temperature: 0°C to 49°C
- Air Velocity Range 0-4000 fpm

HEAT DETECTOR

The Heat detector shall be an addressable sensor that provide accurate temperature measurement data to the fire alarm control panel. These sensors shall be well-suited for environments where dust, cooking fumes or other factors make the use of smoke sensors impractical.

The sensor shall be a thermistor while allowing maximum air flow. The thermistor circuit produces a voltage proportional to the temperature.

Heat sensor spacing shall be in compliance with NFPA 72 or about 9.1m apart from the center or 83 sq.m in area. The distance between heat sensors shall not exceed their listed spacing or all points on the ceiling shall have a sensor within a distance equal to or less than 0.7 times the listed spacing. Heat sensors shall be located within a distance of one-half the listed spacing, measured at right angles from all walls or partitions extending upward to within the top 15 percent of the ceiling height.

Technical Specifications:

- Low profile - only 2.00" high, including base
- Addressable device
- Rate of rise temperature threshold = 15°F/Min (determined by panel)
- Adjustable threshold temperature = 135°F - 190°F (determined by panel)
- UL maximum spacing of 21 meters
- Operating Voltage: 24 - 41 VDC
- Transmission Method: DCP - Digital Communication Protocol
- Rate of Rise: 8.3° C/Min.
- Operating Temperature Range: -10 °C to 50 °C
- Maximum Humidity: 95% RH Non-Condensing

ANNUNCIATOR

The annunciator shall provide a remote display of status, alarm, and information of sensors at a specified location for responding personnel or staff in the New PTB. Annunciators shall be connected to the control panel via the serial communication interface. It shall have a character display and navigation buttons that mimic the control panel display. The use of a common interface allows the user to easily operate the annunciator as if operating control panel directly.

Security shall be established by the use of a password or firefighters enable key. The annunciator shall be surface or flush mounted on the wall.

Technical Specifications:

- Functions:
  - LED indicators for Fire, Supervisory Alarm, Pre- Alarm, Fire Output Active, AC Power On, On Test, Panel Sounder Silenced, Delay Active, More Events, Point Bypassed, General Trouble, Power Trouble, System Trouble & NAC Trouble
  - Local piezo sounder for event notification
  - Supports user codes & firefighter key to enable access & controls
  - Fire drill function
- Specifications:
  - 24VDC supply voltage
  - ABS/steel enclosure
  - Operating Temp.: 0° C to 49° C
  - Relative Humidity: 85% RH Non-Condensing
  - Network Interface: RS485 port
  - Standards: UL 864 9th Edition Listed

HORN-STROBE

The horn and strobe combination shall be an audible and visual alarms output from the FACP. It shall be in areas which are visible and audible to people inside the NEW PTB.

Technical Specifications:

- Nominal Voltage: 24 VDC
- Field selectable candela options of 15, 30, 60, 75, and 110 candela
- Synchronize strobe and/or horn with FACP
- Supports 12 to 18 gauge wire
- Selection for high or low dBA
- Selectable switch for chime, whoop, mechanical and 2400Hz tone
- Can silence horn while strobes remain flashing
- Tamperproof enclosure
- Standards: UL 464 & UL 1971 Listed - S8369
- NFPA 72 compliant

MANUAL CALL POINT

The addressable manual pull stations shall provide a fast and practical means of manually initiating a fire alarm signal. Both single action and dual action manual pull stations are available. Resetting of the pull station requires 1/8" hex key.

An alarm condition shall be actuated by pulling down on the handle. Once the pull station is activated, the handle cannot be put back into a normal standby condition without using the key operated reset feature. When an alarm condition is actuated by pulling the handle, the LED will latch Red to indicate the alarm condition.

Technical Specifications:

- Operating Voltage: 17 to 41 VDC
- All metal construction
- Status LED indicates Standby and Alarm conditions
- Key lock or hex key lock

- Enclosed switch with glass rod
- Address shall be programmed when installed

RELAY MODULE

The relay module shall provide an independent 2 contacts for monitoring circuits while utilizing one address. This shall be used to integrate or interface other system such as the Access Control System and Paging System. The module shall be programmed to monitor Normally Open (NO) or Normally Closed (NC) contact fire alarm and supervisory devices.

This module also shall provide EOL (End-of-line) to device detectors within the loop.

Technical Specifications:

- Supply Voltage: 25.3 to 39 VDC
- Average Current Consumption: 600µA (Typical) 720µA (Alarm)
- Programmable Inputs: 2 Independent Monitoring Inputs
- EOL Device: 22K ohms Resistor
- Max. Quantity Per Loop: 127
- Operates on Class A or Class B SLC loop
- Accepts up to 14 AWG wire

CABLING

The smoke and heat detector loops as well as the manual call point, horn-strobe and annunciator of the Fire Detection & Alarm System (FDAS) shall have its own fire rated cabling infrastructure independent of the SCS. The awarded supplier shall supply and install all the necessary sensor cables, roughing-ins, EMT pipes and accessories, utility and junction boxes, threaded rods, hangers, flexible metal conduits, strut channels and clamps, accessories and ancillaries to complete the device loop cabling infrastructure.

The cable shall be a shielded fire alarm cable with 2 cores.

The sensor cables shall be terminated directly to the terminal blocks of the sensor with appropriate connectors.

The awarded supplier shall determine the appropriate cable core size in order to keep the resistance and the voltage drop to a minimum.

INTERFACING AND INTEGRATION

The Fire Detection & Alarm System shall have features and functions built into it to integrate and interface with the subsequent systems and the awarded supplier shall install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

ACCESS CONTROL SYSTEM

The system shall provide integrations with ACS system allowing the doors to open in case of Fire emergencies. The interface shall be based on relay contact (for automatic door release). Following are few important functions that are expected out this interface.

1. The interface initiator shall be the FDAS equipment.

2. The interface responder shall be the ACS equipment.
3. The system will be interfaced with the ACS system using the fire alarm relay modules. All shall be wired and set as “Fail Safe”.
4. In case of an emergency, the FDAS has priority over Security. When zone in alarm has been detected all security that are used as safety accesses will automatically unlock.
5. Dry contact from fire alarm will be hardwired up to the access controller box, sequence of operation will be coordinated with ACS.

The awarded supplier shall coordinate with the ACS supplier and the DIAA Fire Safety Team on the cause-and-effect configuration for the Fire Alarm Control Panel (FACP) of FDAS. This shall also determine the proper and correct zone assignments of the ACS.

PAGING SYSTEM

The Fire Detection & Alarm System (FDAS) shall be interfaced with the Paging System (PAS) through hard-wired dry contacts in the relay module. Upon receipt of a fire alarm signal, the PAS shall automatically broadcast the emergency messages without any manual intervention.

The following are the conditions for interfacing with FDAS:

1. The interface initiator shall be the FDAS equipment.
2. The interface responder shall be the PAS equipment.
3. Pre-defined voice alarm zones shall be wired on the assigned relay module. Emergency messages shall be broadcasted automatically based on the signals or inputs from FDAS
4. Connection to the FDAS shall be for 8x dry contacts intended for each of the eight (8) zones of the PAS, including the “all clear” signal

The awarded supplier shall coordinate with the PAS vendor or supplier and the DIAA Fire Safety Team on the cause-and-effect configuration for the Fire Alarm Control Panel (FACP) of FDAS. This shall also determine the proper and correct zone assignments of the PAS.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-05 – FLIGHT INFORMATION DESIGN SYSTEM (FIDS)

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ABBREVIATION

ACS	Access Control System
BoM	Bill of Materials
EPC	Engineering, Procurement and Construction
FIDS	Flight Information Display system
HD	High Definition
HDMI	High Definition Multimedia Interface
IP	Internet Protocol or Ingress Protection
LAN	Local Area Network
LED	Light-Emitting Diode
LD	Layout Diagram
MCS	Master Clock System
NTP	Network Time Protocol
PC	Personal Computer
PoE	Power over Ethernet
PTB	Passenger Terminal Building
RJ45	Registered Jack
SCS	Structured Cabling System
TDS	Technical Design Specifications
TV	Television
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the FIDS System and its components, peripherals, accessories, ancillaries, field devices and associated items for the FIDS System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. FIDS System – Bill of Quantities

c. FIDS System – Schematic Diagram

d. FIDS System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- LED TV
- Android Device
- System administration for management and maintenance
- Latest software and firmware
- Interface with the existing FIDS at the old PTB
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the FIDS System.

The FIDS TVs and Android devices shall be distributed at the following areas:

- International Arrival Concourse
- International Departure Concourse
- Pre-Check In Lobby
- Check in Counters
- Carousel Area
- Baggage Breakdown Area
- Baggage Make-Up Area
- Passenger Lounge
- Pre-Departure Lobby
- Terminal Manager Office
- VIP Lounge
- Pre-Departure Lounge

GENERAL DESIGN REQUIREMENT

The FIDS shall be designed based on the minimum requirements and specifications of the PROJECT.

A new FIDS shall be provided in the new PTB, in all areas under the scope described herein, for the purpose of providing the passengers and other airport stakeholders with an on-line, real-time and accurate flight information data.

The new FIDS shall interface with existing FIDS server located at the Old PTB. A LAN Switch shall be provided in the old PTB (under LAN System) connected via a 24-core Fibre Optic cable under the SCS.

The FIDS at the new PTB, shall be remote units or clients querying and receiving information from the FIDS server at the old PTB, in a client-server architecture.

A set of the flight information display system contains two main components namely the TV and an Android device. The TVs used in the systems will be commercially available capable of running in a 24x7 operations environment. The Android device shall come in a small form factor unit suitable in a 24x7 operations environment.

Each Android device receives the data to be displayed onto the TV from the FIDS Server. The information is generated by the Flight MIS that manages the entire system. The FIDS Operators enter all the information required pertaining to flight schedules, airline schedules with flight numbers, registries, aircraft details, status, etc. This information shall be pushed to a local web server where the Android device get its information and displays it accordingly to the FIDS TV.

The existing FIDS administration and workstations at the old PTB shall be used to manage the new FIDS at the new PTB. The DIA shall provide access from the existing server to the new management terminal at the new PTB if required.

The awarded supplier shall coordinate with the current supplier and service provider of the existing FIDS at the DIA. The solution shall be to provide additional remote FIDS at the new PTB with reference to its existing design and solution.

All new FIDS shall be connected to the LAN and SCS Systems infrastructure provided in the new PTB for communicating with the existing FIDS server.

The FIDS shall be scalable in order to accommodate additional quantity of FIDS displays (in the future).

The FIDS shall interface directly with other systems, such as the LAN, SCS, Master Clock and the existing FIDS, as described herein.

TECHNICAL DESIGN CRITERIA

Aside from the equipment mentioned in the previous section, the FIDS shall include all other necessary components and peripherals to complete a functional FIDS System.

SYSTEM ARCHITECTURE

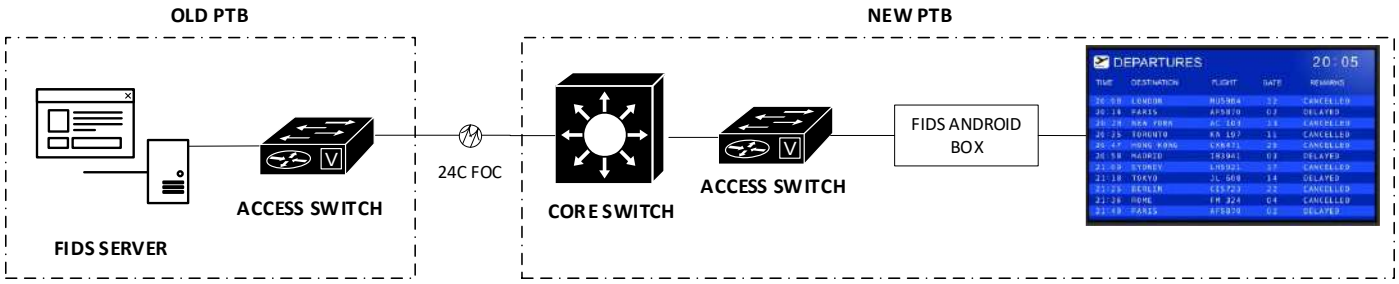

Figure 5: FIDS System Architecture

FIDS TV

The FIDS TVs shall come in three (3) sizes: 32", 43" and 55". The contents or displayed information shall be carefully designed considering the reading distance for the people inside the new PTB.

The FIDS TV shall have the minimum requirements:

- 32", 43" and 55" LED TVs
- 1080p full HD resolution
- At least 2 x HDMI 2.0 and 2.0 USB ports
- AV input/component
- Wall and Ceiling mount type
- AC 100-240V 50/60Hz Operating Voltage

Two (2) FIDS TVs shall be located outdoors (under a canopy) in the International arrival and departure concourses of the new PTB. VENDOR shall supply the FIDS with an enclosure or encasement that shall protect the equipment from water and dust ingress with vents. The awarded supplier shall properly design and engineer the encasement and shall present this to the END-USER for approval before any delivery since this will affect the aesthetics of the new PTB.

All FIDS shall conform to the architectural design, aesthetics and finish of the installation location. The awarded supplier shall coordinate with the EPC and END-USER to properly locate the FIDS and its installation components with consideration to the passengers' view and aesthetics.

The awarded supplier shall provide the mounting brackets, VESA mounts, pole/pendants mounts (ceiling and floor mounts) accordingly, depending on the installation location. All other cables, accessories and ancillaries shall be included to complete the installation.

FIDS ANDROID DEVICE

The VENDOR shall provide the Android device in a small form factor type in order to connect to the FIDS TV via the LAN. The information shall be displayed in the FIDS TV via an HDMI cable.

The FIDS Android device shall have a minimum of the following:

- Latest Android Operating System (or O/S compatible with the existing FIDS server)
- Minimum of Cortex-A5 8-core CPU up to 2GHz
- Latest chipset
- Minimum memory of 2GB
- Minimum 10/100MBps RJ45 PoE ethernet interface
- HDMI and USB Ports

The awarded supplier shall provide the mounting brackets, accessories and ancillaries to mount the Android device to the back of the FIDS TV to complete the installation.

INTERFACING AND INTEGRATION

The FIDS System shall have features and functions built into it to integrate and interface with the subsequent systems.

The awarded supplier shall install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

MASTER CLOCK SYSTEM

The FIDS System shall be interfaced with the Master Clock System for its time synchronization via Network Time Protocol (NTP) over ethernet. The Master Clock shall be under the scope of the Master Clock System.

LAN SYSTEM

The FIDS System shall be supported by the LAN System as its transport for all the FIDS System components. The LAN and Switches required by the FIDS System shall be under the scope of the LAN System.

In cases where the field UTP cables from the LAN Switch to the FIDS field devices exceed 90 meters, a FO transceiver or media converter shall be installed by the awarded supplier together with the power cables. Extra care must be taken in measuring the length of the UTP cables.

STRUCTURED CABLING SYSTEM

The FIDS System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure to the LAN System onwards to the main FIDS System. The SCS shall use CAT6 UTP cables for this purpose with Information Outlets (IO) for terminating the camera cable tails to the RJ45 keystones with UTP patch cords.

EXISTING FIDS

The new FIDS in the New PTB shall be interconnected to the existing FIDS server via a LAN Switch (under the LAN System) and a 24-core Fiber Optic cable (under SCS System) wherein all international and domestic flight schedules shall be displayed in all of the new FIDS TVs. The integration of the new FIDS system shall be coordinated with the DIAA to liaise the proper authority and the existing FIDS supplier and service provider for the integration and commissioning.

SERIES 7000- TELECOMMUNICATION WORKS

Section 7200-06 – LOCAL AREA NETWORK (LAN)

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ABBREVIATION

ACS	Access Control System
AES	Advanced Encryption Standard
ARP	Address Resolution Protocol
ASIC	Application Specific Integrated Circuit
AVMS	Automatic Voice Messaging System
BGM	Background Music
BGP	Border Gateway Protocol
BoM	Bill of Materials
BPDU	Bridge Protocol Data Unit
CATV	Cable TV
CCTV	Closed Circuit Television
DDoS	Distributed Denial of Service
DES	Data Encryption Standard
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
ERPS	Ethernet Ring Protection Switching
FDAS	Fire Detection and Alarm System
FIDS	Flight Information Display System
FOC	Fiber Optic Cable
GB	Giga byte
Gbps	Giga bit per second
GE	Giga bit Ethernet
GUI	Graphical User Interface
HTTP	HyperText Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPS	Intrusion Prevention System
LAN	Local Area Network
LACP	Link Aggregation Control Protocol
LC	Lucent Connector
LCD	Liquid Crystal Display
LD	Layout Diagram
LED	Light Emitting Diode
MAC	Media Access Control
Mbps	Mega bit per second
MCS	Master Clock System
MLD	Multicast Listener Discovery

MM	Multi-Mode
NAT	Network Address Translation
NMS	Network Management System
NTP	Network Time Protocol
OSPF	Open Shortest Path First
PAS	Public Address System
PABX	Private Branch Exchange
PoE	Power over Ethernet
PPPoE	Point-to-Point Protocol over Ethernet
PPTP	Point-to-Point Tunneling Protocol
PTB	Passenger Terminal Building
RIP	Routing Information Protocol
SCS	Structured Cabling System
SD	Schematic Diagram or Software Defined
SFP	Small Form Pluggable
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SSD	Solid State Drive
SSH	Secure Shell
SSL	Secure Sockets Layer
SSO	Single Sign On
SVI	Switched Virtual Interface
TCP/IP	Transmission Control Protocol / Internet Protocol
TDS	Technical Design Specifications
TLS	Transport Layer Security
URL	Uniform Resource Locator
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
VRF	Virtual Routing and Forwarding
WiFi	Wireless Fidelity

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the LAN System and its components, peripherals, accessories, ancillaries and associated items for the LAN System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. LAN System – Bill of Quantities

c. LAN System – Schematic Diagram

d. LAN System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- Core Switch
- Server Switch
- Firewall
- Non-PoE Access Switches
- PoE Access Switches
- Network Management System
- System administration and workstation for management and maintenance
- Latest software and firmware
- Telecom cabinet and wiring (may be shared with other Telecom Systems)
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the LAN System.

The main LAN System and its associated peripherals shall be installed in the G/F Telecom Room of the new Passenger Terminal Building (PTB).

GENERAL DESIGN REQUIREMENT

The LAN System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new LAN System shall be provided in all areas under the scope described herein, for the purposes of providing the network connectivity of the various Telecom Systems in this PROJECT. It shall provide the infrastructure and the logical connections of the Telecom Systems' field devices to their respective servers, controllers and central equipment within the new Passenger Terminal Building (PTB). It shall also provide the bandwidth as required by the telecom systems to distribute and share their data.

Telecom Systems to which the LAN System shall provide network connectivity:

1. Access Control System (ACS)
2. Cable TV System (CATV)
3. Closed Circuit Television System (CCTV)
4. Flight Information Display System (FIDS)
5. Master Clock System (MCS)
6. Public Address System (PA)
7. Telephony System (PABX)

8. Wireless Fidelity System (WiFi)

The Virtual Local Area Network (VLAN) shall be deployed in this PROJECT to have a single cost-effective LAN for the DIAA Expansion Project for its network communication requirements, instead of having separate networks for each Telecom System.

The LAN System shall be software controlled, easily configured and allow for future expansion.

It shall be scalable in order to accommodate the additional IP-based equipment as needed (in the future). In the event that the existing PTB's LAN System be included or added into the new LAN System (in the future), then this shall only entail additional switches without any replacements of any major component.

The LAN System shall provide the three (3) layers required of an active network topology:

- Security Layer provided by the Firewall
- Core Layer
- Access Layer for connectivity of Telecom Systems' devices

The LAN System design and its approach shall be confirmed during the implementation once the END-USER has confirmed the inclusion of non-Telecom Systems/IT networks into the LAN System of the new PTB.

TECHNICAL DESIGN CRITERIA

A new LAN System shall provide the communications for the IP-based Telecom Systems over the wired network and WiFi System. The design shall be patterned with best practices and recommended by the industry.

Generally, the design shall follow a two-tier hierarchical design or a collapsed core. Currently, the network is not expected to grow significantly over a larger network or the quantity of endpoints, wherein the collapsed core shall suffice for the DIAA. This shall still be dependent on the design approach where the END-USER shall confirm the inclusion of the IT networks for the new and old PTBs.

The Firewall shall be for the perimeter security and shall connect to the Core Switch over 10GE SFP with a fiber patch cord. Outgoing and incoming traffic from the internet will go through the Firewall, where access rights and traffic routing shall be performed by the firewall.

The Core Switch shall connect all the access switches over 1GE and 10GE SFP with fiber patch cords.

The Server Switch shall connect to the Core Switch over 10GE SFP with a fiber patch cord.

The Access Switches, both PoE and non-PoE, shall have 1GE and 10GE downlinks for the devices or services. 10GE shall be used where heavy traffic occur on some switches.

The services or Telecom Systems shall be segregated into VLANS that will be isolated from each other.

The LAN System shall include all other necessary components and peripherals to complete a functional LAN System.

SYSTEM ARCHITECTURE

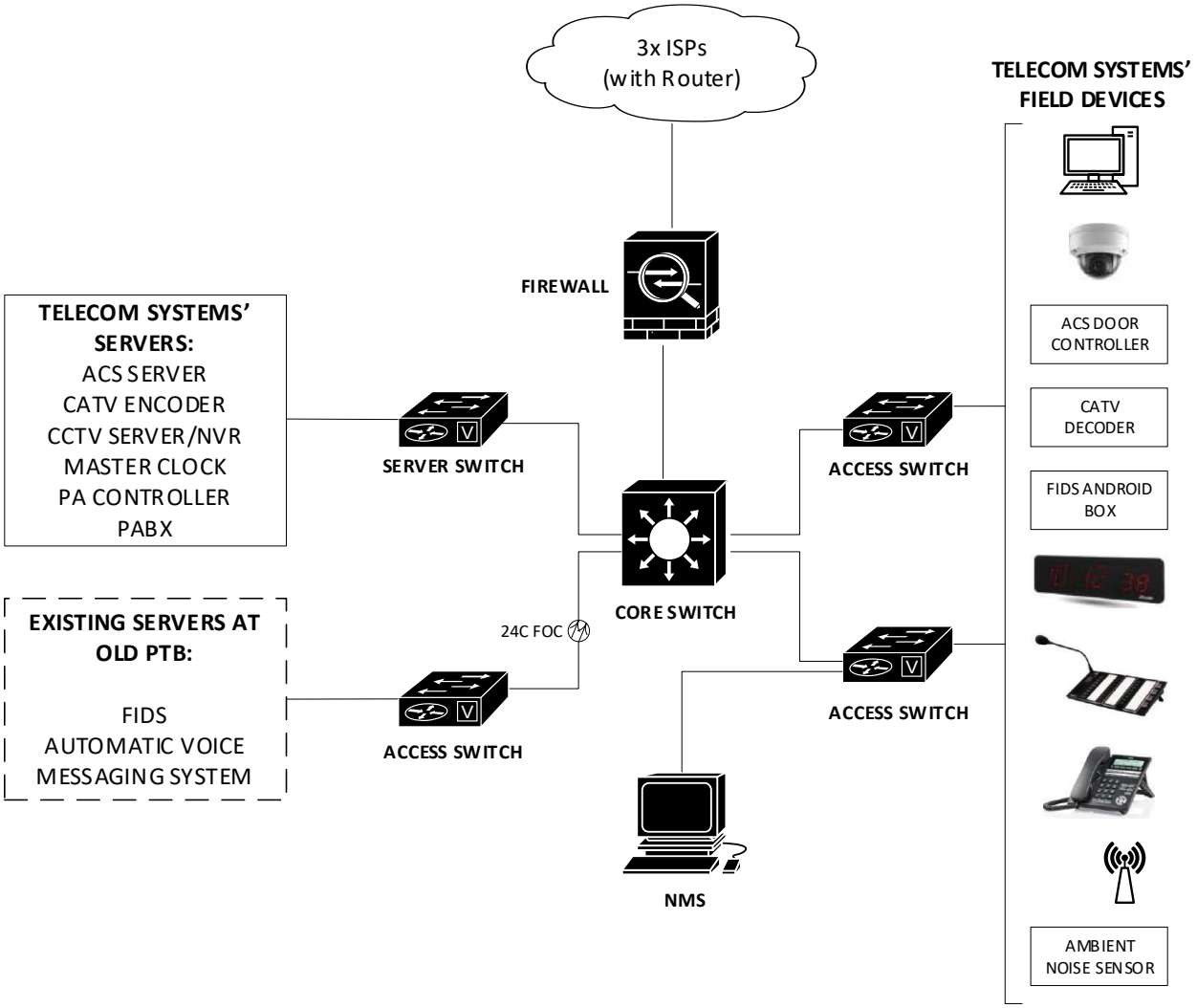

Figure 6: LAN System Architecture

SECURITY LAYER

The new LAN System shall have a security layer that will be using a firewall, which shall be the ingress and egress of all internet traffic of the new PTB.

The Firewall shall have the following as minimum requirements:

- Rackmount
- Storage 128GB M.2
- Logical VLAN and tunnel interfaces, minimum of 250
- SSO Users, minimum of 39,000
- Number of access points supported, minimum of 30

FIREWALL AND VPN PERFORMANCE

- Firewall Inspection throughput at least 5Gbps
- Threat Prevention throughput at least 3Gbps
- Application Inspection throughput at least 4Gbps
- IPS throughput at least 3.5Gbps
- Anti-malware Inspection throughput at least 3Gbps
- TLS/SSL inspection and decryption throughput of 850Mbps
- IPSec VPN throughput at least 2Gbps
- Connections/sec of at least 22,000
- DDoS attack prevention
- Stateful packet inspection
- Deep packet inspection for TLS, SSL, SSH

VPN

- Site-to-site VPN tunnels of minimum 2,800
- IPSec VPN clients of 50-1000
- Encryption/Authentication DES, 3DES, AES (128, 192, 256-bit)/MD5, SHA-1, Suite B Cryptography
- Route based VPN: RIP, OSPF, BGP
- Certificate support: Verisign, Thawte, Cybertrust, RSA Keon, Entrust, SCEP
- VPN features: Dead Peer Detection, DHCP Over VPN, IPSec NAT Traversal, Redundant VPN Gateway, Route-based VPN
- Secure SD-WAN
- Auto-provision VPN

SECURITY SERVICES

- Deep Packet Inspection services: Gateway Anti-Virus, Anti-Spyware, Intrusion Prevention, DPI SSL
- Content Filtering Service (CFS): HTTP URL, HTTPS IP, keyword and content scanning, Comprehensive filtering based on file types such as ActiveX, Java, Cookies for privacy, allow/forbid lists
- Supports Comprehensive Anti-Spam Service, Application Visualization, Application Control, Capture Advanced Threat Protection

NETWORKING

- IP address assignment: Static (DHCP, PPPoE, L2TP and PPTP client), Internal DHCP server, DHCP relay
- NAT modes: 1:1, 1:many, many:1, many:many, flexible NAT (overlapping IPs), PAT, transparent mode
- Routing protocols: BGP4, OSPF, RIPv1/v2, static routes, policy-based routing
- QoS: Bandwidth priority, max bandwidth, guaranteed bandwidth, DSCP marking, 802.1e (WMM)
- Authentication: LDAP (multiple domains), XAUTH/RADIUS, TACACS+, SSO, Radius accounting NTLM, internal user database, 2FA, Terminal Services, Citrix, Common Access Card (CAC)
- Local user database of 1000
- VoIP: Full H323-v1-5, SIP
- Standards: TCP/IP, UDP, ICMP, HTTP, HTTPS, IPSec, ISAKMP/IKE, SNMP, DHCP, PPPoE, L2TP, PPTP, RADIUS, IEEE 802.3
- Certifications: FIPS 140-2 (with Suite B), UC APL, IPv6 (Phase 2), ICSA Network Firewall, ICSA Anti-virus, Common Criteria NDPP (Firewall and IPS)
- Supports Common Access Card (CAC)
- Supports High availability: Active/Passive with stateful synchronization
- VLAN trunking
- Jumbo frames
- Port Security
- Bandwidth management
- Interfaces: 24x 1GE, 6x 10GE SFP+

OTHERS

- Cloud-based analytics
- Application/bandwidth/threat usage
- Logging
- Web GUI
- Equipped with power supply
- Shall come with the 1G SFP and 10G SFP+ LC MM Transceivers, 1G SFP RJ45 Transceivers
- 5yr subscription licenses

The three (3) Internet Service Providers (ISP) shall be connected to the Firewall. This firewall shall have failover and load sharing capabilities for the three (3) ISPs. In cases wherein one or two ISPs fail, the other ISP takes over. The firewall shall also be capable of distributing the traffic amongst the available ISPs. The END-USER shall subscribe to these the (3) ISPs.

The above solution may also be possible through a multi-WAN router. The VENDOR has to provide multi-ISP solution for the approval of the END-USER and EPC.

The awarded supplier shall ensure the necessary quantity and appropriate transceivers based on the final LAN System design and quantity of switches together with the services. This shall be determined after the design has been firmed up and before the implementation.

CORE LAYER

The new LAN System shall come with a Core Switch to connect all the edge or access switches and firewall. This will be the gateway for all L3 VLANs.

The Core Switch shall have the following specifications as minimum:

- Rackmount
- ASIC architecture
- Support a stackable L3 switch
- System Switching capacity of 880Gbps
- System Throughput capacity of minimum 650Mpps
- Average Latency @ 1Gbps of 1.99µs; @ 10Gbps of 1.49µs
- Stacking bandwidth of 200Gbps
- Number of SVI of 1,024
- IPv4 Host Table (ARP) of 49,152
- IPv6 Host Table (ND) of 49,152
- IPv4 Unicast Routes of 61,000
- IPv6 Unicast Routes of 61,000
- IPv4 Multicast Routes of 8,192
- IPv6 Multicast Routes of 8,192
- MAC table capacity of 32,768
- IGMP Groups 8,192
- MLD Groups 8,192
- VRF of 256
- Jumbo frames
- Packet storm protection
- Support VRRP
- Uni-directional link detection
- LACP
- Ethernet Ring Protection Switching (ERPS)
- Traffic prioritization
- QoS
- NTP
- Services: Bi-directional Forwarding Detection (BFD), UDP, OSPF, ARP, DHCP, DNS, mDNS, GRE
- Routing: BGP, BGP4, ECMP, MP-BGP, RIPv2, OSPF, Static IP route, Policy-based route,
- With network analytics engine
- Centralized configuration
- Interfaces: 24x 1G/10G SFP+ ports; 4x 1G/10G/25G SFP ports
- Equipped with 2x field replaceable fans
- Equipped with hot-swappable power supply
- Shall come with the 1G SFP and 10G SFP+ LC MM Transceivers, 1G SFP RJ45 Transceivers
- 5yr subscription licenses

The awarded supplier shall ensure the necessary quantity and appropriate transceivers based on the final LAN System design and quantity of switches together with the services. This shall be determined after the design has been firmed up and before the implementation.

SERVER SWITCH

The Server Switch shall connect all the Telecom Systems' servers or central equipment over 1GE uplinks. This server switch shall connect to the Core Switch over 10GE SFP uplink over a fiber optic patch cord.

The Server Switch shall have the following as minimum requirements:

- Rackmount
- ASIC architecture
- Support stackable switch
- Switching capacity of 128Gbps
- Throughput capacity of minimum 95Mpps
- Average Latency @ 1Gbps of 2.28µs; @ 10Gbps of 1.46µs
- Number of SVI of 128
- IPv4 Host Table (ARP) of 8,192
- IPv6 Host Table (ND) of 8,192
- IPv4 Unicast Routes of 2,048
- IPv6 Unicast Routes of 1,024
- MAC table capacity of 16,000
- IGMP Groups 1,024
- MLD Groups 1,024
- NTP
- L2 Switching: VLAN, Jumbo packet, RPVST+, MVRP, VXLAN encapsulation, BPDU, Port mirroring, STP, RSTP, MSTP, IGMP
- L3 Services: OSPF, ARP, DNS, Route maps, DHCP
- L3 Routing: RIPv2, OSPF, Static IP route, mDNS Gateway, ECMP
- With network analytics engine
- Centralized configuration
- Interfaces: 24x 1GE Base-T; 4x 1G/10G SFP ports
- Equipped with power supply
- Shall come with the 1G SFP and 10G SFP+ LC MM Transceivers, 1G SFP RJ45 Transceivers
- 5yr subscription licenses

The awarded supplier shall ensure the necessary quantity and appropriate transceivers based on the final LAN System design and quantity of switches together with the services as per approved design and prior to implementation.

POE ACCESS SWITCH

PoE Access Switches shall be required to provide the network connectivity of the endpoints and to provide these devices with power over the standard iEEE 802.3af and 802.3at. IP devices such as IP Phones, CCTV Cameras, CATV decoders, NTP clocks, Wireless Access Points, FIDS Android box, Call Stations and other Telecom Systems' devices that require PoE power shall be connected to the PoE Access Switches onwards to their respective servers or central/main equipment.

The PoE Access Switch shall have the following specifications as minimum:

- Rackmount
- ASIC architecture
- Switching capacity of 176Gbps
- Throughput capacity of minimum 98Mpps
- Average Latency @ 1Gbps of 1.9µs; @ 10Gbps of 1.8µs
- Number of SVI of 16
- IPv4 Host Table (ARP) of 1,024
- IPv6 Host Table (ND) of 512
- IPv4 Unicast Routes of 512

- IPv6 Unicast Routes of 512
- MAC table capacity of 8,192
- IGMP Groups 512
- MLD Groups 512
- NTP
- L2 Switching: VLAN, Jumbo packet, RPVST+, MVRP, BPDU, Port mirroring, STP, RSTP, MSTP, IGMP
- L3 Services: ARP, DNS
- L3 Routing: Static IP route
- Centralized configuration
- Interfaces: 48x 1GE Base-T Class 4 PoE ports; 4x 1G/10G SFP ports
- Up to 370W of Class 4 PoE power
- Equipped with power supply
- Shall come with the 1G SFP and 10G SFP+ LC MM Transceivers, 1G SFP RJ45 Transceivers
- 5yr subscription licenses

The awarded supplier shall ensure the necessary quantity and appropriate transceivers based on the final LAN System design and quantity of switches together with the services as per approved design and prior to implementation.

NON-POE ACCESS SWITCH

Access Switches shall be required to provide the network connectivity of the endpoints such as Door Access Controllers, and other Telecom Systems' devices that require network connectivity shall be connected to the non-PoE Access Switches. These access switches shall not supply power to these endpoints.

The non-PoE Access Switch shall have the following specifications as a minimum:

- Rackmount
- ASIC architecture
- Switching capacity of 176Gbps
- Throughput capacity of minimum 98Mpps
- Average Latency @ 1Gbps of 1.9µs; @ 10Gbps of 1.8µs
- Number of SVI of 16
- IPv4 Host Table (ARP) of 1,024
- IPv6 Host Table (ND) of 512
- IPv4 Unicast Routes of 512
- IPv6 Unicast Routes of 512
- MAC table capacity of 8,192
- IGMP Groups 512
- MLD Groups 512
- NTP
- L2 Switching: VLAN, Jumbo packet, RPVST+, MVRP, BPDU, Port mirroring, STP, RSTP, MSTP, IGMP
- L3 Services: ARP, DNS
- L3 Routing: Static IP route
- Centralized configuration
- Interfaces: 48x 1GE Base-T; 4x 1G/10G SFP ports
- Interfaces: 24x 1GE Base-T; 4x 1G/10G SFP ports (for the old PTB)
- Equipped with power supply
- Shall come with the 1G SFP and 10G SFP+ LC MM Transceivers, 1G SFP RJ45 Transceivers
- 5yr subscription licenses

The awarded supplier shall ensure the necessary quantity and appropriate transceivers based on the final LAN System design and quantity of switches together with the services as per approved design and prior to implementation.

LAN SYSTEM NETWORK MANAGEMENT SYSTEM AND WORKSTATION

The LAN System shall be managed by an administration workstation or Network Management System (NMS) and shall be responsible for the configuration, monitoring, diagnostics and troubleshooting of the LAN system.

The NMS shall be a cloud-based networking tool that shall provide a unified management of the wired and wireless networks and devices. The WiFi System shall be of the same manufacturer with the LAN System to facilitate a seamless integration between both systems.

The NMS shall be powered by the AI technology to provide insights for faster deployments, monitoring, network optimization and troubleshooting. It shall have a dashboard providing quick insights and analytics of the network and client health, application visibility, where the IT personnel may analyze and improve the wired and wireless networks. Troubleshooting shall include live events, packet capture, logs, etc.

This NMS shall employ AI-powered optimization for the WiFi network by delivering SLA-grade QoS, improving wireless capacity and coverages, optimize client connectivity and enable seamless handoffs. It shall have AI and machine learning capabilities to analyze RF data to derive configuration changes for the access points.

The NMS shall have setup wizards, templates, step-by-step workflows, flexible configurations, upgrades and zero touch provisioning. It shall also provide the necessary reports and upgrades needed by the switches and access points.

The NMS shall provide security features such as (but not limited to), Role-based policies, Cloud authentication and policy, Secure wireless segmentation, Intrusion detection, Web content filtering, Integrated policy enforcement firewall, etc.

The NMS shall also come with the necessary foundation and subscription licenses for all switches and access points.

The minimum required specifications of the LAN NMS shall be:

- Workstation shall be of a reputable manufacturer
- Minimum Intel Core i7 processor
- Minimum 16GB RAM
- Minimum 1TB HDD
- Minimum 200GB SSD
- Minimum 1GB video/graphic card
- Minimum 24” LED monitor, full HD
- HDMI and VGA ports
- At least 4 USB ports
- Keyboard, mouse and speakers
- Latest operating system software with license
- 5yr subscription licenses

Note that the specifications mentioned above are minimum requirements whereby the awarded supplier shall configure the workstation with higher specifications as deemed necessary by the NMS. This is due to the intensive graphic displays of the NMS features.

LINK BUDGET CALCULATION REPORT

The awarded supplier shall develop a Link Budget Calculation Report in order to determine the maximum signal loss on the fiber optic cable (FOC) that will be incurred in this LAN System. The report shall help determine whether to improve the links, connectors, splices, or minimize them, as the case may be.

The FOC shall be under the Structured Cabling System to provide the necessary link between the old and the new PTB. The old PTB existing systems such as FIDS and the Automatic Voice Messaging System are required to be interfaced to the new Telecom Systems.

VLAN AND IP ADDRESS LIST

The awarded supplier shall develop a VLAN scheme for the LAN-dependent Telecoms Systems in the new PTB. These services shall be segmented into Virtual LANs based on its specific service and traffic.

Aside from the number of Telecom Systems involved in this PROJECT, the VENDOR shall allot spare VLANs to accommodate future expansion.

The IP address blocks to be used shall be advised by the END-USER IT Department once the LAN System design has been firmed up and before its implementation. The VENDOR shall prepare an IP Address List Report detailing all the IP addresses, VLANs, Users, Services, switch connections, etc.

INTERFACING AND INTEGRATION

The LAN System shall have features and functions built into it to integrate and interface with the subsequent systems.

The awarded supplier shall install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

MASTER CLOCK SYSTEM

The LAN System shall be interfaced with the Network Time Protocol (NTP) Server for its time synchronization over ethernet. The NTP shall be under the scope of the Master Clock System.

STRUCTURED CABLING SYSTEM

The LAN System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure for the various endpoints to connect to the LAN System. The SCS shall use CAT6 UTP cables for this purpose with Information Outlets (IO).

EXISTING FIDS AND AUTOMATIC VOICE MESSAGING SYSTEM

A 24-Port non-PoE Access Switch shall be deployed at the old PTB to connect to the existing systems – Flight Information Display System (FIDS) and the Automatic Voice Messaging System (AVMS). These existing systems are required to be interfaced to the new systems at the new PTB in order for the latter to get the information needed by the FIDS – to display the real-time flight information; PA System – to automatically announce in real-time the flight information messages to its loudspeakers.This 24-port access switch shall be connected to the new Core Switch via a 24 fiber optic cable provided under the SCS.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-07 – MASTER CLOCK SYSTEM (MCS)

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ABBREVIATION

µs	micro seconds
ACS	Access Control System
BoM	Bill of Materials
DHCP	Dynamic Host Configuration Protocol
EN	European Norm or Standard
FDAS	Fire Detection And Alarm System
GPS	Global Positioning System
Hz	Hertz
I/O	Input / Output
IP	Internet Protocol or Ingress Protection
LAN	Local Area Network
LD	Layout Diagram
LED	Light Emitting Diode
MCS	Master Clock System
NTP	Network Time Protocol
PoE	Power over Ethernet
PTB	Passenger Terminal Building
RAIM	Receiver Autonomous Integrity Monitoring
SCS	Structured Cabling System
SD	Schematic Diagram or Secured Digital
SMD	Surface Mounted Diode
TCP/IP	Transmission Control Protocol / Internet Protocol
TDS	Technical Design Specifications
UL	Underwriters Laboratories
UTC	Coordinated Universal Time
UTP	Unshielded Twisted Pair

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the Master Clock System and its components, peripherals, accessories, ancillaries, field devices and associated items for the Master Clock System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. Master Clock System – Bill of Materials

c. Master Clock System – Schematic Diagram

d. Master Clock System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- Time Server
- Multi-time zone Digital Time Display
- 10cm 6-Digit Display NTP PoE Digital Clock
- 7cm 6-Digit Display NTP PoE Digital Clock
- 5cm 6-Digit Display NTP PoE Digital Clock
- GPS Antenna
- Surge Protector
- System administration with the latest software and firmware
- Peripherals, accessories, cables, ancillaries, and other related works and supplies necessary to complete the installation of the Master Clock System.

The main Master Clock System and its associated peripherals shall be installed in the G/F Telecom Room of the new Passenger Terminal Building (PTB).

The digital clocks shall be distributed at the following areas:

- Arrival Immigration area
- Baggage carousel/ Re-claiming area
- Baggage breakdown area
- Arrival hall area
- Check-in counter area
- Pre-Departure lounge
- Departure Immigration area
- VIP lounge
- Command & Control room
- Passenger lounge area

GENERAL DESIGN REQUIREMENT

The Master Clock System shall be designed based on the minimum requirements and specifications of the PROJECT.

The new Master Clock System shall provide the new PTB with an IP based clock system and digital display in the desinated areas and provide the network time using NTP protocol connection via the LAN network. Thus, it shall provide an accurate, synchronize and identical time on a set of equipment connected to an IT network which limit the risk of record manipulation, timestamp each event, logs and many more. In the transport sector, punctuality is key to customer satisfaction. This need for punctuality starts with a reliable time synchronisation system.

The Time Server is the main equipment located in the Telecom Room. Time server shall use the NTP protocol to distribute exact and accurate time information to all the digital clocks. It also provides ultra-secure synchronisation of all devices on the IT network: computers, video surveillance system, access control, automatic ticket machines, etc. All coordinated by a timestamp function that enables accurate traceability of all events. The time server allows to keep a chronological event log with an accuracy greater than one microsecond. This optimises the timestamping and sequencing of activities on the IT network.

The Time Server reads the actual time from a reference clock using the GPS and internal oscillator when GPS is not available. GPS is a worldwide system that employs 24 orbiting satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time. The internal oscillator can have a holdover accuracy of 0.00548 sec per year with a precision of $1x10^{-11}$. The GPS antenna shall be located at the roof deck of the new PTB and shall have a surge protection to prevent damage of the time server when lightning occurs.

Network Time Protocol (NTP) is the internet protocol used to synchronize with computer clock and devices time sources in a network. NTP uses Coordinated Universal Time (UTC) to synchronize computer clock times with extreme precision.

Digital clocks provide the passengers in keeping track of the time and be certain not to miss their departure. Digital clocks come in different sizes to suit the visibility in a specific area. A 10cm, 7cm and 5cm digit height display allow optimal viewing distances of 40m, 30m and 20m respectively. All the digital clocks shall be connected via PoE switch under the LAN system and shall use the UTP cable from the structured cabling system.

The Master Clock System shall interface directly with other systems, LAN, SCS, Telephone, ACS, PA, CATV, CCTV, WiFi, FDAS and FIDS Systems, as described herein.

TECHNICAL DESIGN CRITERIA

A new Master Clock System shall consist of the Time server, GPS antenna, surge protector, digital clocks, LAN switches and backbone network (under the LAN System), system administration, software and interfaces.

The Master Clock System shall include all other necessary components and peripherals to complete a functional Master Clock System.

SYSTEM ARCHITECTURE

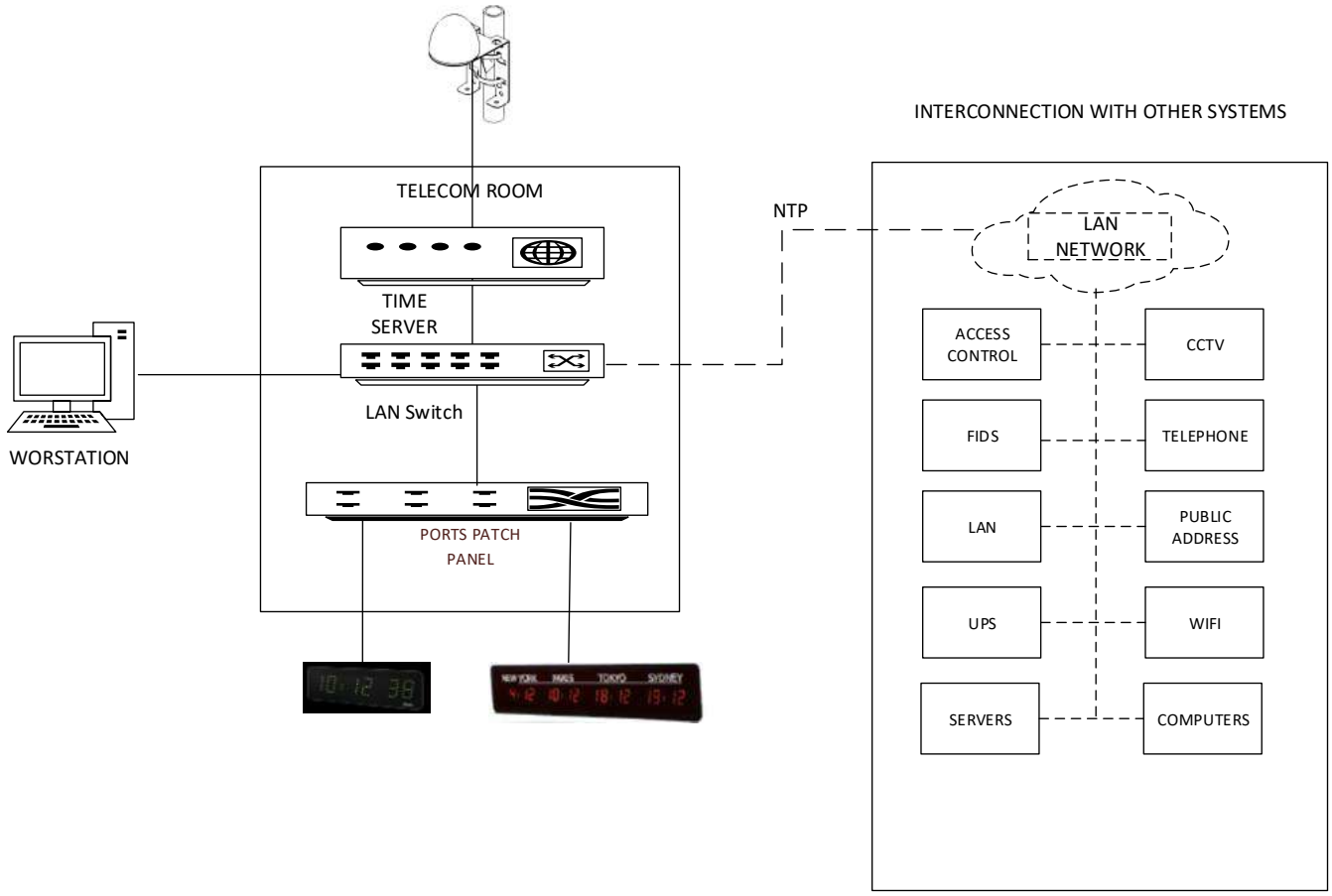

Figure 7: Master Clock System Architecture

TIME SERVER

NTP server shall be installed at new PTB, Telecom room and shall receive the time signals from the GPS antenna. Network Time Protocol (NTP), an Internet standard protocol (built on top of TCP/IP) that assures accurate synchronization to the millisecond of computer clock times in a network of computers. All airport IT systems that are connected to new PTB receives the time signal from NTP. All IT systems act as a NTP client to NTP server and the NTP clients sends periodic time requests to servers, obtaining server time stamps and using them to adjust its own clock.

- Signal time input through GPS or NTP
- 32,000, maximum number of NTP clients
- Internal oscillator using OCXO Quartz
    - Accuracy (average after 24h when GPS), $1x10^{-11}$
    - Medium Term Stability (without GPS after 2 weeks of GPS synchronisation, $1x10^{-9}$/day
    - Holdover after 24h (after 2 weeks of GPS synchronisation at constant temperature), ±15 µs
- Accuracy to UTC (1 sigma locked to GPS), ±50 ns

- Digital clocks synchronization by NTP multicast or unicast
- IP configuration DHCP, static IPv4 & IPv6
- System accessibility shall be Telnet, SSH & SNMP
- Network interface shall be RJ45, 10/100/1000 BASE-T
- Time signal outputs NTP Multicast or unicast
- Server indication status on Power supply, synchronization, LAN status & alarm via LED or Display
- Network security management: Enable/disable encryption, authentication, and access protocols.
- The server shall be rack Mountable
- Applicable standards:
    - RoHSv6
    - EN 61000-6-4 : 2007 / A1 : 2011
    - EN 50121-4 : 2016 / A1 2019
    - EN 55032 : 2015
    - EN 62368-1 : 2020
    - EN 61000-3-2 : 2014
    - EN 61000-3-3 : 2013
    - EN 55024 : 2010
    - EN 55035 : 2017
    - EN 61000-6-2 : 2005

GPS ANTENNA

The GPS antenna shall receive the signals from the GPS satellites onwards to the NTP server.

The GPS antenna shall have the following specifications.

- Receiver: 72 channels (GPS L1C/A, GLONASS L1OF, BeiDou B1, Galileo E1B/C). Double frequency.
- Supports RAIM (Receiver Autonomous Integrity Monitoring).
- Standard Ethernet cable connection to time server.
- Status LED indicator visible on the side of the antenna and from below.
- The GPS antenna is immune to the GPS rollover phenomenon.
- Coldstart: Maximum 12.5 minutes for synchronisation.
- Hotstart: 1 second
- Constellations selection: Parameter setting from the time server
- Power supply and data: Through an Ethernet cable connected to the time server
- Maximum cable length: 1200 m
- Operating temperature range: -30°C to +70°C.
- Humidity: 0 to 95%, non condensating
- Connections: 1x RJ45, waterproof connector
- Applicable Standards: Directive EMC 2017/30/EU : EN55032 (2015), EN55024 (2010)
- The GPS antenna shall be installed on the Roof Deck. Vendor shall install this in a 2-inch galvanized steel pipe with a base plate. All accessories, junction box, bolts and ancilliaries shall be provided. Vendor shall ensure that the installation shall be sturdy to withstand strong winds, rain and solar radiation.

SURGE PROTECTOR

The surge protector protects the time server from any ingress of unwanted voltage such as lightning from the GPS antenna.

The Surge Protector shall have the following specifications.

- Device designed to protect the time servers connected to GPS antenna.
- Maximum line voltage: 28V DC
- Nominal discharge current: 5 kA
- Maximum discharge current: 20 kA
- Shock current: 2,5 kA
- Protection mode(s): Common mode/Differential
- Operating temperatures: -40°C to +85°C
- Applicable Standards: EN 61643-31, UL497A et B
- Shall be installed inside the telecom cabinet

IP BASED DIGITAL CLOCKS

The IP based digital clocks shall be synchronized using the NTP server and shall be distributed accordingly within the new PTB.

MULTI-TIME ZONE DIGITAL CLOCK

The multi-zone digital clock shall have the following specifications.

- SMD (Surface Mounted Diode) LED technology for indoor installation
- Connects to time server via NTP
- Synchronisation unicast, multicast and by DHCP
- Network interface shall be RJ45, 10/100/1000 BASE-T
- Hours and minutes display (4 cities horizontally).
- Height of digits 5 cm, optimal viewing distance: 20 metres
- Display of cities: height of stickers 3 cm, optimal viewing: 12 meters. A maximum of 12 characters per city (cities' names).
- Angle of vision 120°
- Adjustable brightness
- 12- or 24-hour display mode
- Time base backup in case of power failure
- Power supply: 100-240VAC 50/60Hz
- Comes with mounting bracket and accessories

DIGITAL CLOCKS

The multi-zone digital clock shall have the following specifications.

- Selection of various digit display in 10cm, 7cm and 5cm digit heights for varying viewing distances.
    - 10 cm = 40 meters viewing distance
    - 7 cm = 30 meters viewing distance
    - 5 cm = 20 meters viewing distance
- SMD LED technology for indoor installation
- Connects to time server via NTP
- Synchronisation unicast, multicast and by DHCP
- Network interface shall be RJ45, 10/100/1000 BASE-T
- SMD LED technology for indoor installation
- Connects to time server via NTP

- Synchronisation unicast, multicast and by DHCP
- Angle of vision 120°
- Adjustable brightness
- 12- or 24-hour display mode
- Digit: 7 segments with 5 LEDs each
- Time base backup in case of power failure
- Power: PoE (Power over Ethernet) – class 0
- Applicable Standards: EMC: EN55032, EN55024, LVD: EN62368-1, EEE 802.11 b/g

SYSTEM ADMINISTRATION

The Master Clock System (MCS) shall be managed by an administration workstation and shall be responsible for the configuration, monitoring, diagnostics and troubleshooting the Master Clock system.

The time server shall come with a telnet interface to workstation using the serial interface (RS-232, DB9 connector) and ethernet port for a web based server access. The front panel shall also be capable of programming the time server as well on the initial start-up of the time server.

The time server workstation shall present the logs, events and faults in the system in real-time. System administration shall share with other workstations of the Telecom Systems.

INTERFACING AND INTEGRATION

The IP based Master Clock System shall interface with the subsequent systems through NTP protocol and LAN system to derive its timing requirements. An IP address shall be assigned by End-user for the NTP server access.

1. Access Control System (ACS)
2. Cable TV System (CATV)
3. Closed Circuit Television System (CCTV)
4. Flight Information Display System (FIDS)
5. Local Area Network System (LAN)
6. Public Address System (PA)
7. Telephony System (PABX)
8. Wireless Fidelity System (WiFi)

STRUCTURED CABLING SYSTEM

The Master Clock System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure for the various endpoints to connect to the LAN System. The SCS shall use CAT6 UTP cables for this purpose with Information Outlets (IO). The awarded supplier shall install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-08 – PUBLIC ADDRESS SYSTEM (PA)

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ABBREVIATION

ACS	Access Control System
AES	Audio Engineering Society
ANS	Ambient Noise Sensor
AVMS	Automatic Voice Messaging System
BGM	Background Music
BoM	Bill of Materials
dB	decibel
DC	Direct Current
DSP	Digital Signal Process
EOL	End Of Line
FACP	Fire Alarm Control Panel
FDAS	Fire Detection And Alarm System
FM	Frequency Modulation
GPIO	General Purpose Input Output
HDD	Hard Disk Drive
Hz	Hertz
I/O	Input / Output
IP	Internet Protocol or Ingress Protection
LAN	Local Area Network
LCD	Liquid Crystal Display
LD	Layout Diagram
LED	Light Emitting Diode
Mbps	Mega bit per second
MCS	Master Clock System
Mic	Microphone
NTP	Network Time Protocol
PAS	Public Address System
PoE	Power over Ethernet
PTB	Passenger Terminal Building
PTT	Press To Talk
RMS	Root Mean Square
SCS	Structured Cabling System
SD	Schematic Diagram or Secured Digital
SNR	Signal to Noise Ratio
SPL	Sound Pressure Level
STIPA	Speech Transmission Index for Public Address system
TCP/IP	Transmission Control Protocol / Internet Protocol
TDS	Technical Design Specifications
TLS	Transport Layer Security
USB	Universal Serial Bus

UTP	Unshielded Twisted Pair
VGA	Video Graphics Array
W	Watt

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the Public Address System and its components, peripherals, accessories, ancillaries, field devices and associated items for the Public Address System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. Public Address System – Bill of Quantities

c. Public Address System – Schematic Diagram

d. Public Address System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- Controller
- Amplifiers
- Audio Mixer
- Power Supply
- Battery
- Remote Call Stations
- Extension keys
- Fireman's Microphone
- Loudspeakers – ceiling, column, cabinet/wallmount and horn
- Ambient Noise Sensor
- End Of Line
- Storage cards
- System administration and workstation for management and maintenance (workstation may be shared with other Telecom Systems)
- Latest software and firmware
- Interfacing with the existing FIDS and Automatic Voice Messaging System at the old PTB
- Telecom cabinet and wiring (may be shared with other Telecom Systems)
- Loudspeaker cables, roughing-ins and connectors
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the Public Address System.

The main Public Address System and its associated peripherals shall be installed in the G/F Telecom Room of the new Passenger Terminal Building (PTB).

The loudspeakers shall be distributed at the following areas:

- Lobbies
- Check-in lobby/counters
- Public spaces
- Arrival areas
- Departure areas
- Immigration areas
- Offices
- Rooms
- Toilets
- Corridors
- Baggage claim/handling areas
- Gate lounges
- Passenger lounges
- Hallways or corridors
- New PTB entrance and sides
- Airside corridor

GENERAL DESIGN REQUIREMENT

The Public Address System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new Public Address System shall be provided in all areas under the scope described herein, for the purposes of public announcements, background music and most importantly – alert messages and emergency announcements or voice alarms for the evacuation and safety of people within the new Passenger Terminal Building (PTB).

The Public Address System shall provide the daily announcements, pre-recorded information and background music to the public, offices and other areas of the new PTB.

The Public Address System shall provide the emergency live and pre-recorded announcements to assist passengers and airport personnel during emergency situations that require either alert, partial or full evacuation of the new PTB. This emergency announcements are generally triggered automatically by the Fire Detection and Alarm System (FDAS). Moreover, it shall still be possible to initiate emergency alarms with pre-recorded messages or make live emergency announcements. The emergency announcements shall be of a higher sound pressure level than the rest of the messages or music. Under this circumstances, the ambient noise sensors shall be bypassed.

Several loudspeaker types – ceiling, cabinet, column and horn loudspeakers, shall be distributed at areas mentioned herein. The amplifiers shall drive these multiple loudspeakers and shall be sized up correctly with significant spare capacity. The loudspeakers and its associated peripherals shall be located in a manner that facilitates easy access for routine operation and maintenance.

End Of Line modules shall be required to monitor the loudspeaker line loop for any abnormalities such as line cut, grounded, etc. The Public Address System shall still be able to broadcast to all loudspeakers in that loudspeaker line loop even if its loudspeaker line is cut.

Where areas that have varied noise levels, ambient noise sensors shall be installed to automatically adjust the sound pressure level or volume of that particular area.

The Call Stations shall have buttons assigned for zones and shall be configurable to page a zone, group of zones or all zones.

Priorities shall be set over the available inputs whether it be call station, fireman's microphone, audio input, etc. Emergency messages shall override other messages or announcements.

The Public Address System shall be software controlled, easily configured and allow for future expansion. It shall be scalable in order to accommodate the existing quantity of loudspeakers at the existing Passenger Terminal Building (PTB). In the event that the existing PTB's Public Address System be included or added into the new Public Address System (in the future), then this shall only entail additional modules or amplifiers without any replacements of any major component.

The Public Address System shall be divided into zones to properly manage the announcements. This shall also conform to the cause-and-effect configuration to be developed by the Fire Safety Team of the new PTB.

The Public Address System shall be capable of routing audio inputs to specified locations or zones.

The Public Address System shall interface directly with other systems, such as the existing Emergency Voice Messaging System (at the old PTB), LAN, SCS, FDAS and Master Clock Systems, as described herein.

TECHNICAL DESIGN CRITERIA

A new Public Address System shall consist of the Controller, Amplifiers, Audio Matrix, Power supply with battery, Call stations, Fireman's mic, Loudspeakers, End of Line device, Ambient noise sensor, LAN switches and backbone network (under the LAN System), management workstation, software, interfaces and telecom cabinet. The PA System shall be EN 54-16 compliant on all major components.

The Public Address System shall include all other necessary components and peripherals to complete a functional Public Address System.

SYSTEM ARCHITECTURE

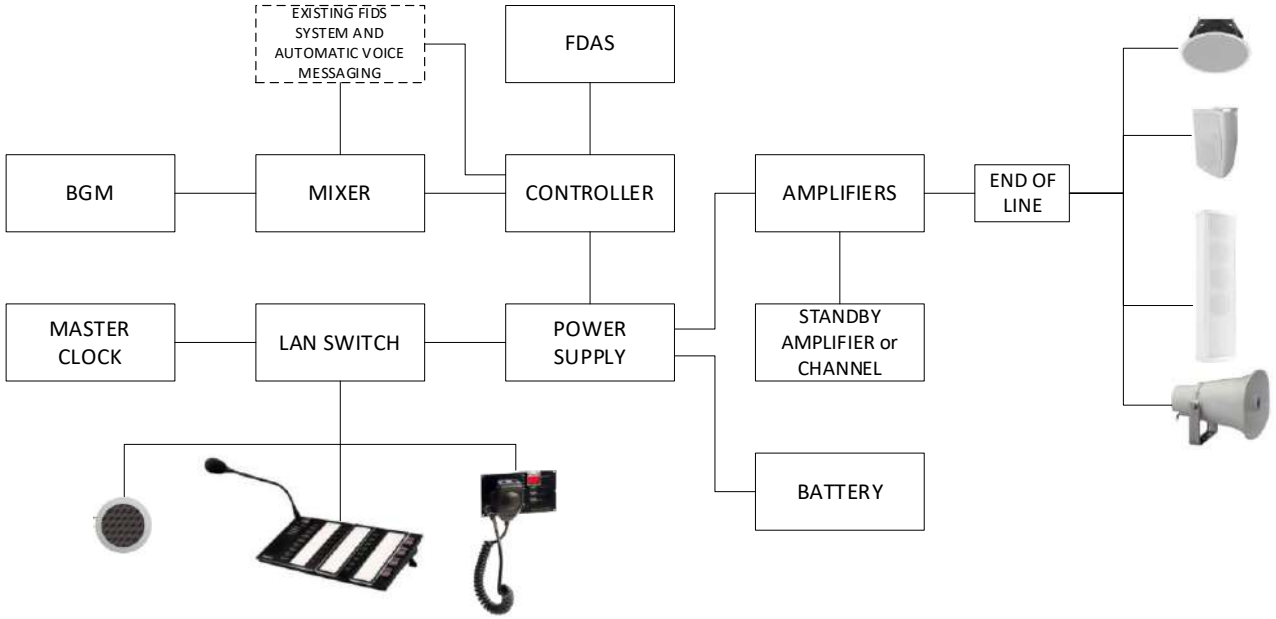

Figure 8: Public Address System Architecture

The new Public Address System shall be IP-based and shall use the 100V line.

ACOUSTIC REQUIREMENTS

The Public Address System shall perform with a Speech Transmission Index for PA System (STIPA) of ≥0.6 at 90% of the areas within the new PTB. The messages must be intelligible and understood by the listener.

For emergency broadcasts, a Sound Pressure Level (SPL) shall be set at 70dBA or about 10dB above the ambient SPL, whichever is higher.

PAGING ZONE REQUIREMENTS

The new Passenger Terminal Building (PTB) shall be divided into zones to accommodate the live and emergency broadcasts of the new PTB. The current defined number of zones is seven (7) plus one (1) for all zones.

The number and placement of zones shall be subject to review with possible changes depending on the final design to be developed by the awarded supplier. This shall be properly coordinated with the END-USER and other disciplines like the Fire Detection and Alarm System, Access Control System, Fire Safety Team of DIAA and the Fire Safety Plan to be implemented. Phased evacuation shall also be considered in the review, where physically adjacent zones receive the same messages simultaneously.

EMERGENCY MESSAGES

The Public Address System (PAS) shall have pre-recorded emergency messages for the following:

- Evacuation message
- Alert message
- Warning message
- All clear message
- Test message

The above messages shall have the following requirements as a minimum:

- Stored in the PAS
- Pre-announcement alarm tone/chime
- Each message to last not more than 60 seconds.

The pre-recorded messages shall be recorded professionally, must be clear and audible whereby scripts shall be decided and approved by all concerned parties.

NON-EMERGENCY MESSAGES

The call stations shall be configured to push non-emergency pre-recorded messages to the destination or zone through its configured buttons. Daily announcements shall be made from the call stations.

The pre-recorded messages shall be recorded professionally, must be clear and audible whereby scripts shall be decided and approved by all concerned parties.

CONTROLLER

The Controller of the Public Address System (PAS) shall manage the functions of the PA System. It handles the routing of all audio inputs and outputs, including live, pre-recorded messages, emergency broadcasts and background music.

The Public Address System's Controller shall have the minimum requirements:

- Rackmount
- IP based
- Capable of accepting Dante and AES67 audio streams
- Capable of redundant configuration
- Supervise the storage of memory and tone files
- Capable of playing multiple messages simultaneously, schedule announcements
- Adopts AES128 for audio data
- Adopts TLS for control data
- Status and fault indicators
- Comes with 32GB SD Card
- Logs all call and fault events
- Network audio latency maximum of 10ms
- Ethernet 100/1000Mbps
- Protocols: OMNEO, Dante, AES70, AES67
- Message storage minimum of 90mins

AMPLIFIER

The Amplifiers of the Public Address System shall be IP-based with a Class D amplifier using the 100v line.

The amplifier shall have the following minimum requirements:

- Rackmount
- Output power of the channels shall be adaptable to the connected loudspeaker load allowing flexibility of channel power partitioning
- DSP with equalization per channel
- Built-in independent standby spare amplifier channel for automatic failover
- Independent A/B zone outputs for all channels
- Supervision of connected loudspeaker lines
- Shall be installed with End Of Line to supervise the loudspeaker loop
- Frequency response from 20Hz to 20kHz
- Minimum SNR ≥110dBA @100V line
- With pilot tone
- Protection levels/supervision:
    - Temperature supervision for overheat
    - Overload
    - RMS output power limiter
    - Ground fault of <50kΩ
    - Short circuit
    - Watchdog for controller continuity
    - DC output
    - Network interface and RSTP (for dual ethernet connections)
    - Fan rotation speed
- LED status indicators

Amplifier sizing shall have a 20% spare capacity per channel.

POWER SUPPLY AND BATTERY

A power supply unit shall be required to provide the DC power needed by the Public Address System components. This shall come with a backup 12V Valve Regulated Lead Acid (VRLA) battery.

The power supply and battery shall have the following as a minimum:

- Shall have independent 48VDC power supplies
- Supervised DC power supply
- With GPIO
- Control inputs and outputs are software configurable
- With power factor correction
- Integrated battery charger for a single 12V VRLA battery
- Automatic failover to battery during commercial power failure without any interruption

The awarded supplier shall calculate the battery capacity to ensure that the PAS shall continue operating during power outages for a minimum of 10mins, in time for the emergency generator to provide power to the new PTB and shall also consider the required battery autonomy during emergencies like fire as required by Public Address System standards, where the PAS shall continue operating specially during emergencies for the safety of the people inside the new PTB. The minimum 10mins autonomy may change depending on the standard set forth by Public Address Ssytems.

BACKGROUND MUSIC SOURCE

A Background Music Source (BGM) shall be required to provide the music to be broadcasted across the new PTB over the PA loudspeakers. The BGM shall be operated as necessary and according to the needs of the DIAA.

The BGM source shall have the following minimum requirements:

- Rackmount
- FM tuner with frequency synthesizer and presets
- FM range: 87.5 to 108MHz
- FM tuner SNR minimum of 50dB
- Comes with a 32GB SD card
- Comes with a USB memory stick
- SD/USB SNR minimum of 70dB
- Repeat and random play modes
- Play MP3
- Player and tuner may operate simultaneously on different outputs
- Comes with remote control

AUDIO MIXER / MATRIX

An Audio Mixer or Audio Matrix is required to accept the inputs from the existing Automatic Voice Messaging System of the old PTB and the BGM source. This shall combine, process and monitor the audio of the inputs.

The audio matrix shall have the following minimum requirements:

- Rackmount
- Matrix control with mixing functionality, signal processing, network routing and supervision

- 24x24 matrix with DANTE/OCA
- Minimum of 12x mic/line analog inputs and 8x analog line outputs
- Phantom power
- Frequency response of 20Hz to 20kHz
- SNR ≥118dB
- Signal latency of <0.45ms @ 48kHz
- Minimum of 60 DSP presets
- 100/1000 Mbps ethernet
- Network audio inputs and outputs: 24 channels each OMNEO/Dante format
- Minimum of 8x GPIO (switchable analog/digital)
- Status and fault indicators

LOUDSPEAKERS

The Public Address loudspeakers shall be carefully selected to meet the specifications in this PROJECT including its conformance to the new PTB's architectural design, aesthetics and finish. These loudspeakers must be approved first by the END-USER and EPC before any delivery or installation. Special attention must be considered on the sound level and intelligibility. Location of the loudspeakers must also conform to the aesthetics of the new PTB.

All supplied Public Address loudspeakers for this PROJECT shall have the following as minimum requirements:

- Loudspeakers must be designed for voice alarm, live speech, pre-recorded messages and music
- Built-in protection where fire does not cause any failure of the connected circuit
- Minimum of 3 power taps
- Minimum Sound Pressure Level (SPL) at 1W, 1m shall not be less than 88dB
- Effective frequency range @ -10dB shall be between minimum of 240Hz and 16hKz (indoor) and 240Hz and 5kHz (outdoor)
- Minimum IP32 for indoor, IP65 for outdoor
- Monitoring frequency shall be inaudible
- Generally, loudspeakers shall come in white color. However, the loudspeaker color shall be decided on some areas during implementation as it may affect the architectural finish.
- Loudspeaker mountings
- Loudspeaker cables shall be terminated directly to the loudspeaker cable tails with appropriate connectors
- IP66 Junction box for outdoor installation to secure the loudspeaker cable termination

The loudspeaker shall either be mounted on the ceiling, wall or pole depending on the location of the loudspeaker installation. The awarded supplier shall provide the necessary mountings for installations where special brackets, pendants or poles are required.

For outdoor installations, the loudspeakers' housing must be suitable for the environment. The housing must be capable of withstanding prolonged direct exposure to solar radiation, strong winds and rain.

The Public Address loudspeakers shall be:

1. Ceiling loudspeaker
2. Cabinet loudspeaker
3. Column loudspeaker
4. Horn loudspeaker

CEILING LOUDSPEAKER

The Ceiling loudspeakers shall have the following as minimum:

- SPL at 1W, 1m of 90dB
- Four (4) power taps of 0.75W to 6W
- Effective frequency range at -10dB of 90Hz to 20kHz
- Opening angle at 1Khz of 180º
- Opening angle at 4Khz of 50º
- Rated impedance at 100V from 1.6kΩ to 13kΩ
- Shall come with a metal fire dome and a safety wire or cord

The ceiling loudspeaker with fire dome shall be installed with a safety cord to support its weight against the ceiling. This safety cord shall be fixed on the fire dome and fastened on the concrete slab above it.

COLUMN LOUDSPEAKER

The Column loudspeakers shall be the slim type with good directivity.

The Column loudspeakers shall have the following as minimum:

- SPL at 1W, 1m of 92dB
- Four (4) power taps of 2W to 20W
- Effective frequency range at -10dB of 240Hz to 16kHz
- Horizontal opening angle at 1Khz of 210º
- Vertical opening angle at 1Khz of 80º
- Rated impedance at 100V from 500Ω to 4kΩ
- Minimum IP65
- Shall come with a swivel mounting bracket and cable gland

CABINET LOUDSPEAKER

The Cabinet loudspeaker shall be used where ceiling mount are impractical and not feasible due to the area's construction or the equipment installed within that designated area.

The Cabinet loudspeakers shall have the following as minimum:

- SPL at 1W, 1m of 88 to 94Db
- For indoor: Four (4) power taps of 0.75W to 6W
- For outdoor: Four (4) power taps of 2.5W to 20W
- Effective frequency range at -10dB of 90Hz to 20kHz
- Opening angle at 1Khz of 120º
- Opening angle at 4Khz of 55º
- Rated impedance at 100V from 500Ω to 13kΩ
- For indoor installation, minimum IP32
- For outdoor installation, minimum IP65
- Shall come with a mounting bracket and cable gland

HORN LOUDSPEAKER

The Horn loudspeakers shall be installed outdoors or under a canopy area where horn types are best suited for the locations. This shall be industrial grade where material housing can withstand prolonged exposure to heat, wind and rain.

The Horn loudspeakers shall have the following as minimum:

- SPL at 1W, 1m of 108dB
- Four (4) power taps of 1.5W to 15W
- Effective frequency range at -10dB of 300Hz to 9kHz
- Opening angle at 1Khz of 119º
- Opening angle at 4Khz of 38º
- Rated impedance at 100V from 600Ω to 5.3kΩ
- Minimum IP66
- Shall come with a mounting bracket

FIREMAN'S MICROPHONE

A fireman's microphone shall be installed in the new PTB and its designated location shall be determined during the implementation.

The fireman's microphone shall have the following minimum requirements:

- The call station shall come with a handheld omni-directional microphone with a PTT
- It shall have zone selection keys for all individual zones
- Functions shall be accessible for operators wearing gloves
- Provide control and routing of live announcements and stored messages
- Fitted with status and fault indicators

The fireman's microphone or call station shall come with a IP65 enclosure.

The Fireman's microphone shall use CAT6 STP cable with Information Outlet which shall be under the Structured Cabling System (SCS).

CALL STATIONS

The Call Stations shall be used for live announcements, enabling pre-recorded messages and music control. These shall have buttons assigned for zones and shall be configurable to page a zone, group of zones or all zones. Each call station shall be configurable according to its assigned priority within the PAS.

Call stations shall be distributed accordingly:

- Security Office
- Two (2) for the Boarding gates at the Pre-Departure Lounge
- Information center - Arrival Hall
- Information center – Entrance of the new PTB

The call stations shall have the following requirements as a minimum:

- IP-based and powered via PoE, 100/1000Mbps
- Desktop unit with a gooseneck cardioid unidirectional microphone
- Press-to-talk button

- Built-in loudspeaker with volume control
- Touch screen or keys
- Status and fault indicators
- Internal monitor speaker
- Extension keys to accommodate all zones (except for the Boarding gates) and shall be expandable
  - Keys shall be configurable for various functions
  - Each key shall have an associated LED status light indicator
  - Keys shall have minimum of 3 protection covers or caps to prevent unintentional activation of buttons
- Indication for successful broadcasts
- Pre and post announcement chime
- SNR ≥70dBA
- Frequency response of 100Hz to 14kHz

Call Stations installed at the boarding gates shall be allowed to call only its assigned zone (loudspeakers only on the Pre-Departure Lounge and VIP Room).

All the call stations shall use CAT6 STP cables with Information Outlets which shall be under the Structured Cabling System (SCS).

AMBIENT NOISE SENSOR

Ambient Noise Sensors (ANS) shall be installed to monitor the changes in ambient noise levels and shall automatically adjust the announcement or music level. This shall ensure that the audio level is above the ambient noise to ensure intelligibility of the broadcast.

A few have been considered in this system whereby the VENDOR shall determine the actual number of ANS required, depending on the area to be covered.

The Ambient Noise Sensor shall have the following as a minimum:

- IP-based and powered via PoE, 100/1000Mbps
- Omni-directional microphone
- With integrated DSP
- In an area with more than one (1) ANS, the information from the sensors shall be combined
- Ambient noise capture range: 50 to 100dB SPL
- Frequency range: 50Hz to 10kHz
- Sensitivity tolerance, pink noise at frequency range shall be <2dB
- Minimum IP54

The ANS shall adopt a fail-safe operation wherein a failure or the device or loss of communication, shall enable the amplifier channel to be set to its maximum.

The ANS shall use CAT6 STP cables with Information Outlets which shall be under the Structured Cabling System (SCS).

CONTROL I/O AND AUDIO I/O

The Control inputs and outputs of the Public Address System shall be configurable. These may be configured as dry-contacts or pull up/down capability to facilitate a range of functions required.

The Audio inputs and outputs shall be configurable as balanced and unbalanced, mic and line level with switchable phantom power. Audio inputs shall have controls for gain, treble and bass. Output levels shall have equalization controls and output level adjustments.

SYSTEM ADMINISTRATION

The Public Address System (PAS) shall be managed by an administration workstation and shall be responsible for the configuration, monitoring, diagnostics and troubleshooting the Public Address system.

The PA administration workstation shall come with its software or access to the PA System interface. It shall be capable of programming the audio routes, levels, equalization, call stations, tones, messages both pre-recorded and emergency, zones, etc.

The PA administration workstation shall present the logs, events and faults of the system in real-time.

The Public Address System shall have access rights management where the administrator shall assign levels of access for various users. The workstations shall have minimum of three (3) hierarchical password levels based on the credentials of each user of role-based control for administration and operations wherein these are logged into the system and may be retrieved for audit trails.

The PA administration terminal shall be shared from other Telecom Systems.

SOUND COVERAGE STUDY

The VENDOR shall develop a Sound Coverage Study Report to depict the loudspeakers' coverage within the new PTB. This report shall enable the END-USER to review and confirm if the loudspeakers' coverage is properly aligned, correctly positioned and that the loudspeakers are correctly chosen for its purpose.

The Sound Coverage Study Report shall also determine if the number of loudspeakers, its locations and speaker power are appropriate and that the zone assignments meet the requirements of the PROJECT.

This shall also determine the final number of paging zones, appropriate loudspeaker cable routes to be taken considering the structure of the new PTB and the minimum loudspeaker cable core sizes that shall be used.

CABLING

The loudspeaker lines or loudspeaker loops of the Public Address System (PAS) shall have its own cabling infrastructure independent of the SCS, FDAS and ACS. Interface to the existing FIDS and Automatic Voice Messaging system at the old PTB shall also be included.

The awarded supplier shall supply and install all the necessary loudspeaker cables, roughing-ins, EMT pipes and accessories, utility and junction boxes, threaded rods, hangers, flexible metal conduits, strut channels and clamps, hooks, accessories and ancillaries to complete the loudspeaker loop cabling infrastructure.

The awarded supplier shall determine the appropriate cable core size in order to keep the resistance and the voltage drop to a minimum.

The loudspeaker cables shall be terminated directly to the cable tails of the loudspeaker with appropriate connectors and shall be sealed properly, inside a square box with cover.

The call stations, ambient noise sensors and PA workstation shall use the CAT6 STP cables and IO which are under the Structured Cabling System (SCS).

INTERFACING AND INTEGRATION

The Public Address System shall have features and functions built into it to integrate and interface with the subsequent systems.

The awarded supplier shall install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

MASTER CLOCK SYSTEM

The Public Address System shall be interfaced with the Network Time Protocol (NTP) Server for its time synchronization over ethernet. The NTP shall be under the scope of the Master Clock System.

LAN SYSTEM

The Public Address System shall be supported by the LAN System as its transport for some of the Public Address System components. The LAN and PoE Switches required by the Public Address System shall be under the scope of the LAN System. The LAN System shall be able to provide the requirements of the Public Address System including its field devices such as call stations, fireman's microphone and ambient noise sensors that require PoE ports from the LAN Switches.

The awarded supplier shall ensure that the Public Address System shall have its own VLAN configured within this PROJECT and shall ensure that the bandwidths are properly allocated considering that the PROJECT has other Telecom Systems that will use the LAN System as its backbone for transporting its own data.

STRUCTURED CABLING SYSTEM

The Public Address System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure to the LAN System onwards to the main Public Address System. The SCS shall use CAT6 STP cables for this purpose with Information Outlets (IO) for terminating the call stations, fireman's microphone and ambient noise sensors to the RJ45 keystones with STP patch cords.

FIRE DETECTION AND ALARM SYSTEM

The Public Address System (PAS) shall be interfaced with the Fire Detection and Alarm System (FDAS) through hard-wired dry contacts. Upon receipt of a fire alarm signal from the FDAS, the PAS shall automatically broadcast the emergency messages without any manual intervention.

The following are the minimum requirements for interfacing with FDAS:

- Emergency messages shall be broadcasted and reset automatically based on the signals or inputs provided by the FDAS
- Connection to the FDAS shall be for 8x dry contacts intended for each of the eight (8) zones of the PAS, including the "all clear" signal
- The signals from the FDAS for each zone, shall consist of the alert, evacuation and all clear

The awarded supplier shall coordinate with the FDAS vendor or supplier and the DIAA Fire Safety Team on the cause-and-effect configuration for the Fire Alarm Control Panel (FACP) of FDAS. This shall also determine the proper and correct zone assignments of the PAS.

EXISTING AUTOMATIC VOICE MESSAGING SYSTEM

The Public Address System (PAS) shall be interfaced with the existing FIDS System and Automatic Voice Messaging System (AVMS) of the old PTB. The existing FIDS and AVMS automatically and regularly sends out messages that are broadcasted over the PA System of the old PTB. The messages are information on the flight

schedules, arrival and departure time, flight status, boarding gate and time, pre-recorded announcements, etc. These automatic voice messages shall also be sent over to the new PTB onwards to the new Public Address System of the new PTB. The PAS shall receive the information and signals from the AVMS in order for the new PAS to broadcast the necessary messages to its particular destination or zone within the new PTB.

The interfacing may be through audio inputs and control inputs from the FIDS and/or AVMS. A number of audio inputs may be required due to the number of messages and its particular zone destination. The control inputs shall determine the zone destination of the particular message to be broadcasted. The broadcasts may be simultaneous on different zones.

The awarded supplier shall coordinate with the supplier and service provider of the existing FIDS and/or AVMS, the DIAA and other concerned parties in order to properly design and engineer the solution for the new PTB.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-09 – STRUCTURED CABLING SYSTEM (SCS)

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ABBREVIATION

ACR	Attenuation to Crosstalk Ratio
ACS	Access Control System
BoM	Bill of Materials
EIA	Electronics Industries Association
EMT	Electrical Metallic Tubing
FDAS	Fire Detection And Alarm System
FPP	Fiber Patch Panel
IDC	Insulation displacement connectors
I/O	Input / Output
OSP	Outside Plant
LAN	Local Area Network
NEXT	Near end Crosstalk
LD	Layout Diagram
MCS	Master Clock System
NTP	Network Time Protocol
PA	Public Address System
PTB	Passenger Terminal Building
RSC	Rigid Galvanized Steel
SCS	Structured Cabling System
SD	Schematic Diagram
TCP/IP	Transmission Control Protocol / Internet Protocol
TDS	Technical Design Specifications
TER/TR	Telecom Equipment Room/Telecom Room
UTP	Unshielded Twisted Pair

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the Structured Cabling System and its components, peripherals, accessories, ancillaries, field devices and associated items for the Structured Cabling System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. Structured Cabling System – Bill of Materials

c. Structured Cabling System – Schematic Diagram

d. Structured Cabling System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- Cat6 UTP Cables
- Information Outlets
- Faceplates, single and dual
- Patch Panels, both for Fibre and UTP Cables
- 24core fiber optic cable, multimode
- Cable Management
- Telecom Cabinet and wiring
- Cable trays/pathways, Cable Ladders, harness
- Roughing-ins
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the Structured Cabling System.

The main Structured Cabling System and its associated peripherals shall be installed in the G/F Telecom Room of the New Passenger Terminal Building (PTB).

The Information Outlets shall be distributed at the following areas:

- Airline Offices
- Check-in lobby/counters
- Immigration Booths
- Information/Tourist Counter
- Departure areas
- Immigration areas
- Offices
- Rooms
- Baggage claim/handling areas
- Passenger lounges
- VIP Lounge
- Baggage Make-up Area
- Terminal Lobby
- Fan Room
- Pump Room

GENERAL DESIGN REQUIREMENT

The Structured Cabling System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new Structured Cabling System shall be provided in all areas under the scope described herein, for the purposes of having a physical layer for transmission of Telecom Systems' data, information and applications, e.g. voice, data, video etc. within the new Passenger Terminal Building (PTB).

The Structured Cabling System shall provide physical layer of data transmission to the following telecom systems:

1. Access Control System (ACS) – Access Controllers
2. Closed Circuit Television System (CCTV) – CCTV Cameras
3. Cable TV System (CATV) - Decoders
4. Flight Information Display System (FIDS) – Android Devices
5. Local Area Network System (LAN) – IT Devices
6. Master Clock System (MCS) – IP Clocks
7. Public Address System (PA) – Call Stations and Ambient Noise Sensors
8. Telephony System (PABX) – IP Telephones
9. Wireless Fidelity System (Wi-Fi) – Access Points

The Structured Cabling System composes of horizontal cabling in the specified areas where voice, data, video, etc. are required. All UTP cables shall homerun to the Telecom Room at the Ground floor of the new PTB.

The Structured Cabling System shall be an end-to-end solution using the CAT6 standard as minimum and shall be used by the systems mentioned above. The SCS may also be used by non-Telecom devices depending on the END-USER's requirements. This shall be coordinated with the END-USER before the implementation and design.

Initially, the Common Use Terminal Equipment (CUTE) and Common Use Self Service (CUSS) shall be provided with Information Outlets, UTP Cabling and switchports for their respective connections. The terminals, "kiosk" and software applications shall be provided by others.

TECHNICAL DESIGN CRITERIA

A new Structured Cabling System shall consist of Telecom cabinets, Fiber Optic cables, UTP Cables, STP Cables, Information Outlets, roughing-ins, UTP Patch Panels, Fiber Optic Patch Panel, cable management system, face plates with RJ45 keystones and In-Building Cable tray System.The Structured Cabling System shall include all other necessary components and peripherals to complete a functional Structured Cabling System.

SYSTEM ARCHITECTURE

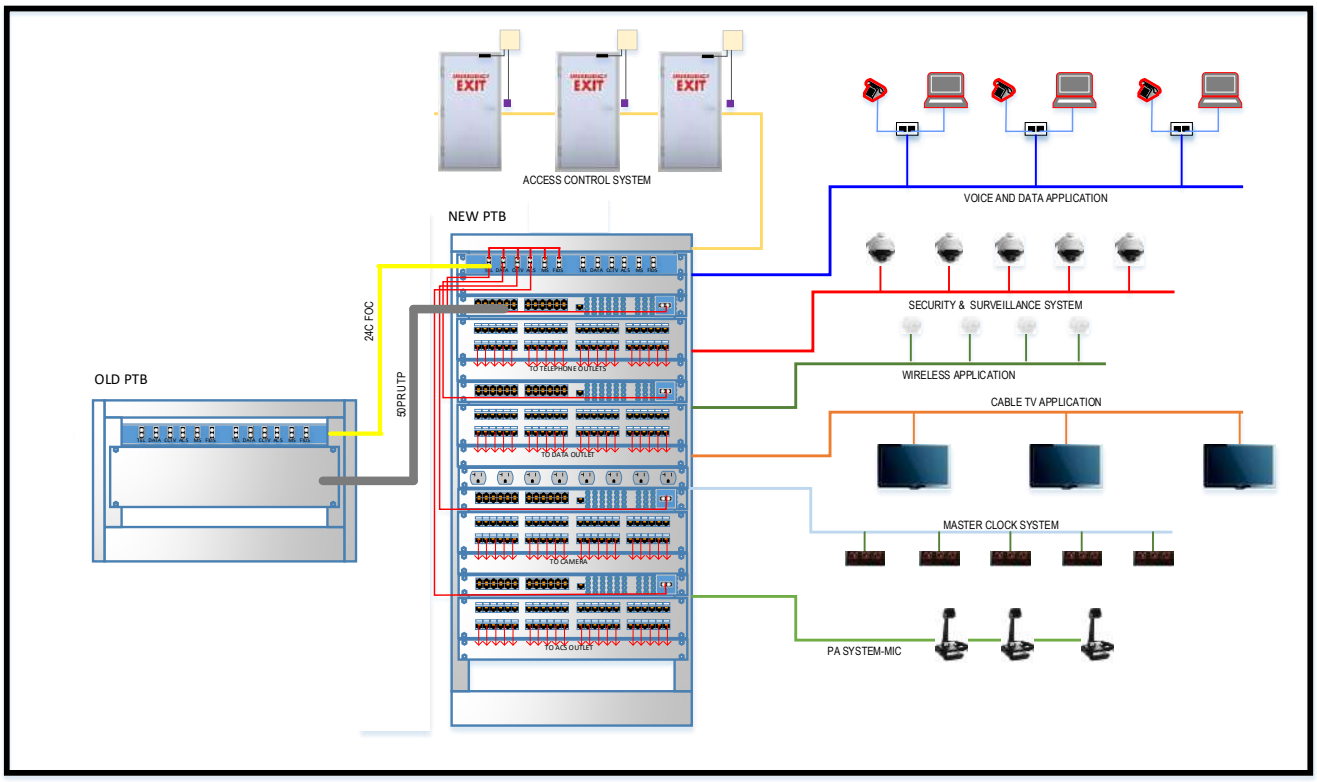

Figure 9: Structured Cabling System Architecture

IN-BUILDING CABLE tray SYSTEM

The horizontal pathways shall be composed of Cable tray and EMT and PVC conduit system to be constructed in compliance with the requirements of the Philippines electrical code standards.

The size requirements for horizontal distribution pathways depend on the following considerations:

- Usable floor space served by the pathway.
- The usable floor space is the area used by occupants for their normal daily work functions including corridors, lobbies and excluding other common areas of the building (e.g., door entrances, elevator, rest rooms, stairways, and garden areas).

Cable tray and EMT Conduit system shall be utilized to serve the Structured Cabling System requirement inside the building.

HORIZONTAL CABLING SYSTEM

Horizontal Cabling System includes the provisions and installation of the horizontal (or distribution) cables required to transport communication services in the new PTB.

Horizontal cabling system provides the physical means of connectivity for transporting IT & telecommunications signals between the LAN dependent system in the work & field areas to telecom equipment in the telecom room. Telecom equipment in the telecom room shall host all the necessary telecom hardware where these cables shall be terminated in a structured and well laid out manner.

The horizontal cabling shall utilize a physical star-wired configuration. The cable shall be run uninterrupted from the Telecom Room to information outlets (I/O). The maximum allowable cable run is 90 meters.

Cables laid inside the overhead cable trays shall be segregated into different cable type groups (bundles), and lashed and tie-wrapped to every meter.

The schematic diagram describes the connectivity for the horizontal cabling system for data points.

- UTP Cat6 cable shall be laid from the field end location to the telecom room, routing through the horizontal cable containment / pathway.

- In the telecom room, the cables shall be routed on to the rack and terminated on the patch panel.

- The cables laid to the field end shall be routed into the furniture and terminated in the respective information outlet and fixed with a Faceplate.

INFORMATION OUTLET DISTRIBUTION

- The New Passenger Terminal Building comprises of 2 floors viz. Arrival, Departure.
- The location of the Telecom Room in the ground floor gives the flexibility to cable up the required IT endpoints in departure and arrival areas without the need for additional room in the 2nd floor.
- UTP Category 6 standard based horizontal cabling system shall be considered for field end data and voice, video and control requirements.
- All cables shall be terminated onto telecom cabinets in the Telecom Room.
- For each information outlet 1 Data and 1 Voice port is considered or as per the operational requirement.
- For IT subsystems (ACS, CCTV, CATV, FIDS, LAN, MCS, PABX and Wi-Fi) 1 outlet of data shall be provisioned at each of these field location.
- One outlet of data shall be considered for each CCTV location.
- Data outlets for ACS shall be considered at locations where it is required to connect to the ACS system. (like the door interface panels).
- At check-in counters there shall be 1 outlet of data and 1 outlet of voice port considered for telephone connectivity.
- At Boarding gate counters there shall one outlet of data and one outlet of voice ports considered.
- As part of wireless network infrastructure provisioning, considered necessary cabling for connecting the wireless access points across the terminal.
- For the work areas like support office and airline office, 1 outlets of data and 1 outlets of voice shall be considered for every 25sqms area.
- For the commercial areas like concessionaires, 1 outlets of data & 1 outlets of voice shall be considered for each location.

- For Voice interconnection with the Old Terminal Building, a 50pair CAT6 cable shall be laid from the new PTB Telecom Room to the old PTB Telecom Room.
- A 24 core of Fiber Optic cable shall be laid from the new PTB Telecom Room to the Old PTB Telecom Room.
- For the unspecified areas in the New PTB, 1 outlet of data and 1 outlet of voice shall be considered for every 40sqm area.
- For electrical and mechanical room 1 outlets of data shall be considered for any kind of connectivity requirements for NON telecom systems.
- The network is designed with modular network, where-in, the addition of new services, new ports and backbone network is scalable, and also the distribution capacities are sized to expand easily till the end device.
- As part of the current plan all the active network components shall have 10% additional port density capacity to expand in future.

Note: Above mentioned design consideration shall be further fine-tuned as the design progresses.

CABLING PATHWAYS

Design for horizontal cable pathways/trays differ from floor to floor. In general for arrival floors, Ceiling pathway approach shall be considered for most of horizontal cable distribution. Floor pathways and wall drops shall be considered for last mile connectivity to the field locations. For departure ceiling the horizontal cable distribution shall mostly be based on floor approach. The design shall consider only 40% fill ratio for all the cable pathways. Following types of pathway materials that are considered for horizontal cabling of Data & Voice, video and control

In screed: PVC conduits of 25mm, 32mm.
In screed: GI / Junction boxes
In Ceiling: GI / Powdered coated Wire ways
In Ceiling: GI/ Powdered coated pull boxes of adequate sizes shall be considered at the required junctions.
In Ceiling: EMT conduits
In ceiling: Metallic Flexible conduits
In walls: PVC conduits
In Telecom Room: Cable Ladders
In Telecom Room raised floor: Cable Ladders

The above mentioned cable pathway components shall be used as per the requirement at each location. The below section gives the minimum specification requirement for cable pathways.

CONDUITS, WIRE WAYS AND CABLE TRAYS

EMT CONDUITS

- Provide tubing of high grade steel electrically welded with exterior protective coating of hot galvanized zinc, applied by the electro galvanized process.

- Fitting shall be with proper connectors.

It shall be the responsibility of the awarded supplier to ensure that above sizes are suitable with extra spare capacity. Otherwise, VENDOR shall recommend applicable sizes.

FLEXIBLE METAL CONDUITS

- Provide die cast fittings of the type that screw into the inside of the conduit with threaded edges
- Supplied in different sizes like 20mm, 32mm and 40mm.

PVC CONDUITS

- Provide heavy wall, rated for use with 90 deg C conductors, polyvinylchloride schedule 40 conduit with solvent joints. Good for exposed and direct burial application.
- Fittings and cement shall be provided. All joints shall use solvent in accordance with the manufacturer's recommendations. Match to conduit or tubing type and material.
- Supplied in different sizes like 20mm, 32mm and 40mm.

It shall be the responsibility of the awarded supplier to ensure that above sizes are suitable with extra spare capacity. Otherwise, awarded supplier shall recommend applicable sizes.

WIRE WAYS

- Sheet metal troughs with hinged or removable covers. Shall be a hot dipped galvanized and powdered coated to protect from corrosion.
- Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with cable trays/ wire gutters as required for a complete system.
- The thickness of material of metal trunking shall be 1.6mm
- Supplied size shall be 150mm x 100mm, 300mm x 100mm, 450mm x 100mm.

It shall be the responsibility of the awarded supplier to ensure that above sizes are suitable with extra spare capacity. Otherwise, awarded supplier shall recommend applicable sizes.

CABLE LADDERS

- Sheet metal and angle and flat bars. Shall be a hot dipped galvanized and powdered coated to protect from corrosion.
- Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and other fittings to match and mate with cable trays as required for complete system.
- The thickness of material of metal trunking shall be 1.6mm
- Supplied size shall 150mm x 75mm, 300mm x 75mm.

It shall be the responsibility of the awarded supplier to ensure that above sizes are suitable with extra spare capacity. Otherwise, awarded supplier shall recommend applicable sizes.

The horizontal cable system shall consists of various components as mentioned below;

- UTP Cables
- Information outlets
- Face plates
- UTP Patch panels
- UTP Patch cords
- Cable Management

CABLES, PANELS, INFORMATION OUTLETS AND OTHER SCS DEVICES

UTP CABLE

The category 6 UTP cable that shall be used for the horizontal cabling system in this project shall meet the minimum required specification as mentioned below;

- 4 Pair Cable, 24 AWG Copper with integral cross -member pair separator for uniform characteristic impedance.
- Cable jacket characteristics shall have high tensile strength
- It shall be certified by independent test labs to meet Cat -6 Standards.
- Cables shall be UL listed.
- Cables shall support different speed requirements like 100 base TX and 1000 Base T gigabit Ethernet.
- The cable shall have 100 ohm impedance and data transmission frequencies up to 250 MHz.
- For all frequencies from 1 MHz to 250 MHz, category 6 cable propagation delay skew shall not exceed 45 ns.
- The UTP-based cabling system shall use matched components from a single manufacturer.
- The cabling system shall be certified to deliver Applications performance over the lifetime for which the cabling system was originally designed to support.
- All components used in the UTP-based cabling system shall have a design life and product warranty of 20 years from date of acceptance against defects in materials.
- All Passive Components shall be RoHS (Restriction of Certain Hazardous Substances) compliant. Declaration for RoHS Compliance shall clearly be mentioned on datasheets of each Passive Component.

MULTI PAIR UTP CABLE

50 pairs Cat6 Cable support support high-bandwidth application up to 1Gigabit Ethernet. The cable shall be composed of 24 AWG bare solid copper conductors insulated with High Density Polyethylene (HDPE) insulation.

- 50 twisted pairs
- 24 AWG stranded (7x32) tinned copper conductors,
- semi-rigid PVC insulation,
- PVC jacket.

110 block

A 50-pairs, Cat6 110 Block with Legs. Including connecting blocks, labels and holders shall be used to cross connect voice and control transmission from New PTB to Old PTB.

INFORMATION OUTLET

- All Outlets shall complies with Category 6 standards and interoperable and backwards compatible with Cat.5e and Cat.5.
- The Category 6 Outlets shall be of single metal piece design without any PCB to support the IDC / Contacts.
- It shall have IDC to hold conductor without using any tool for termination of cable.
- Shall be reusable and tool less in design in terms of termination of solid wire installation cable AWG22-24 as well as stranded cables AWG 22/7 – 26/7.
- Compatible with RJ standard plugs (RJ11, RJ12, RJ45), PCB-free and tool-free Easy-Lock connection of installation cables AWG 24 – 22 (0.5 mm – 0.65 mm) and flexible cables AWG 26/7 – AWG 22/7.
- Shall be certified by third party.
- A blanking plate shall be installed where modules are not used.

FACEPLATE

- Faceplate Material Shall be of Poly Carbonate and ABS.
- Shall be Halogen-free in accordance with DIN/VDE 0472/815.
- Suitable for RJ45 connection modules and fiber optic connectors with support plates.

UTP PATCH PANEL

- The CAT 6 patch panel shall be used to provide a centralized Category 6, rack-mounted termination, identification and service assignment point for UTP horizontal cabling.
- The patch panels shall be suitable for mounting in 19" frames within cabling cabinets and shall be fixed using securing bolts and captive nuts at either side.
- Patch panel design shall allow for sufficient finger space around the connectors to allow patch cables to be connected and disconnected and to allow individual connectors to be mounted and dismounted without disturbing other adjacent connectors.
- Panels shall accommodate full labelling of every connector.
- Panels shall contain cable support at the rear for cable dressing individual cables.
- Cables terminating in connectors shall be dressed in the panel with due consideration to minimum bending radius. The cable dressing shall not cause permanent indentation of cable sheath.
- Sufficient cable reserve shall be installed such that re-termination of connectors can occur in addition to an allowance for removal and inspection of the complete panels.
- Strain relief shall be provided at each termination such that any strain on the cable is not transferred to the electrical contacts in the connector.
- Cable management units shall be provided in both 1u and 2u sizes as appropriate dependent on the quantity of cabling required in each instance.

UTP PATCH CORD

- All UTP patch cords shall conform to the requirements of EIA/TIA 568B cabling Standard, Horizontal Cabling Section, and be part of the UL LAN certification. Cords shall be equipped with an 8-pin modular connector on each end.
- Performance guaranteed with Cat.6 (250 MHz) requirements: ISO/IEC 11801 2nd Edition Compliant with Cat.6 component standards IEC 60603-7-4 and 60603-7-5.
- Patch cords to use IDC contact technology or Equivalent for all the conductor terminations for better performance and not piercing type contact technology.
- The Category 6 patch cord shall be factory assembled and tested using Category6 compliant patch plugs and stranded Category 6 cable. No patch lead shall be manufactured, assembled or fabricated on site.
- The Category 6 patch cord shall consist of eight insulated 22-24AWG copper conductors, arranged in four colour-coded twisted-pairs.
- The Category 6 patch cord shall be available in factory made standard lengths of 2 and 3 meters or appropriate lengths depending on the installation.
- Use integrated lock protectors at both ends (factory assembled plug-ended jumpers) for patch panels.

MULTI-MODE FIBER OPTIC CABLE

The Multi-mode Fiber Optic Cable shall have the following as a minimum specification for the horizontal cabling system components:

- OM4 Category
- Operates at a wavelength of 850 nm spectrum
- Core size or core diameter shall of 50-62.5 micro meters
- OM3 cable is distinguished by an aqua jacket.

FIBER OPTIC PATCH PANEL

Fiber Optic Patch Panels shall be rack mount enclosures designed for termination of fiber optic cables located at specific location in the Telecom Cabinet in the Telecom Room.

- Rack Mount Fiber Patch Panel System will provide a centralized, rack-mounted termination, identification and service assignment point for optical fiber cabling.
- Rack Mount Fiber Patch Panel System will consist of 24 Fiber Module units, which can be used for termination of 24 cores of fiber optic cable.
- Drawer concept will allow for, easy access to splicing tray and easy access to backside of connector.
- Rack Mount Fiber Patch Panel System will provide for bend radius control throughout the panel as well as storage space for slack cabling.
- Rack Mount Fiber Patch Panel System will use universal connector strips allowing flexible and customized patch panel design.
- The panels will enable splicing or pre-polished connector within the fiber optic housing or can be mated with separate housing for on -the-rack splicing.

- Provide cross connect and splicing capabilities, and contain the proper troughs (may provide separate Hardware) for supporting and routing the fiber cables/jumpers.
- 19" slide in unit capable of accommodating duplex LC or SC type Adaptors with cassette type panel, Splice tray panel with 2/4/8 splice tray, cable guard to route buffered cable, labelling strip, mounting kit, Grounding kit to ground armoured cable, 4 numbers of Knock out hole for cable entry with gland for strain relief and rodent protection.
- Have a front face "window" section to insert coupler panels/cassette type panel for mounting of LC connectorized fibers.
- Provide terminating capability of 24 fibers in 1U for LC or SC connector type requirement.
- The proposed panel/enclosure will be free from openings at the rear end. However in order to ease OFC cable entry, it is recommended that the panel will carry a knock-out to install the fiber gland and route the cable inside the panel/enclosure for splicing.
- Cables entering panels shall be protected by appropriate protective glands or grommets. Where practical, the external sheath of the cable shall not be stripped back outside of the strain relief of the patch panel.
- UL listed

FIBER PIGTAILS

- Multi-mode Pigtail with LC type factory terminated polished ceramic connector.
- Connector will have locking type latched push-pull.
- OM3/OM4 fiber type
- LSZH jacket
- Cable length will be a minimum of one meter
- Factory Tested

FIBER PATCH CORD

- High-quality laser-optimized 50/125 Multimode LC to LC OM4 Fiber Patch Cable.
- Intended for fast Ethernet, Gigabit Ethernet Speeds, LAN and Asynchronous Transfer Mode (ATM) applications.
- Shall supports video, data and voice services.
- OM4 Fiber Patch Cable connects to 10GBase-SR, 10GBase-LRM, SFP+ and QSFP+ transceivers for 10 GB networks.
- OM4 Multimode Fiber Patch Cable shall conforms to ITU-T G.651.1, TIA/EIA 492AAAC and IEC60793-2-10 A1a.2a standards and complies with all RoHS environmental specifications.
- Color jacket with a 3 mm diameter. OM4 cables have a 1500 MHz-km bandwidth and a 2.3dB/km maximum attenuation at 850 nm light sources. T
- Shall have a 500 MHz-km bandwidth and a 0.6dB/km maximum attenuation at a 1300 nm wavelength.
- Fiber patch cords operate at -20°C to +70°C and have a minimum installation bending radius of 5.0 cm and a minimum long term bending radius of 3 cm.

TELECOM ROOM

The awarded supplier shall design and equip the Telecoms Room for the co-location of data, voice, video and control equipment and distribution on each floor in accordance with the standards.

The awarded supplier shall design, procure, install, construct, test and commission all associated facilities within the Telecom Room to include but not limited to, cable splice closure, grounding system, cable tagging.

The awarded supplier shall procure and install all cable infrastructure, to include but not limited to, cable ladders, cable runways, cable ducts, etc.

The Telecom Room shall accommodate as a minimum:

- 6 x Telecom Cabinets 19 inch 600mm x 1000mm, 42U
- The EPC shall ensure to provide the entrance cable facility with spares
- Raised floor with a minimum height of 400mm consisting of cable ladder for cable management.

The awarded supplier shall design, procure, install, construct and commission the cable ladder and cable trays for Telecom Room. The ladders and trays shall consist of, but not limited to hangers, ground straps, fixtures, etc. The size of the ladders and cable trays shall be determined and approved before the implementation.

CABLING AND ROUGHING-INS

The awarded supplier shall supply and install all the necessary UTP cables, STP cables, Fiber Optic cables, roughing-ins, cable trays/pathways, cable ladders, EMT pipes and accessories, PVC pipes and accessories, utility and junction boxes, threaded rods, hangers, flexible metal conduits, strut channels and clamps, hooks, accessories and ancillaries and other necessary items to complete the SCS cabling infrastructure.

The awarded supplier shall determine the appropriate roughing-in sizes of the cable ladders, pathways, pipes and ancillaries in order to maintain the standards of the Structured Cabling System as indicated in the Telecom Systems - General Design Requirements Document.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-10 – TELEPHONY SYSTEM (PABX)

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ABBREVIATION

AA	Automated Attendant
ACS	Access Control System
BoM	Bill of Materials
BRI	Basic Rate Interface
CAS	Call Accounting System
DECT	Digital European Cordless Telephone
DSS	Direct Station Selection
IO	Information Outlet
IP	Internet Protocol
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LD	Equipment Layout Diagram
MDF	Main Distribution Frame
PABX	Public Automatic Branch Exchange
PoE	Power over Ethernet
PRI	Primary Rate Interface
PSTN	Public Switch Telephone Network
PTB	Passenger Terminal Building
RoHS	Restriction of Hazardous Substances in Electrical and Electronic Equipment
SCS	Structured Cabling System
SD	Schematic Diagram
SIP	Session Initiation Protocol
TDS	Technical Design Specifications
TEL	Telephony System
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair
VLAN	Virtual LAN
VoIP	Voice over Internet Protocol

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the Telephony System and its components, peripherals, accessories, ancillaries, field devices and associated items for the Telephony System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. Telephony System – Bill of Materials

c. Telephony System – Schematic Diagram

d. Telephony System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- PABX or Communication Server
- IP Phones
- Analog Phones
- Automated Attendant
- Voicemail
- Call Accounting System
- Main Distribution Frame
- System administration and workstation for management and maintenance (may be shared with other Telecom Systems)
- Latest software and firmware
- Telecom cabinet and wiring (may be shared with other Telecom Systems)
- Peripherals, accessories, cables, roughing-ins, connectors, ancillaries, and other related works and supplies necessary to complete the installation of the Telephony System.

The PABX and its associated peripherals shall be installed in the G/F Telecom Room of the New Passenger Terminal Building (PTB).

The telephone units shall be distributed at the following areas:

- Check-in lobby/counters
- Offices
- Offices and Rooms
- Passenger bridge
- VIP and Pre-departure lounge
- Pre check-in counter
- Immigration booth
- Bridge
- Quarantine Room and Doctor's Office
- Baggage make-up area
- Transfer counter
- Telephone Operator
- Information/Security counter

GENERAL DESIGN REQUIREMENT

The Telephony System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new Telephony System shall be a Unified Communications system to provide the seamless voice communications to the various internal and external stakeholders for their day-to-day communications. The telephony system shall have a distributed architecture to support the New PTB requirement.

The Telephony System shall monitor, operate, control and manage the PABX, trunks, telephones and other auxiliary equipment/feature such as the Automated Attendant, Voicemail, Call Accounting, etc.

It shall support all types of connectivity like IP, analog, digital, DECT and wireless phones. The telephones shall be distributed in the areas mentioned herein.

The PABX shall interconnect with the Public Telephone Switched Network (PSTN) for the necessary trunklines. These shall come in the form of analog, ISDN (PRI & BRI) and IP trunks. The incoming trunklines shall be routed either directly to the Telephone Operator or through the Automated Attendant.

The Telephony System shall be software controlled, easily configured and allow for future expansion. It shall be scalable in order to accommodate the existing quantity of telephones at the old Passenger Terminal Building (PTB). In the event that the old PTB's telephones be included or added into the new PABX (in the future), then this shall only entail additional modules or servers without any replacements of any major component.

The PABX shall be connected to the LAN server switch onwards to the access switches (under the LAN System) as the transport infrastructure of the IP phones and the management workstation. Analog telephones shall directly connect to the PABX System.

The PABX shall be powered via the commercial power of 220VAC, 60Hz at the Telecom Room. A common Telecom UPS shall be used to provide emergency power during commercial power outages.

The Telephony System shall interface directly with other systems, such as the LAN, SCS, Master Clock and the PSTN.

TECHNICAL DESIGN CRITERIA

A new Telephony System shall consist of a PABX or communication server equipped with analog extension card, VoIP, trunk boards – analog, ISDN, IP trunks; Automated attendant, Voicemail and Call Accounting.

The Telephony System shall include all other necessary components and peripherals to complete a functional Telephony System.

SYSTEM ARCHITECTURE

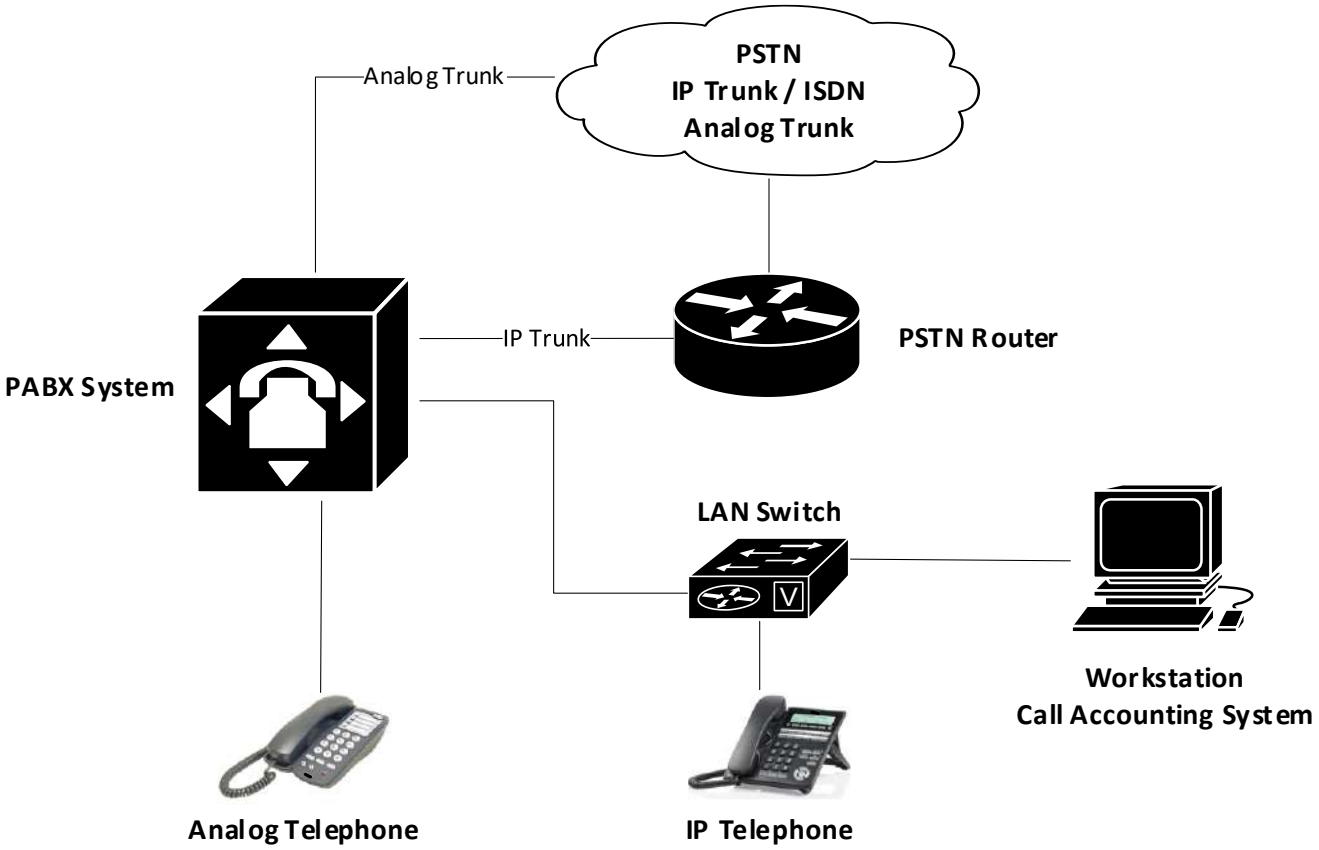

Figure 10: Telephony System Architecture

PABX / COMMUNICATION SERVER

The PABX shall be properly designed for the required capacity + a 10% spare port capacity for future telephone expansion. It shall be modular through the installation of additional boards or cards. The system may be stacked to increase its capacity without any major component replacement, for future expansion.

The PABX shall have the following as minimum requirements:

- Terminal Capacity:
  - IP Terminals – minimum of 800
  - Soft phones – minimum of 200
  - Digital Terminals – minimum of 300
  - Analog Terminals – minimum of 90
  - Smartphone client - minimum 200
- Trunk Capacity:
  - IP Trunks – minimum of 350
  - Analog trunks – minimum of 180
  - ISDN PRI Channels – minimum of 180
  - ISDN BRI Channels – minimum of 180

- Applications:
  - IP Gateway channels – minimum of 200
  - Voice-mail - 40 hours of storage; 896 Mailboxes
  - Built-in applications - Toll Fraud Defence, Property Management System, Call Management and Unified Communications
- Networking:
  - NetLink - minimum of 45 Sites
  - SIP/H.323 TIE Lines - minimum of 300-Ch
  - CTI Integration
  - TAPI Interface
- Voice Compression:
  - G.711, G.722, G.723, G.726, G.729
- Protocols:
  - H.323
  - Media Gateway Control Protocol
  - Session Initiation Protocol
- Compliance:
  - EMC - EN55032 Emission, EN55024 Immunity, EN61000 Powering
  - Safety - EN60950-1
  - Transmission and signalling - TBR3, TBR4, ES203-021, TBR8, TBR38

The number of VoIP resources shall determine the allowed number of simultaneous calls. The awarded supplier shall ensure that this is properly sized up to cater to the current requirements plus a 10% spare capacity.

The PABX shall come with the latest software and firmware versions and licenses.

TELEPHONY SYSTEM FEATURES

The Telephony System shall come with features that shall enhance the user experience in going about their daily work through the use of telephone communications.

The PABX shall have the following features as a minimum:

- Account code
- Attendant call queue
- Auto Attendant
- Automatic Route Selection
- Music on Hold
- Barge In
- Call conference
- Call forwarding
- Call on hold
- Call pickup
- Call transfer
- Call waiting
- Callback
- Caller ID
- Class of Service
- Department Calling
- Direct Inward Dialing

- Direct Inward System Access
- Direct Station Selection
- Do not disturb
- Follow Me
- Flash
- Hold
- Hotline
- Hunt Group
- Meet me Conference
- Message Waiting
- Mobility
- Night Service
- One-touch calling
- Operator
- Paging
- Park
- PC Programming
- Power Failure Transfer
- Programmable function keys
- Redial
- Save Number Dialed
- Manager / Secretary feature
- Softkeys
- Speed dial
- Station Message Detail Recording
- Trunk hunting
- Unified Communications
- Uniform Call Distribution
- Voicemail
- Ring tone selection

TRUNKLINES

The PABX shall come with trunklines that will enable the users to call and be called from the outside of the new PTB. These trunklines shall be subscribed and maintained from the PSTN by the END-USER. It is recommended to have subscriptions from different PSTN, Public Telephone Companies or ISP for high availability and resilience.

The PABX shall be equipped with analog trunk interfaces, ISDN Primary Rate or E1 with maximum of thirty (3) voice channels and IP trunk interfaces together with the required number of licenses.

The trunklines shall be terminated at the old PTB and shall run to the G/F Telecom Room at the new PTB via the SCS 50-pair UTP cable.

The final number of trunks (analog, ISDN and IP) shall be determined and advised by the END-USER before the implementation.

EXTENSION TELEPHONES

The Telephony System shall be equipped with the required number of extension lines to be distributed within the new PTB. This shall require certain types of boards to be installed within the PABX unit.

The final number of extensions telephones (analog and IP) shall be determined and advised by the END-USER before the implementation.

IP TELEPHONES

The IP phones shall offer user intuitive navigation, LCD display, good audio quality and easy access to the telephony system's services and features. The IP phone shall be ideal for IP business communications. The IP phones shall be desktop or wall mounted telephones.

The IP phones shall be located in offices, rooms, information counters, check-in counters, lounges and operator position in the New PTB.

The IP telephones shall have the following as minimum requirements:

- Twelve (12) programmable keys
- Incoming LED
- LCD with LCD backlit
- Softkeys
- Cursor key
- Full duplex handsfree
- Minimum 10/100Mbps with PoE (max. of Class 2)
- PC Port
- Tilt angles with adjustable stand
- Capable of wall mounting with wall mounting kits
- Wideband including G.722
- 2-port 10Base-T/100Base-TX/1000Base-T
- Optional Headset input
- Standards: EN 55022, EN 55024 Class B
- ROHS Compliant
- Safety EN 60850, EN 62368
- UTP Patch cord and handset coil cord
- Color black

The IP telephone assigned to the Telephone Operator shall come with a Direct Station Selection (DSS) with at least 60-keys. These shall be programmable keys that may be assigned to extension numbers, trunks and other features as may be required by the END-USER.

ANALOG TELEPHONES

The analog telephones shall be provided in certain areas that would complement the IP phones.

The analog telephones shall have the following as minimum requirements:

- Desktop or Wall Mounted
- Adjustable ringer and handset volume
- Time Flash
- Switchable tone or pulse dialling
- Last Number Redial
- Mute control
- 3 Programmable ringing tones
- LCD display
- Line cord and handset coil cord

TELEPHONE NUMBERING

The Telephony system shall have a flexible four-digit numbering scheme for extensions. The extension numbering scheme shall be arranged per group or department.

This numbering scheme shall also consider the access codes, feature codes, administration codes, etc.

The awarded supplier shall coordinate with the DIAA operations and IT department for the detailed numbering plan whereby the starting digits of 0, 2, 3 and 9 are currently used in the old PTB and shall ensure that no numbering conflict shall occur with respect to the existing Telephone System of the old PTB. This is in anticipation for the possible upgrade of the existing telephone system.

AUTOMATED ATTENDANT

An Automated Attendant (AA) shall be provided together with the Telephony System. This shall allow the AA to answer incoming trunklines directly or indirectly.

The AA shall have two (2) possible configurations:

- Answer incoming trunkline calls directly or
- Answer incoming trunkline calls in cases where the Telephone Operator is busy attending to other calls

The greetings and scripts shall be recorded professionally since this will be the first line of contact for the incoming callers.

The AA scripts shall also come with a menu whereby a caller may choose which amongst the departments or persons to connect his call to.

The AA shall be flexible, programmable and allow a minimum of 5 simultaneous calls at any time. The AA shall always restart from the greetings page for every call.

VOICEMAIL

The Telephony System shall have a Voicemail facility that shall be made available to selected telephones. The Voicemail shall allow callers, whether internal or external, to record voice messages to an extension's voicemail box.

The Voicemail shall have a minimum of three (3) possible ways of receiving messages:

- Answer incoming calls and record voice messages after a pre-set number of rings or time
- Answer incoming calls and record messages in cases where the called party is busy with another call
- Answer incoming calls and record messages directly from the Voicemail menu

The extension with a voicemail shall be prompted of voice messages in his mailbox through a message display on the LCD screen or through an LED on the telephone unit.

The awarded supplier shall ensure that the Voicemail is properly sized up to cater to the number of voicemail users and that the memory is able to handle the number of hours required for the voicemail messages.

CALL ACCOUNTING SYSTEM

A Station Message Detail Record (SMDR) shall be provided by the Telephony System whereby details of all calls are recorded.

The data of this SMDR shall include the following minimum parameters:

- Incoming and Outgoing trunkline calls
- Trunkline number used
- Internal calls
- Caller ID
- Called party extension number
- Calling party extension number
- Data and time of call
- Duration of call
- and other useful parameters for reporting
-

The Telephony System shall have a sufficient memory buffer to store the SMDR data.

The Call Accounting System (CAS) shall be software based linked to the PABX to extract and retrieve the SMDR data and process the information to generate reports as required by the END-USER. The reporting requirements shall be coordinated by the awarded supplier with the END-USER.

MAIN DISTRIBUTION FRAME

A Main Distribution Frame (MDF) shall be mounted on the Telecom Cabinet to where the PABX unit is installed.

This shall come with a minimum 50-pair CAT6 terminal block where all the trunks and analog telephones shall be terminated. Jumper cables shall be used to interconnect the MDF with the CAT6 Terminal Block (TB) of the SCS at the latter's Telecom Cabinet.

The SCS's TBs shall have interconnections with the old PTB for the trunklines and another for the analog telephone where connectorized cords shall be used to terminate them at the UTP Patch Panels onwards to the analog telephones.

SYSTEM ADMINISTRATION

The Telephony System shall be monitored, controlled and managed by an administration workstation. This workstation shall be a common terminal with other Telecom Systems.

The software shall be Windows and GUI-based connected to the LAN System. This software shall allow the administrator to modify parameters, change values, add extensions and other administrative functions. This shall also provide the alarms from the telephony system and reports of system performances.

The Call Accounting System's software may also be loaded onto this terminal.

INTERFACING AND INTEGRATION

The Telephony System shall have features and functions built into it to integrate and interface with the subsequent systems.

The awarded supplier shall design, engineer, supply, install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

MASTER CLOCK SYSTEM

The Telephony System shall be interfaced with the Network Time Protocol (NTP) Server for its time synchronization over ethernet. The NTP shall be under the scope of the Master Clock System.

LAN SYSTEM

The Telephony System shall be supported by the LAN System as its transport for all the Telephony System components. The LAN and PoE Switches required by the Telephony System shall be under the scope of the LAN System. The LAN System shall be able to provide the requirements of the Telephony System including its telephone units.

The IP telephones shall be connected to the nearest or most suitable LAN switch within the area and subsequently to the core switch of the LAN System. The PABX shall be connected to the server switch.

In cases where the field UTP cables from the LAN switch to the field IP telephones exceed 90 meters, a FO transceiver or media converter shall be installed by the awarded supplier together with the power cables. Extra care must be taken in measuring the length of the UTP cables.

The IP telephones shall be terminated on minimum 10/100Base-TX ports of the LAN Switch.

The awarded supplier shall ensure that the Telephony System shall have its own VLAN configured within this PROJECT.

STRUCTURED CABLING SYSTEM

The Telephony System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure to the LAN System onwards to the PABX System.

The telephones shall use the SCS CAT6 UTP cables for this purpose with Information Outlets (IO) for terminating the IP telephone's UTP patch cord to the RJ45 keystones. The analog telephones shall also use the SCS UTP CAT6 terminating the analog telephone's line cord RJ11 to the SCS IO, onwards to the PABX unit.

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-11 – WIRELESS FIDELITY SYSTEM (WIFI)

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INTERFACING AND INTEGRATION 132
LAN SYSTEM *132*
MASTER CLOCK SYSTEM *132*
STRUCTURED CABLING SYSTEM *132*

ABBREVIATION

ACC	Advanced Cellular Coexistence
ACS	Access Control System
BLE	Bluetooth Low Energy
BoM	Bill of Materials
BPDU	Bridge Protocol Data Unit
BPSK	Binary Phase-Shift Keying
BSSID	Basic Service Set IDentifier
CATV	Cable TV
CCTV	Closed Circuit Television
DHCP	Dynamic Host Configuration Protocol
FDAS	Fire Detection and Alarm System
FIDS	Flight Information Display System
Gbps	Giga bit per second
GUI	Graphical User Interface
HE	High Efficiency
IP	Internet Protocol
ISP	Internet Service Provider
LAN	Local Area Network
LD	Layout Diagram
MAC	Media Access Control
Mbps	Mega bit per second
MCS	Master Clock System
MIMO	Multiple- Input Multiple-Output
MU	Multiple User
NMS	Network Management System
NTP	Network Time Protocol
OFDMA	Orthogonal Frequency Division Multiple Access
PAS	Public Address System
PoE	Power over Ethernet
PTB	Passenger Terminal Building
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying
RSSI	Received Signal Strength Indicator
SCS	Structured Cabling System
SD	Schematic Diagram or Software Defined
SLA	Service Level Agreement
SSID	Service Set IDentifier
SU	Single User
TDS	Technical Design Specifications

TxBF	Transmit Beam Forming
UTP	Unshielded Twisted Pair
VLAN	Virtual Local Area Network
WiFi	Wireless Fidelity
WLAN	Wireless Local Area Network

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the WIFI System and its components, peripherals, accessories, ancillaries and associated items for the WIFI System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. WIFI System – Bill of Materials

c. WIFI System – Schematic Diagram

d. WIFI System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- Wireless Access Points
- Network Management System
- System administration and workstation for management and maintenance (under the LAN System)
- Latest software and firmware
- Peripherals, accessories, cables, ancillaries and other related works and supplies necessary to complete the installation of the WIFI System.

The WIFI System and its associated peripherals shall be installed at designated areas within the new Passenger Terminal Building (PTB).

GENERAL DESIGN REQUIREMENT

The WIFI System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new WIFI System shall be provided in the areas under the scope described herein, for the purposes of providing the wireless connectivity of mobile device users to the internet. It shall also provide the bandwidth as required by the users to send and receive data to their mobile devices. Currently, access to the WiFi System shall be for all public users, Airline and Airport personnel, Concessionaires, Agencies, etc. inside the new Passenger Terminal Building (PTB).

The END-USER shall subscribe to Internet Service Providers (ISP) to provide the internet services to the new PTB. The bandwidth shall be dependent of the projected number of users and the type of allowed services to be accessed.

The WIFI System shall be software controlled, easily configured and allow for future expansion.

It shall be scalable in order to accommodate additional areas and users as needed (in the future). In the event that the existing PTB's WIFI System be included or added into the new WIFI System (in the future), then this shall entail an inclusion of a WLAN Controller and additional access points. Currently, an estimate of nine (9) access points shall be sufficient for the new PTB, where a controller-less WiFi System shall suffice in the new PTB. *(The current number of access points is indicative only and shall be adjusted based on the WiFi Heatmap to be developed by the awarded supplier.)*

The WIFI System design and its approach shall be confirmed during the implementation once the END-USER has confirmed the allowed users and number of access points of the WIFI System in the new PTB.

TECHNICAL DESIGN CRITERIA

A new WIFI System shall provide the wireless communications for the mobile device users within the new PTB. The design shall be patterned with best practices and recommended by the industry.

The internet service subscriptions may come from three (3) different internet service providers that may be load-shared or offer a failover on the internet providers. The firewall (under the LAN System) shall have this feature of load sharing and/or failover of three (3) ISPs. In the event that a multi-WAN router offers a better option, then the solution has to be presented to the END-USER and EPC for approval.

The Wireless LAN (WLAN) Controller shall be software-based and assigned to one of the access points. Currently, a physical hardware WLAN controller is not envisaged. This is due to the number of access points that the new PTB would require. In case the number of access points increases, like expanding its coverage to include the old PTB, then this shall already require a hardware-based WLAN Controller.

The Access Points shall be distributed across the new PTB to cover its designated areas. These shall be WiFi 6 and PoE powered. Given that on average, a person has about 2 or 3 mobile devices – handphone, tablet and laptop; the WiFi 6 technology shall prove fit for the requirements of the END-USER as hundreds will have access to the WiFi network. Aside from faster speeds, WiFi 6 access points communicate with more devices at one time, lets it send data to multiple devices in the same broadcast and lets devices schedule check-ins with the access points.

To segregate the public users from the END-USER personnel and other users, different SSIDs shall be created with different VLANs, WLANs and IP blocks.

The WiFi System shall come with a voucher system that will provide an option for the END-USER to use this for their intended purposes. This shall provide timed internet access to the WiFi clients and to allow control on the usage too.

The WIFI System shall include all other necessary components and peripherals to complete a functional WIFI System.

SYSTEM ARCHITECTURE

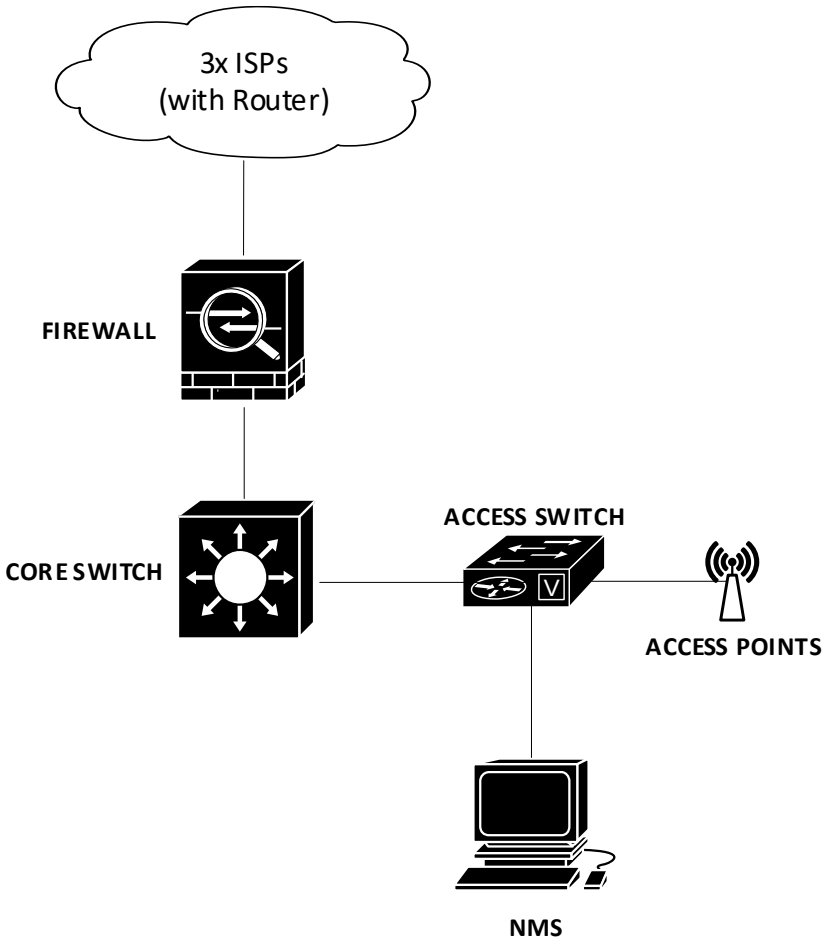

Figure 11: WIFI System Architecture

ACCESS POINT

The Access Points shall come in two (2) types – 2x2 MIMO and 4x4 MIMO. Deployment shall depend on the density of people within its coverage.

The 2x2 MIMO shall be installed in the VIP Lounge. The rest of the designated locations shall have the 4x4 MIMO wherein more users and data traffic to the internet are expected in these areas.

4X4 MIMO ACCESS POINT

The 4x4 MIMO Access Point shall have the following requirements as minimum:

- WiFi 6 802.11ax, backward compatible with older radio technologies (802.11b/a/g/n/ac)
- Indoor ceiling mount
- Dual radio – 5GHz and 2.4GHz @ 802.11ax 4x4 MIMO
- 4x built-in integrated dual-band downtilt omni-directional antennas
- Peak antenna gain of 3.5dBi @ 2.4GHz

- Peak antenna gain of 5.4dBi @ 5GHz
- 5GHz
  - 4x spatial stream Single User (SU) MIMO up to 2.4Gbps with individual 4SS 802.11ax clients or
  - 4x 1SS or 2x 2SS 802.11ax MU-MIMO
- 2.4GHz
  - 4x spatial stream Single User (SU) MIMO up to 1.147Gbps with individual 4SS 802.11ax clients or
  - 2x 2SS 802.11ax MU-MIMO
- Support 1,024 clients per radio
- 16x BSSIDs per radio
- Transmit power of +24dBm @ 2.4GHz
- Transmit power of +24dBm @ 5GHz
- Orthogonal Frequency-Division Multiple Access (OFDMA) with 37x Resource Units in the 80MHz channel
- Dynamic Frequency Selection
- Modulation types: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM
- High Efficiency (HE) support: HE20, HE40, HE80, HE160
- Configurable transmit power
- Advanced Cellular Coexistence (ACC)
- Transmit beamforming (TxBF)
- Interface – autosensing 10/100/1000/2500/5000Base-T, 802.3at PoE max of class 4
- Bluetooth Low Energy (BLE) 5.0
- Visual indicators, reset button
- Mounting bracket
- 5 year subscription license

2X2 MIMO ACCESS POINT

The 2x2 MIMO Access Point shall have the following requirements as minimum:

- WiFi 6 802.11ax, backward compatible with older radio technologies (802.11b/a/g/n/ac)
- Indoor ceiling mount
- Dual radio – 5GHz and 2.4GHz @ 802.11ax 2x2 MIMO
- 2x built-in integrated dual-band downtilt omni-directional antennas
- Peak antenna gain of 4.9dBi @ 2.4GHz
- Peak antenna gain of 5.7dBi @ 5GHz
- 5GHz
  - 2x spatial stream Single User (SU) MIMO up to 1.2Gbps with 2SS 802.11ax clients
- 2.4GHz
  - 2x spatial stream Single User (SU) MIMO up to 574Mbps with 2SS 802.11ax clients
- Support 256 clients per radio
- 16x BSSIDs per radio
- Transmit power of +21dBm @ 2.4GHz
- Transmit power of +21dBm @ 5GHz
- Orthogonal Frequency-Division Multiple Access (OFDMA) with 8x Resource Units in the 80MHz channel
- Dynamic Frequency Selection (DFS)
- Modulation types: BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM
- High Efficiency (HE) support: HE20, HE40, HE80
- Configurable transmit power

- Advanced Cellular Coexistence (ACC)
- Transmit beamforming (TxBF)
- Interface – autosensing 10/100/1000Base-T, 802.3at PoE max of class 4
- Bluetooth Low Energy (BLE) 5.0
- Visual indicators, reset button
- Mounting bracket
- 5 year subscription license

WIFI SYSTEM NETWORK MANAGEMENT SYSTEM

The WiFi System shall be managed by an administration workstation or Network Management System (NMS) and shall be responsible for the configuration, monitoring, diagnostics and troubleshooting of the WiFi system. This NMS shall be a combined terminal and software with the LAN System as both systems shall be of the same manufacturer for a seamless integration.

The NMS shall be a cloud-based networking tool that shall provide a unified management of the wired and wireless networks and devices.

The NMS shall be powered by the AI technology to provide insights for faster deployments, monitoring, network optimization and troubleshooting. It shall have a dashboard providing quick insights and analytics of the network and client health, application visibility, where the IT personnel may analyze and improve the wired and wireless networks. Troubleshooting shall include live events, packet capture, logs, etc.

This NMS shall employ AI-powered optimization for the WiFi network by delivering SLA-grade QoS, improving wireless capacity and coverages, optimize client connectivity and enable seamless handoffs. It shall have AI and machine learning capabilities to analyze RF data to derive configuration changes for the access points.

The NMS shall have setup wizards, templates, step-by-step workflows, flexible configurations, upgrades and zero touch provisioning. It shall also provide the necessary reports and upgrades needed by the switches and access points.

The NMS shall provide security features such as (but not limited to), Role-based policies, Cloud authentication and policy, Secure wireless segmentation, Intrusion detection, Web content filtering, Integrated policy enforcement firewall, etc.

The NMS shall also come with the necessary foundation and subscription licenses for all the access points.

WIFI HEATMAP REPORT

The awarded supplier shall develop a WiFi Heatmap Report before any implementation on the WiFi System. This report shall detail the new PTB's coverage area with the locations of the access points, expected transmit powers, area's signal strengths received, access points' antenna patterns, interferences, etc.

The awarded supplier shall prepare two (2) WiFi Heatmap Reports - Predictive WiFi survey before the implementation and a Post-deployment WiFi survey. These Heatmap Report surveys will help the END-USER confirm the actual output against the designed values, wherein adjustments may be made, depending on the results.

The expected and final Received Signal Strength Indicator (RSSI) value should at least be -70dBm across the designated coverage area.

INTERFACING AND INTEGRATION

The WIFI System shall have features and functions built into it to integrate and interface with the subsequent systems.

The awarded supplier shall design, engineer, supply, install and implement all the modifications (both hardware and software) required in the system for the purpose of integrating with other systems.

LAN SYSTEM

The WIFI System shall be interfaced with the LAN System to provide the network and logical infrastructure of the access points and the ISP. The Firewall, Core and Access Switches shall be under the LAN System. Moreover, the NMS shall be a unified cloud-based software for both LAN and WiFi Systems.

MASTER CLOCK SYSTEM

The WIFI System shall be interfaced with the Network Time Protocol (NTP) Server for its time synchronization over ethernet. The NTP shall be under the scope of the Master Clock System.

STRUCTURED CABLING SYSTEM

The WIFI System shall use the Structured Cabling System (SCS) as its physical connection or infrastructure for the access points. The SCS shall use CAT6 UTP cables for this purpose with Information Outlets (IO).

SERIES 7000- TELECOMMUNICATION WORKS

SECTION 7200-12 – UNINTERRUPTIBLE POWER SUPPLY (UPS)

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ABBREVIATION

CCTV	Close Circuit Television
dB	Decibel
KVA	Kilo Volt-Ampere
LAN	Local Area Network
LD	Layout Diagram
L-N-G	Line Neutral, Ground
PTB	Passenger Terminal Building
RAM	Random Access Memory
SCS	Structured Cabling System
SD	Schematic Diagram or Secure Digital
SNMP	Simple Network Management Protocol
TDS	Technical Design Specifications
THHN	Thermoplastic, Heat- and water-resistant wire Nylon coated
THHW	Thermoplastic, Heat- and water-resistant wire
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus
UTP	Unshielded Twisted Pair

A. Description

The Technical Design Specifications (TDS) document provides the requirements and specifications of the UPS System and its components, peripherals, accessories, ancillaries, field devices and associated items for the UPS System. These shall be engineered, manufactured, supplied, installed, tested and commissioned for this PROJECT.

This document must be read in conjunction with:

a. Telecom System-General Design Requirements

b. UPS System – Bill of Materials

c. UPS System – Schematic Diagram

d.UPS System – Equipment Layout Diagram

The scope of supply shall include, but not limited to the following:

- 20kVA UPS
- 2kVA UPS
- 1KVA UPS
- By-Pass Panel
- Distribution Panel
- Power and ground cables
- Peripherals, accessories, cables, ancillaries, and other related works and supplies necessary to complete the installation of the UPS system.

The 20kVA and its associated peripherals shall be installed in the G/F Telecom Room of the new Passenger Terminal Building (PTB). The 2kVA shall be installed at 2/F Command and Control room for the CCTV video wall and workstation. The 1200VA shall be installed at G/F Immigration office for the CCTV monitoring.

GENERAL DESIGN REQUIREMENT

The UPS System shall be designed based on the minimum requirements and specifications of the PROJECT.

A new UPS System shall be provided in specified areas under the scope described herein, for the purpose of backup power in case of power failure with a minimum of 10mins backup time. It is given that the new PTB have a standby power using a common generator set capable to provide a stable power 24x7.

The UPS System shall operate with a wide input power range from 120 to 276 VAC and operating frequency from 45 to 66Hz.

The By-Pass panel is an external maintenance switch that shall be manually operated to transfer the loads to the mains electricity supply when an internal fault or failure of the UPS system. Where in such cases shall it require a shutdown due to replacement of the unit or major maintenance such as parts replacement. However, the UPS itself shall have an internal by-pass switch which will be enabled during battery replacement and minor maintenance such as regular testing and cleaning procedures.

An external maintenance bypass switch enables a UPS system to be electrically isolated – taken out of the critical power circuit – for safe UPS maintenance, service work, or unit replacement without any disruption to the load.

The external maintenance bypass will use a manual switching method to transfer the load between UPS output and the mains power supply. This can comprise of a single transfer switch (three pole).

External maintenance bypass should not be confused with the internal maintenance bypass built into UPS, which only allows for safe maintenance work in isolated parts of the UPS – there may still be other "live" parts such as the busbar connections.

In addition, external maintenance bypass should not be mistaken for the static bypass switch in online UPS, which is a safety function in case of fault or failure with the uninterruptible power supply itself. Note that some external maintenance bypasses do incorporate an automatic transfer function which acts in the same way as a static bypass within a UPS.

A circuit breaker panel with a minimum of 8-gang breaker panel shall be provided to protect each telecom cabinet and prevent tripping for an array of loads. The circuit breaker ratings shall depend on the power calculation report for each telecom cabinet. The input power of the circuit breaker panel shall be from the UPS then output to each telecom cabinet.

TECHNICAL DESIGN CRITERIA

A new UPS System shall consist of a 20kVA UPS, a By-pass panel, and a Distribution breaker panel at the Telecom room. A 2kVA UPS to be provide for the CCTV video wall display and workstation. A 1KVA for the CCTV workstation at Immigration room.

Ground bus bar shall be provided to help protect all the telecom equipments within the cabinets from unwanted static and electrical shocks of high voltage.

SYSTEM ARCHITECTURE

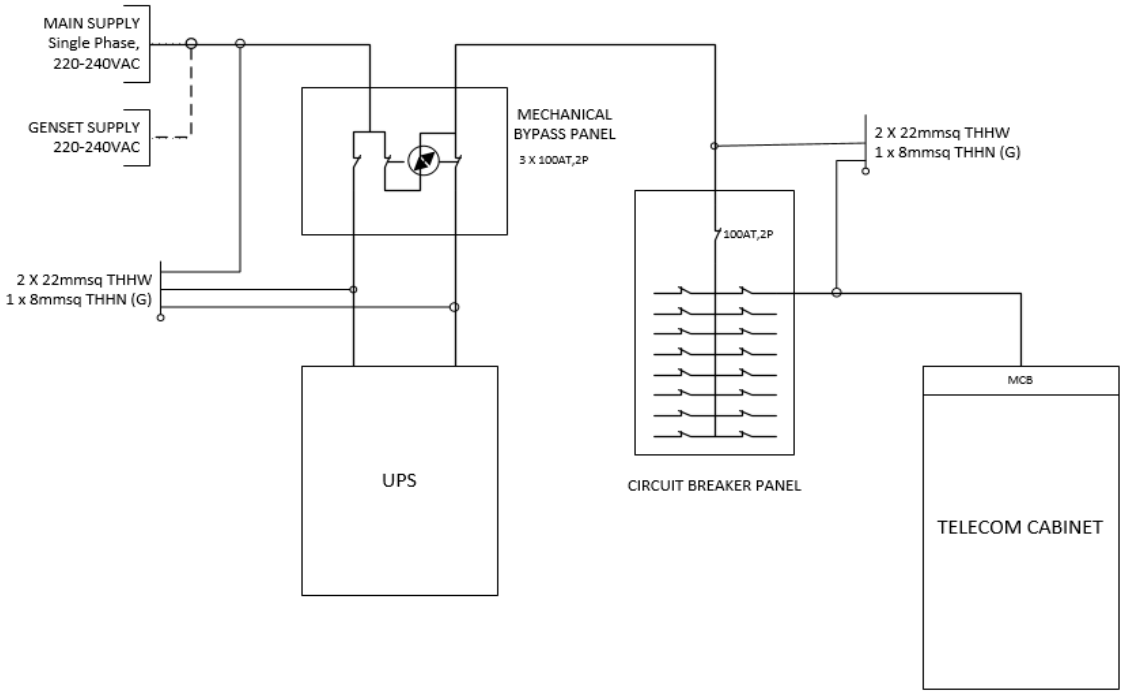

Figure 12: UPS System Architecture

The new UPS System at the Telecom room shall be the main power source for all the telecom cabinets and workstations.

The UPS bypass switch is an addition to an uninterruptible power supply system that, while not integral to UPS operation, is definitely useful in the event of maintenance or repair. If a fault occurs or a removal of a particular unit is required, this bypass switch ensures power continuity is maintained.

A separate UPS will be provided at Command and Control room and Immigration office for the purpose of connecting the video wall display and workstations respectively.

The UPS ratings mentioned, including circuit breaker ratings, bypass panels and cable core quantity and sizes, shall be confirmed during the implementation once all cabinet and field equipment have been firmed up from each of the telecom systems included in this project. Vendor shall size these up based on the power calculation report per telecom cabinet.

20kVA UPS

The 20kVA/18000W UPS shall have the following specifications:

INPUT

- Single Phase, 110-275VAC
- Frequency Range, 54Hz-66Hz
- Wiring, Single Phase with Ground (L-N-G)
- Current Distortion, <5% @Full load

OUTPUT

- Output Power factor, 0.9
- Nominal Output Voltage selection, 200/208/220/230/240 VAC
- Voltage Regulation, ± 1%
- Frequency Range (Battery Mode), 50/60 ± 0.05 Hz
- Current Crest Ratio, 3:1
- Voltage Distortion (THDv), <2% @Linear Load, <5% @Non-Linear Load
- Output Waveform, Pure Sine Wave

EFFICIENCY

- Inverter mode, >93%
- Battery mode, >93%
- ECO mode, >97%

BATTERY

- Battery type, 12V/9Ah (24x2 units)
- Rated battery voltage, 288 VDC
- Backup time (@Full load), 10 minutes
  @75% load, 15 mins

  @50% load, 25 mins
- Recharge time (to 90%), 5hours
- Charging current, 4A

TRANSFER TIME

- Battery mode to Inverter mode, 0ms
- Inverter mode to Bypass mode, 0ms
- ECO mode to Battery mode, <10ms

OTHERS

- SNMP card for monitoring
- With audible alarms
- Noise level, <55db @1meter
- Interfaces, RS232/USB
- With emergency power off

2kVA UPS

The 2kVA/1800W UPS shall have the following specifications:

INPUT

- Single Phase, 120-276VAC
- Frequency Range, 54Hz-66Hz
- Wiring, Single Phase with Ground (L-N-G)
- Current Distortion, <5% @Full load

OUTPUT

- Output Power factor, 0.9
- Nominal Output Voltage selection, 208/220/230/240 VAC
- Voltage Regulation, ± 1%
- Frequency Range (Battery Mode), 50/60 ± 0.2 Hz
- Current Crest Ratio, 3:1
- Voltage Distortion (THDv), <2% @Linear Load, <5% @Non-Linear Load
- Output Waveform, Pure Sine Wave

EFFICIENCY

- Inverter mode, 89%
- Battery mode, 84%
- ECO mode, 95%

BATTERY

- Battery type, 12V/9Ah x 4
- Rated battery voltage, 48 VDC
- Backup time (@Full load), 10 minutes
  @75% load, 15 mins

  @50% load, 20 mins
- Recharge time (to 90%), 3 hours
- Charging current, 1.5A

TRANSFER TIME

- Battery mode to Inverter mode, 0ms
- Inverter mode to Bypass mode, 4ms
- ECO mode to Battery mode, <10ms

OTHERS

- With audible alarms
- Noise level, <45db @1meter
- Interfaces, RS232/USB
- With emergency power off

Note: Awarded supplier shall provide an electrical power strip on the UPS output

1KVA UPS

The 1KVA/900W UPS shall have the following specifications:

INPUT

- Single Phase, 120-276VAC
- Frequency Range, 54Hz-66Hz
- Wiring, Single Phase with Ground (L-N-G)
- Current Distortion, <5% @Full load

OUTPUT

- Output Power factor, 0.9
- Nominal Output Voltage selection, 208/220/230/240 VAC
- Voltage Regulation, ± 1%
- Frequency Range (Battery Mode), 50/60 ± 0.2 Hz
- Current Crest Ratio, 3:1
- Voltage Distortion (THDv), <2% @Linear Load, <5% @Non-Linear Load
- Output Waveform, Pure Sine Wave

EFFICIENCY

- Inverter mode, 88%
- Battery mode, 83%
- ECO mode, 95%

BATTERY

- Battery type, 12V/7Ah x 3
- Rated battery voltage, 36 VDC
- Backup time (@450W), 16 minutes
- Recharge time (to 90%), 3 hours
- Charging current, 1.5A

TRANSFER TIME

- Battery mode to Inverter mode, 0ms
- Inverter mode to Bypass mode, 4ms
- ECO mode to Battery mode, <10ms

OTHERS

- With audible alarms
- Noise level, <45db @1meter
- Interfaces, RS232/USB
- With emergency power off

Note: Vendor shall provide an electrical power strip on the UPS output

BYPASS SWITCH PANEL

The Bypass switch panel shall have the following specifications:

- Wall-mounted panel
- Capacity, 10-20 Kva
- Efficiency at full load, 99%
- Input nominal voltage, 380/400/415V 4W + GND
- Output nominal voltage, 380/400/415V 4W + GND
- Input Frequency, 50/60 Hz
- Operating temperature, 0-40 degC
- System output/ UPS output cable, 22mm²
- System input/UPS input cable, 22mm²
- Standards: CE, EN 50091-2, EN/IEC 62040-1-1, EN/IEC 62040-3

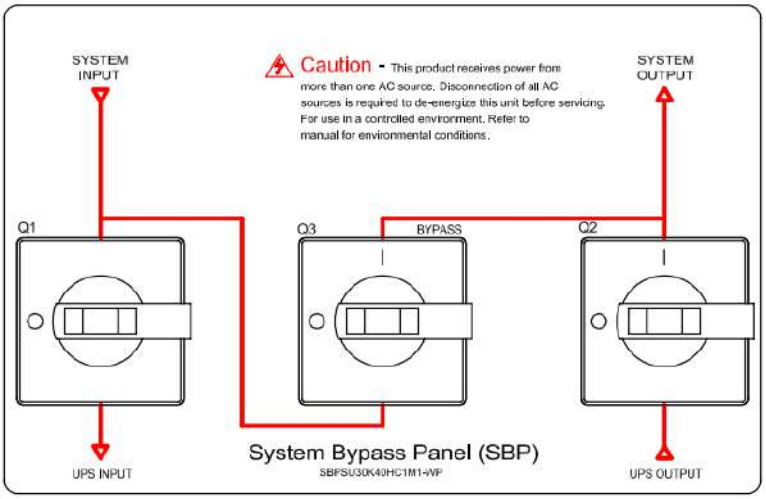

Figure 13: Typical Bypass Switch Panel

CIRCUIT BREAKER PANEL

The Circuit Breaker panel shall have the following specifications:

- Wall-mounted steel panel
- Main breaker capacity: 100A
- Standard circuit breakers: 10/20/30/40 A (screw type)
- 2-Pole shall use copper busbars only
- Minimum of 8-gang holes or branches fitted for a standard circuit breaker.

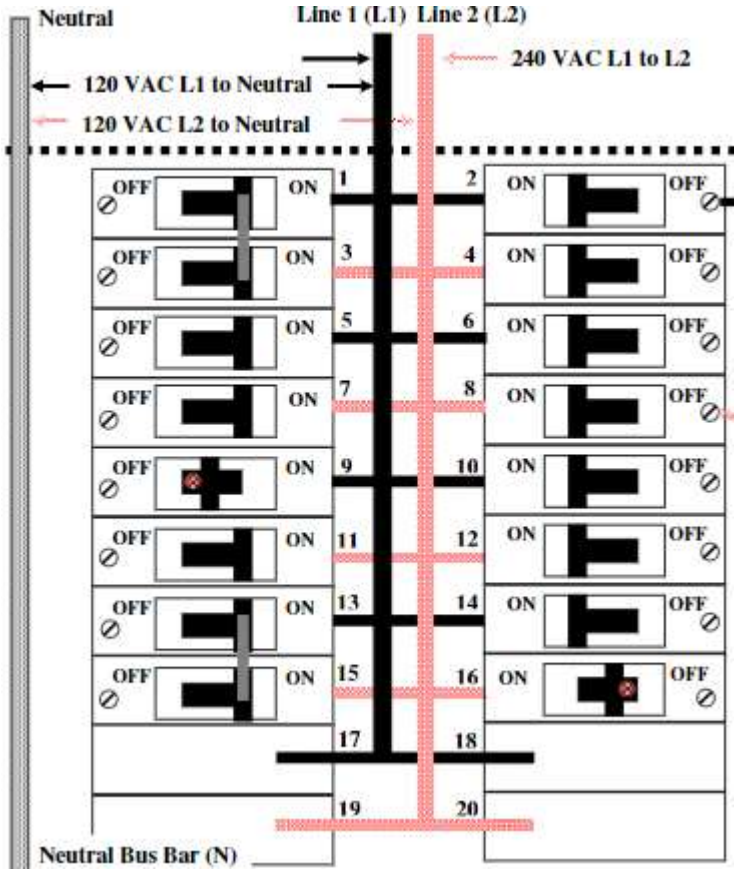

Figure 14: Typical Circuit Breaker Panel

UPS OPERATIONS

When power failures such as power outages occur, computer devices such as servers and workstations may break down, leading to various problems such as the loss of important data and program malfunction. Moreover, even a momentary voltage drop, can result in system stoppages, defective products, and in the worst-case scenario, damage to equipment. These issues can be avoided by having a UPS in the telecom systems, and the like and it is also possible to operate systems with stability and efficiency using the various functions of the UPS. The following are the main applications during the operation of the UPS.

- Backup in the case of power outages/ momentary voltage drops.
- Power source management – commercial power is the primary source of power and during such outage a given time is given to start the generator set. The UPS shall be automatically use its stored battery power (within 10 minutes) enough to run the generator and get back to its normal mode.
- Online UPS – supplying power by converting AC input (utility power) to DC and reconverting it to stable AC by the inverter while constantly charging the batteries. Supplies power without momentary power breaks in the event of a power outage.
- The UPS shall operate continuously 24 hours a day, 7 days a week.

LOAD CALCULATION

The awarded supplier shall calculate the required power load capacity to accommodate all the equipments in the telecom room. This shall be broken down per telecom cabinet and per location. This calculation shall help the VENDOR determine if the UPS System is able to handle the load including that of other systems that shall use the UPS System. This shall include the (2) UPS in the G/F Immigration office for a CCTV workstation and Command & Control room for the CCTV video wall.

WIRINGS

For 20kVA UPS, Bypass panel and Circuit breaker panel

- For L and N – 2C x 22mm2 THHW wire
- For Ground cable – 1C x 8.0mm2 THHN wire

For 2kVA and 1200VA UPS

- 3C x #18AWG royal cord wire

Terminal lugs shall be use to terminate the wirings.

UPS MONITORING

The UPS shall have a capability for management and monitoring using a SNMP card in the UPS. The software that comes with it shall monitor, manage and protect the UPS through a standard Web page.

CONSTRUCTION OF EXPANSION OF PASSENGER TERMINAL BUILDING OF DAVAO INTERNATIONAL AIRPORT DEVELOPMENT PROJECT

BID DOCUMENT SECTION –VI SPECIFICATIONS

SPECIAL EQUIPMENT SERIES 8000

TECHNICAL SPECIFICATIONS FOR SPECIAL EQUIPMENT

SERIES 8000

SERIES 1000 – GENERAL REQUIREMENTS AND CIVIL WORKS

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SERIES 8000- SPECIAL EQUIPMENT

ELEVATORS

1.0 SCOPE OF WORKS

The work to be executed by the Contractor under this Sub-Section shall include the following: -

(a) Supply and installation including electrical, mechanical and civil works to complete the project expansion of Davao International Airport Passenger terminal Building

(b) Provision of spare parts

(c) Testing and commissioning

(d) Training

2.0 ELEVATOR SCHEDULE

2.1 General Feature

(a) Provide technical data for 3 elevators (2-Passenger Elevator and 1- Service Elevator) With a capacity of 21 persons.

2.2 Car Enclosures (for approval of the Engineer or Architect of DIA)

2.3 Car Operating Panel (for approval of the Engineer or Architect of DIA)

Shall include the following:

- Floor call buttons
- Panel direction indicators
- Floor indicator panel
- Door open/hold button
- Door close button
- Interphone
- Emergency stop switch
- Alarm bell button
- Ceiling light switch
- Fan switch
- Overload buzzer
- Identification plate; clearly stating:

- Type of service
- Maximum number of persons permitted
- Maximum load permitted

3.0 WORK REQUIREMENTS

3.1 General

(1) Requirements herein describe equipment, accessories and operations in general terms only. The Contractor shall be responsible for all design and fabrication details necessary to provide work and operations as intended under and required by this Specification.

(2) Requirements herein shall be applicable to all elevators required. Exceptions shall be only as particularly specified or scheduled for an individual elevator.

(3) Each elevator system shall be complete unto itself and independent from other elevators, except respective to emergency power operations as specified.

(4) Operating characteristics, physical features, finishes and other requirements shall be as scheduled herein.

ESCALATORS

1.0 SCOPE OF WORKS

The work to be executed by the Contractor under this Sub-Section shall include the following: -

(a) Supply and installation including electrical, mechanical and civil works to complete the project expansion of Davao International Airport Passenger terminal Building

(b) Provision of spare parts

(c) Testing and commissioning

(d) Training

2.0 ESCALATOR SCHEDULE

2.1 General Feature

(a) Provide technical data for 4 units of escalator with a capacity of 600 perons/hr

(a) Design, manufacture, supply and installation of electric escalators in Passenger Terminal Building and all ancillary equipment required for installation.

(b) Provision of spare parts

(c) Testing and commissioning

(d) Training

3.0 WORK REQUIREMENTS

3.1 General

(1) The requirements herein describe equipment, accessories and operations in general terms only. The Contractor shall be responsible for all design and fabrication details necessary to provide work and operations as intended under and required by this Specification.

(2) Escalator system: essentially self-contained and comprising necessary truss, tracks, step drive units, steps, step chains, comb, comb plates, handrails, driving machine controller, safety devices and balustrades.

(3) Escalator type: inclined, cleat step, reversible; capable of operating under full load conditions for either ascending or descending passenger service.

3.2 Performance Requirement

(1) System capable of and providing step travel along horizontal or incline slope within plus or minus 5 percent of rated speed.

(2) Speed uniform under varying load conditions and free from readily noticeable intermediate variations in speed.

3.3 Operational Requirement

(1) Shall be selectable; shall operate and stop automatically by means of a sensor that detects passenger or manually by person;

(2) System shall be quiet, smooth, even and free from jerking, lurching, chattering or other disturbing or easily detectable variations or readily noticeable changes.

(3) Moving handrails shall be well synchronized with moving steps; with minimum of speed differential between the two.

(4) Step movements shall be quiet and free from squeaks, rattles, clattering or other objectionable sounds along entire course of travel, including both when exposed and concealed.

(5) System motor and drive unit shall be quiet, virtually unnoticeable and free from any groaning or whining sounds under any of various loading conditions from full to empty.

3.4 Structural Requirements

(1) All elements of escalator shall be designed and engineered for proper support and rigidity under all dead and live load conditions, including seismic.

(2) Factors of safety: conforming to JIS or equivalent.

(3) Escalator and components shall be securely and adequately anchored within itself and/or to structure; designed to safely resist seismic acceleration not less than 0.2 G.

(4) Engineering designs and calculations to be prepared and signed by licensed structural engineer retained by the Contractor, and submitted for Engineer's inspection and approval, prior to fabrication and manufacture of the escalators.

BAGGAGE HANDLING SYSTEM

1.0 SCOPE OF WORKS

The work to be executed by the Contractor under this Sub-Section shall include the following: -

(a) Supply and installation including electrical, mechanical and civil works to complete the project expansion of Davao International Airport Passenger terminal Building

(b) Provision of spare parts

(c) Testing and commissioning

(d) Training

2.0 BAGGAGE HANDLING SYSTEM

2.1 General Feature

- Provide technical data as per drawings provided. A sample brochure is provided for reference only, however, final specifications shall be approved by the Architect or Engineer of DIA

- The pallet loop conveyor features a recirculating loop of crescent shaped pallets inked together, providing an endless, articulating conveyor surface which can be configured to many shapes. This unit is suitable for baggage claim and baggage make-up functions in airports of all sizes.
- Normally operating speed of 90 feet per minute, and capable of traveling clockwise or counter-clockwise, the device can be either manually or automatically loaded.
- Manufactured with durable materials, finished to the highest standards, and complimented with leading-edge mechanical and electrical components, this robust and reliable design meets or exceeds all industry standards.

-

- GENERAL
- The conveying surface is comprised of individual crescent shaped pallets that are mechanically fastened to an underlying series of carriages. Any number of carriages can be linked together to provide an endless set of linkages, completing a continuous conveying loop.
- Each carriage and pallet assembly is supported by two parallel, load-carrying wheel raceways. Populated with wheels every 4" (102mm), the result is a minimum of ten wheels supporting the pallet and its load at any point along the conveyor's length. The large number of support wheels provides superior load bearing capabilities, reduced friction, and smooth, quiet operation.
- The bearing and guide wheels are constructed using a high-density plastic tire molded onto a precision, sealed-for-life ball bearing.
- PALLETS
- Each pallet contains a structural steel core that is accurately molded and suspended in black polyurethane, resulting in a consistent skin depth of 0.075" (2mm) that is finished flat and true.
- The quality-controlled pallets meet and exceed the dynamic and static loads specified for pallet loop conveyors, supporting a dead weight of 250 pounds (113.4 kg) and a live load of 70 pounds per foot (104.16 kg/m), while experiencing no undue deflection or damage.
- The overall pallet design results in superior strength and provides the wear and abrasion resistance to withstand both known and anticipated wear and tear in modern airport terminals.

- Pallets are typically manufactured with a ¼" (6mm) steel core with an overall nominal thickness, of ⅜" (10mm), after the moulding process. A 5/16" (8mm) steel core is also available.
- CARRIAGES
- Carriages are fabricated from mild steel, machined to the designed 19½" (495mm) pitch-length, then fitted with a self-aligning joint. A pair of drive-lugs, located on the underside and offset to one side, positively engages the drive chain. An electrogalvanized coating is applied to the finished carriage for lasting protection.
- Each carriage is fashioned with a center guide wheel assembly which leads each pallet / carriage assembly along and around the pre-formed track way.
- FRAMEWORK
- The pallet loop framework, assembled in 10'-0" (3048mm) long straight and 90° curve modules, is manufactured from formed and structural steel sections. The center guide rails and bed rails form a continuous, fully supported frame structure. The formed unit is mounted above the floor, and supported and levelled on robust screw adjustable legs.
- CONVEYOR TRIM / FINISHING
- Pallet loops utilized for baggage claim functions are finished with 12-gauge stainless steel (type 304, # 4 brush finish) in public areas, and in areas unseen by the public, 12 gauge galvanized mild steel is used.
- Pallet loops utilized for baggage make-up, are finished in galvanized mild steel.
- An optional guard rail provides protection from baggage carts and tugs potentially causing undue damage to the device. These can be placed at strategic locations or can be fully encompassing.
- Typically, baggage is prevented from spilling into the center of the pallet loop by providing a formed, 7¼" (184mm) tall, up-stand trim panel, usually forming part of an optional center infill.
- CENTER INFILL
- Pallet loops, intended for baggage claim functions, typically require the open center area to be enclosed and finished. This is accomplished by installing fire-rated, plywood decking material level with the top of the inner up-stand paneling, supported by a metal framework, and finished with decorative covering.
- When a drive unit is installed in a public area, an access hatch is required over the motor / gearbox unit to allow for regular maintenance.
- DRIVE
- The pallet loop drive module incorporates the proven caterpillar drive principal, where an endless chain meshes with and drives against lugs affixed to the underside of the carriages. No less than two carriages are positively engaged at any time, resulting in a direct mechanical link between the gear motor and the conveying surface.
- Powered by a direct drive motor / gearbox, assembly selected for reliability, low noise characteristics and ease of maintenance, the unit is complimented by a variable frequency drive (VFD). This combination provides the speed reduction required and an electronic soft start / stop function, allowing for smooth acceleration and deceleration, with minimal shock loading.
- As an added benefit, the unit can be adjusted down to 1-2 fpm (0.005-0.010 mps) for inspection and maintenance.

- The gear motor and wall mounted control cabinet are typically located on the nonpublic side of operations to accommodate regular access and maintenance. Other drive methods are available, but this is the proven and preferred method.
- The baggage handling system is typically controlled by a Programmable Logic Controller (PLC) or a PC based control system. The type of controller can be selected based on customer specification, as well as present and future requirements. The control system is typically located in an approved electrical panel which is positioned in close proximity to the system that is being controlled. As an alternate arrangement, the controller could be located in a room designated specifically for controls. In either situation, all wiring to and from the controller is always carefully marked with an identifier, correlated to the supplied working drawings.
- Operator interface control stations are located in strategic positions along the route of the conveyor, containing the essential operating controls for the system. Duplicate controls can be located at the system control panel either by mounting parallel buttons or by providing a Man Machine Interface panel (MMI) directly on the panel door. Parallel buttons provide a simple, cost effective solution, whereas the MMI terminal provides both direct control over the system and real time status of both the system and its subcomponents.

AIRPORT SECURITY & SAFETY SYSTEM

1.1 X-RAY LUGGAGE SCANNER

X ray Luggage Machine Scanner with 610 x 420mm tunnel size (BLADE6040)
BLADE6040 is an x-ray baggage inspection which has a tunnel size of 610mm by 420mm and can provide the effective inspection of mail, hand-held baggage, luggage and other items. It allows identification of weapons, liquids, explosives, drugs, knives, fire guns, bombs, toxic substances, flammable substances, ammunition, and dangerous objects.
High-image quality in combination with automatic identification of suspicious objects allows the operator to quickly and effectively evaluate any luggage content.

- Real-time detection to aid operators in identifying suspicious baggage/parcels
- High Performance – typical penetration up to 40mm of Steel
- Startup with fingerprint
- Four Layers of lead curtain
- Uninterruptible power supply
- Equipped with input & output rollers
- Adjustable conveyor speed
- Real-Time remote monitoring system
- Luggage image and walkthrough metal detector status display on the same screen
- Threat Image Projection (TIP)

1.2 WALK THRU METAL DETECTOR

33-Zone Walkthrough Metal Detector (ZK-D4330)
ZK-D4330 adapts beams structure, modular design, and hidden wiring design. This design not only is more convenient for installation, maintenance and logistics, but also enables higher security level.

ZKTeco Walkthrough metal detector (ZK-D4330) can count statistics of alarms and people, program self-diagnostic, has 300 adjustable sensitivity levels, excellent anti-interference, fireproof material, harmless to human body and a remote control.

It has a stainless metal bracket with adjustable viewing angles provides better viewing angle and avoids light reflection. In addition, the brightness of the back-light can be adjusted by the program to make the interface clearer.

It can be used at exhibition center, bank, government offices, prison, electronic factory, hotel.
33-Zones Standard Walkthrough Metal Detector
33 detection zones
7" LCD Screen display interface
Remote Control
Simple installation use
Excellent anti-interference ability and stability
Each zone has 300 adjustable sensitivity level

1.3 ACCESS CONTROL SYSTEM TRIPOD GATE

Tripod Turnstile System (TS2000 Pro Series)
The TS2000 series offer a well-designed, two-legged casework made of stainless steel, ideal for sites where a high traffic and robustness are issued.

By receiving a signal from the access control system, or pushing button, it allows the entry of one person in a time. Entering into different directions are electronically controlled. Default mode is to lock the mechanism until a valid authorization signal is received. If you want to set one side free, you can adjust the mechanism. In case of emergency, the horizontal arm will drop to allow free passage. Led way mode indicators are included as standard.

Reliability

• Alloy steel tripod hub prevents mechanical wear
• Casework and tripod arms manufactured in stainless steel
• Electromagnets for lock are used only when being activated. They are in standby mode when the device is idle.
• ZK patented compact mechanism ensures the long life of the lubricating oil inside.
• High quality electrical components

Safety and User-Orientated Design
• Drop arm designed for emergency purpose
• No exposed screws, safer for the user.
• Smooth operation designed for mass transit application
• The pictogram on the device indicating access permission and direction of movement
• Special designed case shape, user-friendly for passenger to punch card or finger.
• Anti-tailgate

Easy Integration
• Flexible reader installation plate. Customers can easily integrate with third party reader
• Standard electrical interface for third party device.
• Using compact mechanism, the turnstile has more space inside for integration
• ZKTeco provides integration service in factory, with board and peripherals installed, ensuring compliance of the system. When the turnstile is delivered, just plug it in and do the setting. Save the cost of installation.
• The design of being vacuum at the bottom part of the device, enables easy installation for other hardwares.

1.4 SELF SERVICE CHECK IN SYSTEM (TOUCH SCREEN)

The V3 is an ultra slim, high-throughout kiosk platform for express self check-in, self-tagging and airside passenger transit services. Available in an array of purpose driven configurations, the V3 can perform core self service activities, ancillary purchases or be utilized as a high-capacity boarding pass and bag tag print station partnered with web and mobile check-in. Available with biometric options, the V3 is truly next-generation, ready to deliver in the terminal of today and tomorrow.

> ULTRA SLIM FOOTPRINT
> 18.5IN FLOATING TOUCHSCREEN
> DUAL PRINTERS (BP/BTP)
> SECURE KEY-LOCK ACCESS
> FULL PAGE PASSPORT READER
> CREDIT CARD READER
> HIGH PERFORMANCE, 24/7 PC
> 1D/2D BARCODE SCANNER
> NFC/RFID READER
> BIOMETRICS (FACIAL, IRIS, FINGERPRINT)
> WEIGH SCALE INTEGRATION
> ACCESSIBILITY (ADA/DOT) OPTIONS