

# **TERMS OF REFERENCE**

FOR THE

SUPPLY AND INSTALLATION OF ELECTRICAL AND MECHANICAL OF HVAC AND GENERATOR SET OF THE PHILIPPINE SCIENCE HERITAGE CENTER (PHASE 2)

## **I. PROJECT INFORMATION**

The Philippine Science Heritage Center (PSHC) is a prime government center established in 1998 to honor Filipino Scientists and their contribution to the world of science. Republic Act 9107, or the Philippine Science Heritage Center Act was enacted in 2001, mandated the National Academy of Science and Technology to manage, operate and maintain the Center. RA 9107 identified five functions of the PSHC, namely:

- Document the works, ideas, inventions and products of Filipino Scientist and other accomplishments in the field of science and technology.
- Establish a display area for samples of inventions, scientific products, memorabilia, references and library materials;
- Produce printed materials to be used by the academe in teaching values education with scientific insights, and which may be used as an alternative source of information for the generic public;
- Serve as core network of science museums in the Philippines; and
- Perform such as maybe necessary for the effective implementation of the Act.

## **II. OBJECTIVES**

The objective of this project is to provide optimum environment to preserve and maintain the costly equipment and exhibits. 2) To provide thermal comfort and acceptable indoor air quality for the visitors. 3) Promoting green technology using energy efficient of HVAC (Heating, Ventilating and Air Conditioning). 4) To provide back-up power to protect the equipment from power surcharge.

### **III. SCOPE OF Work**

#### **PART 1. - GENERAL**

A. General Requirements: General Conditions set forth shall form part of the Contract for Construction.

B. Scope: Government approvals, Consultant approvals, certified construction drawings, labor, materials, appliances, tools, equipment, facilities, transportation, fees, and services necessary for, and incidental to, performing all operations in connection with demolition, furnishing, delivering, and installation labor necessary and incidental for a complete Ventilation and Air Conditioning System in accordance with previously submitted proposal, as approved by Owner.

C. All of the following items are included in the scope of work.

1. Mechanical Design for Ventilation Systems and Air Conditioning Systems
2. Supply & installation of Variable Refrigerant Flow (VRF) Air Conditioning System
3. Supply & installation of Condensate Drain System
4. Furnish all rigging, cranes, etc. required.
5. Provide cutting, patching, painting, etc., for all areas affected by the scope of this contract, including wall penetrations air supply and exhaust louvers.
6. Furnish all necessary electrical connections.
7. Provide all required sub trades necessary to complete the Mechanical Works for a complete project.
8. Provide submittals, shop drawings, etc., for Owner's review.
9. Obtain all Permits from regulatory agencies having jurisdiction.
10. Provide testing & balancing: Upon completion of the work, provide complete testing and balancing of the entire air supply and return system, as specified herein.
11. Start-up, O&M Training, and assistance to the Owner's Representative as required.

D. The design and installation of all equipment under the scope of this contract shall be in strict conformance with the Mechanical Code, National Building Code, Local Ordinances, ASHRAE, and any/all jurisdictions and/or regulatory agencies having authority. Mechanical Contractor shall be responsible for obtaining all required Mechanical Permit and other statutory requirements.

E. Piping, ductwork, and equipment shall be located in a manner avoiding obstructions, interference between trades, preserving headroom, keeping openings, passageways and common areas clear at all times. Stored material, tools or equipment that in the sole discretion of the Owner presents a hazard to members, employees or tenants or impedes egress or exiting shall be removed and relocated at contractor's expense.

F. Capacity:

1. Prior to ordering equipment, Contractor shall calculate the building heating and cooling loads, based upon governing codes & standards, and shall provide evidence to the Owner that the specific equipment Contractor proposes to install is of suitable size and capacity for the intended use.

2. The load calculations shall reflect the actual building lighting, construction, and occupancy conditions. System shall maintain 25 deg. Celsius indoor temperature in summer.

G. Submittals: Submittals shall be furnished within fourteen (14) calendar days after contract award. The following information is required in the submittal package from the Contractor:

1. The Ventilation and Air Conditioning equipment, duct and piping layouts, indicating location of all valves, flanges, and measuring devices.

2. Manufacturer equipment cut sheets and electrical power requirements on all equipment. Contractor shall verify the electrical voltage and phase of all equipment prior to ordering of equipment.

3. Specify the location of all equipment by dimensions from column lines and show sizes and weights of all equipment, ductwork and piping requiring structural support or framing.

4. Specify the foundation and/or support requirements for mechanical equipment.

5. Drawings and calculations indicating the proposed method of providing electrical power to the proposed equipment.

H. Construction Submittals:

1. Before ordering materials, and before work is started, Contractor shall submit three identical copies of a complete list, including catalogs and other descriptive matter of the following materials and equipment intended for use on the project. Material list shall be submitted in a hard-bound 3-ring binder. Identify the specific make and model applicable to the project. Submittals shall include, but not be limited to, the following:

a. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and

connection requirements. Computer generated fan curves for the air handling unit shall be submitted with specific design operating point noted. A computer generated psychometric chart shall be submitted for each cooling coil with design points and final operating point clearly noted. Sound data for discharge, radiated and return positions shall be submitted by octave band for each unit. Calculations for required base rail heights to satisfy condensate trapping requirements of cooling coil shall be included.

b. Product Data: 1) Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, finishes of materials, electrical characteristics, and connection requirements. 2) Provide data of filter media, filter performance data, filter assembly, and filter frames. 3) Provide manufacturer's installation instructions.

2. Provide submittals for the following equipment:

- a. VRF Air Conditioning Condensing Unit (ACCU)
- b. VRF Fan Coil Unit (FCU)
- c. Insulated refrigerant pipes
- d. Insulated AC drain pipes
- e. Ductwork
- f. VRF controls
- g. Accessories, including louvers, supply / return grills, etc.
- h. Wiring Diagrams necessary for connection of equipment
- i. Vibration Isolators (if necessary)

l. Coordinate work with other trades. Contractor shall manage the coordination with other sections of the specifications or with other contractors, to order and install work in such a manner that each and every item is coordinated. No change orders for additional costs will be accepted by Owner due to lack of coordination between trades.

J. Performance: Contractor shall guarantee the building air conditioning systems to maintain 25 deg. Celsius indoor temperature in summer.

K. Noise and Vibration Control:

1. The Ventilation and Air Conditioning Systems shall be designed per ASHRAE Design Guidelines.

2. Dampers will be located so that their operation will not generate excessive noise in the occupied spaces.

L. Related Work to be included: Contractor shall include the full scope of services of other trades as required or as indicated herein, for the completion of the project Scope of Work:

1. All electrical wiring whether line or control voltage, conduit, wire, flex, starters, disconnects, etc. A complete wiring diagram will be furnished by Contractor, as are all thermostats, sub-bases and temperature control devices.
2. Low voltage wiring for temperature controls, and all other control wiring system.
3. All temperature control panels and devices.
4. Pressure switches indicating equipment run status
5. All Ventilation System and VRF Air Conditioning System will be set in place and connected.
6. Steel works for equipment supports as required.
7. Cutting, patching, coring, painting, fire caulking/sealing, roofing, and framing of openings.
8. Access man holes at ceiling.
9. Condensate drain piping, equipment drains, equipment floor drains, approved receptors, backflow preventers, and all final connections.
10. Acoustical wall lining as may be required.
11. Demolition work (as needed)
12. Work performed outside normal working hours.
13. Air Balance report, independent testing of life-safety systems, duct pressure testing, etc.

M. Installation Methodology: The installation of all materials Mechanical, Electrical and Generator Set should follow the Installation General Methodology of the Supplier including the standard of the local Philippines code & International Code.

## **PART 2. - PRODUCTS**

A. Variable Refrigerant Flow ACCU & FCU:

1. General:

a. Configuration: ACCU shall be configured in systems for optimal efficiency. Location and layout of the ACCU on the roof shall be subject to the Architect's approval. Location and layout of the FCU, refrigerant pipe and condensate drains shall be fully coordinated with the other trades for clash detection and resolution, subject to the Architect's approval.

b. Performance: cooling capacity of 16 deg. Celsius – able to maintain a 25 deg. Celsius indoor air temperature in the summer.

c. Acoustics: FCU shall be silent.

d. Install in accordance with manufacturer's Installation & Maintenance instructions.

## 2. Unit Construction

a. ACCUs & FCUs shall be fabricated according to manufacturer's specifications

b. ACCUs shall be provided with corrosion protection to guarantee against rust and corrosion for six years.

c. Drain pans shall be stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section.

## 3. Electrical

a. Electrical devices and components shall be manufacturer provided and installed.

b. Manufacturer shall provide Energy Efficiency equation details for individual equipment to assist Building Engineer for calculating and monitoring energy efficiency actual performance versus baselines.

c. Mechanical Contractor shall provide all electrical components to satisfy National Electrical Code requirements.

## B. Vibration Isolation and Noise Control:

1. All mechanical equipment will be isolated from the structure, as necessary, by means of resilient or spring vibration and noise isolators. Submit manufacturer's recommended equipment.

2. Isolation for major Mechanical Equipment shall be provided with inertia bases as required.

## C. Seismic Restraints:

1. All base mounted equipment shall be equipped with seismic snubbers. Snubbers shall be capable of withstanding a horizontal force equal to 1 G, and a vertical force equal to 0.5 G. All suspended equipment to be equipped with aircraft cable, with slack.

2. Isolation for smaller equipment and piping systems will be 1.5" deflection springs.

## D. Dampers:

1. Provide balancing volume dampers in each main supply-air duct installed within the mechanical room, under this contract, to provide for complete air balancing. Fit each manual volume damper with bearings and an adjusting device having a locking mechanism.

2. Dampers shall be stamped blade or airfoil design as scheduled.

3. Isolation Dampers: Airfoil blade with jam and blade seals.

E. Ducts, plenums, and sheet Metal Work:

1. All ductwork shall be constructed, erected and tested in accordance with local regulations and procedures detailed in the ASHRAE Handbook of Fundamentals, or the applicable standards adopted in the Philippines. Provide prefabricated spiral lock-seam ducts and fittings and rectangular ducts of galvanized steel.

2. All ductwork to be rigid galvanized steel.

3. All connections to main cold supply ducts shall be made with low loss fittings.

4. Flat duct surfaces shall be crimped diagonally regardless of size. Longitudinal joints in all duct sizes may be flat-lock joints. Transverse joints and intermediate bracing shall be constructed of galvanized sheet metal or galvanized structural angles in accordance with code requirements.

5. Transverse joints on all supply ducts shall be sealed with mastic for all medium pressure applications.

6. Longitudinal joints on low-pressure supply ducts with internal static pressure below 0.75" w.g. shall be sealed with mastic or tape. Above 0.75" w.g. use medium pressure mastic only.

7. Lock joints shall be hammered to make them airtight. Inside of duct shall present a smooth surface to air-flow.

8. Horizontal ductwork shall be supported with 1-inch, 18 gauge galvanized strap hangers in accordance with the requirements of SMACNA and public authorities having jurisdiction.

9. Plenums shall be made of 18 gauge galvanized sheet steel reinforced horizontally on a maximum of 48 inch centers by 1-1/2 x 1-1/4 x 1/8 inch galvanized angles and reinforced vertically by 1-1/2 inches standing seams.

10. Elbows and tees shall have a centerline radius of 1-1/2 times duct width. All square elbows shall be equipped with turning vanes of double thick metal, airfoil design. Holes for duct and damper rods shall be sealed airtight.

11. Pipes, conduits, structural members, or any other material may not pass through ductwork.

12. Flexible connections: Neoprene double-coated fiberglass sleeve, to provide minimum 3 inch, or 150% of clear dimension, in addition to width required, clearance between metal parts of all fan and unit connections. Outdoor flexible connections; double coated with weather-proof, UV and ozone-resistant synthetic rubber.

13. Verify approval of material with Design Consultants and/or local authorities.

14. Seal joints on the main supply air ducts with UL classified sealant. Sealant shall be specifically designed to seal high velocity and medium-pressure ductwork.

15. Supports, access doors not part of ducts, bar or angle reinforcing, damper rods, and items made of uncoated steel shall be painted with two coats of primer.

F. Controls: 1. Provide new dampers, and controls suitable to utilize 100% outside air 'economy cycle' as weather permits.

2. Proximity to chemical vapors: Provide capability to monitor outside air and restore system to minimum outside air when odor conditions exist, as directed by the Owner. System shall re-set to economy cycle after an adjustable preset time, as directed by the Owner.

G. Piping: 1. All piping in accordance with ASTM and ANSI latest Code Standards.

2. Equipment vents, relief valve discharge: Galvanized Steel, schedule 40

H. Valves and fittings: 1. General: The system shall be provided with valves so located and arranged to give complete regulating control over all systems.

a. All valves to be of the same size as the upstream pipe.

b. Valves shall be installed on both sides of all equipment and fixtures, on risers, and on all branch mains.

c. All valves to be easily accessible for maintenance and adjustment control.

d. Valves of similar service to be by same manufacturer.

2. Applications: Unless otherwise noted, the following shall apply:

a. Shutoff service; Ball or butterfly valves.

b. Throttling service: Angle, ball, butterfly or globe valves

c. Main shut-off valves at equipment: provide ¾-inch ball drain valve. Pipe to nearest drain.



3. Flow Control Valves: Automatic pressure compensating type. Valves shall be factory set and have a minimum operating pressure of 2 psi. All working parts shall be stainless steel. Provide certified performance data. Provide metal identification tags for each valve, plus one dual hose meter kit for testing, to be turned over to maintenance personnel, Griswold, Auto Flow Control or equal.

4. Automatic air vents: Cast brass body, automatic float type with brass closed float, non-corrosive seat and stem and means for preventing back leakage of air. Inlet size not less than 3/8". Install at high points of systems. Label for identification. Wheatley or equal.

5. Pressure Relief valves: ASME rated, properly sized for the system in which installed, and with discharge piping run to the nearest approved receptor.

#### 6. Pressure Gauges

a. Bourdon spring type with non-corrosive movement, cast iron case, black flange, press brass rings. Case and rings black enamel finish, minimum 2-1/2" dial with white background. Black lines and figures. Ranges as required. b. Install at inlet and discharge of air handling unit and cooling coils.

#### 7. Fittings:

a. Fitting 2-1/2 inches and larger: Butt welded steel, ANSI B16.9, same thickness as connecting pipe. Elbows shall be long radius type.

b. Fittings to 2 inches: Malleable iron ANSI B16.3, screwed type or butt welded steel with same wall thickness as connecting pipe.

c. Mechanical Couplings: May be substituted for flanges for water services not exceeding 200 degrees F, if coupling is exposed and accessible for service, but not permitted in risers. Manufacturers: Victaulic, Tyler or equal.

d. Pipe sleeves: shall be installed on all pipes passing through walls. Sleeves shall be 18 gauge galvanized steel furnished flush with wall surface. Sleeves shall have a mastic and oakum seal to prevent the entrance of moisture. Insulation shall terminate flush with each end of sleeve. Provide polished chrome-plated finish plates where pipes penetrate finished surfaces.

l. Pipe supports and hangars: Horizontal piping supported by trapeze hangars or clevis type hangars of steel or malleable iron with sockets for rods. Pipe supports for horizontal pipe shall be attached to structure with suitable bolts or lag screws. Vertical pipes shall be secured by means of steel or malleable iron clamps bolted around the pipes and secured to the adjacent building construction. No welding or drilling of the building structure permitted.

J. Metal Guards: Cover all moving parts of machinery, such as shaft couplings, belt-drives, exposed fan intakes, etc., with removable metal guards. Provide access in guard for tachometer readings. Comply with applicable safety regulations.

K. Insulation:

1. All thermal insulation shall comply with the State of California Energy Conservation Standards. All supply air ducting shall be wrapped or lined as specified herein.

2. Thermal Duct Insulation: Insulate all cold supply air ducts and plenums unless otherwise specified, with J-M Microlite fiberglass duct insulation, or equal, foil-faces, 1 lb. density, 1-1/2-inch-thick insulation wrapped entirely around duct with joints lapped at least 2 inches and secured with staple bonds. All joints to be taped and sealed. Insulation shall cover all surfaces including standing seams.

3. Piping 2 inches and smaller: 1-inch-thick insulation.

4. Piping larger than 2 inches: 1-1/2-inch-thick insulation.

5. Fittings, valves, flanges, shall be insulated with thermally equivalent thickness of fiberglass insulation, with PVC fitting covers, suitable for easy removal and re-attachment.

6. Areas of equipment which may be subject to sweating shall be insulated.

L. Acoustical and thermally lined ducts:

1. Supply and return ducts in mechanical equipment room shall be internally lined.

2. Material shall be flexible glass fiber, blanket type duct liner. Lining must be approved by local Codes and in accordance with NFPA standards. NRC rating shall be at least 0.80 at frequencies above 1000 Hz. Maximum moisture adsorption of 0.5% by volume when exposed to moisture laden air at 120 degrees F. and 96% RH. 0.24 'K' value maximum.

3. Certain-Teed, Owens Corning, Johns Manville Duct liner or equal.

**PART 3. - EXECUTION**

A. General: Examine the project area and conditions prior to commencing any work. Document and report any conditions which are different than at time of pre-bid tour. Report any conditions which would adversely impact the prosecution or completion of the installation

B. Install all equipment such that satisfactory and adequate clearance to electrical and mechanical components is maintained for service and installation. Ensure that the project will not cause overloading of building electrical system and cause of any damage on existing electrical/mechanical setup of Philippine Science Heritage Building i.e. transformers, main circuit breakers, and solar PV rooftop.

C. The Contractor has sole responsibility to implement any and all safety precautions in the hoisting and installation of materials and equipment. That any damage that may cause in the delays/stop of building operations during the executive phase will be shouldered by the contractor and shall be addressed immediately.

D. Installation of Ductwork

1. General: Piping and ductwork shall be supported and braced by SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems", and to the currently adopted CBC and California Code of Regulations.

2. Sheet metal ductwork.

a. Cross-break or kink flat surfaces to prevent vibration.

b. All supply and return air ducts lined with flexible blanket type insulation with plastic coating to air stream.

c. Internally seal with mastic at joints.

3. Connections:

a. Install and make necessary connections for the complete supply, re-circulation, and exhaust systems, including ductwork, collars, intake housings, hangers, connections, fasteners and other items required.

b. All air supply and return air ducts shall have their longitudinal and transverse seams tightly sealed to provide an air-tight system.

4. Volume dampers:

a. Provide adjustable volume dampers in all main supply ducts installed as part of this contract.

b. Locate the dampers as close as possible to the main plenum.

c. Provide remote operating device where damper is inaccessible.

5. Fire dampers and combination smoke/fire dampers:

a. Install as required by governing Code.

b. Contractor shall confirm with local Fire Marshal that all required fire dampers are installed and in compliance with Applicable Law.

E. General Ductwork Insulation

1. All ductwork, equipment and appurtenances handling air at temperatures above or below room ambient shall be insulated as generally described herein.

2. Installation shall be neat and workmanlike in appearance and quality of workmanship. Insulation shall be neatly cut at supports, etc., and beveled at inspection doors, unions, etc., and shall be first class in workmanship. Installation shall be in direct compliance with manufacturer's written and approved instructions for these particular materials.

3. Extraordinary care shall be taken during installation to eliminate or reduce dust and dirt to a minimum. Waste and debris shall be removed as it accumulates, but no less than daily.

4. Insulation shall be continuous through any wall, floor, or roof penetrations, other than at fire-rated walls and partitions.

5. At fire rated walls and partitions; install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire-damper sleeves, and externally insulate damper sleeve to match adjacent insulation and overlap duct insulation a minimum of two inches.

#### F. Piping Insulation

1. All workmanship shall reflect the best current practices in the trade. Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands, and tapes shall be smoothly and securely pasted down. Adhesives shall be applied on a full-coverage basis, unless otherwise specified.

2. Install insulation over all joints, fittings, valves, strainers, flanges and unions and other specialties with a continuous thermal and vapor barrier.

3. Insulation shall be continuous through any wall, floor, or roof penetrations.

4. All piping to be fully pressure tested and approved before insulation is applied.

5. All joints shall be tight with insulation lengths tightly butted against each other. Use preformed fitting insulation or mitered fittings of the same material and density as adjacent piping. Each piece shall be butted tightly against adjacent pipe insulation, and finished with an insulating adhesive.

6. Where lengths are cut, cuts shall be smooth, and square and without breakage of end surfaces. Where insulation terminates, ends shall be neatly tapered and effectively sealed, or finished as specified. Longitudinal seam of exposed insulation shall be directed away from normal view.

7. All materials shall be clean and free of all oil and grease before insulation adhesives or mastics are applied. Solvent cleaning required to bring metal surfaces to such condition shall be provided.

8. Piping shall be covered with a fiberglass pipe insulation with factory-attached, pre-sized, white glass cloth. Jackets, jacket laps, flaps, and bands shall be securely cemented in place with vapor barrier adhesive. Jacket overlap shall be not less than 1-1/2". Jacketing bands for butt joints shall be 3" wide.

9. Unions: Insulate in same manner as fittings, flanges and valve bodies.

10. Pipe supports shall be installed on the outside of the insulation. An insert section of foamed glass or urethane pipe insulation (1/8" long) shall be installed at all supports of piping larger than 1 1/2" diameter. Insert sections shall be provided as specified herein.

11. The jacketing shall be continuous over all surfaces, including areas inside pipe sleeves, hangers, and other concealment.

12. Jacket laps, flaps, and bands shall be securely cemented in place with aluminum jacket sealant. Jacketing bands for butt joints shall be 6" wide.

13. All exposed longitudinal edges of aluminum jacketing shall be stiffened by bending a 1" hem on one edge.

14. Expansion joint shall provide for maximum and minimum dimensional fluctuations.

15. To prevent corrosion, the aluminum jacketing shall not come in direct contact with other type of metal.

16. At each pipe hanger protect insulation with 4-inch-long, 18 gauge galvanized metal shield.

17. At all openings in jacket, an outdoor vapor barrier coating shall be applied for 2" in all directions; the jacketing shall be applied while waterproofing is tacky.

#### G. Piping Installation

1. Installation shall be the best standard practice of the trade. Inspect all piping prior to installation. Coupled short sections of piping, bushings, close nipples, long screws, bullhead tees and crosses are prohibited.

2. All piping systems shall be pitched and valved to provide complete drainage and control of all systems.

3. Install piping to allow for expansion, using offsets necessary to prevent undue strain on piping. The springing of piping into place is prohibited. Required offsets, fittings, unions, flanges, and the like shall be furnished to allow valving-off for maintenance, removal, and repair with minimal removal of piping. Provide flexibility of equipment connections and branch line takeoffs with 3 elbow swing joints.

4. All piping shall be installed in such a manner as to prevent any undue noise from the flow of water under normal use. Piping shall not come in contact with ceiling construction or partitions in a manner which would create noise or vibration in the wall or ceiling system.

5. Where incompatible materials come in contact, they shall be isolated with the material best suited for that purpose.

6. Pipe supports shall be spaced a maximum of 10'-0" on centers, and provided with lateral seismic restraints.

7. Piping and ductwork shall be supported and braced by SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems", and to the currently adopted Mechanical Code.

#### H. Painting:

1. All pipe supports shall be painted with zinc based paint where original plating has been removed due to welding, threading or scraping.

2. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangars and supports.

3. Galvanized surfaces; clean welds, bolted connections, and abraded areas and apply galvanizing repair paint.

#### I. Equipment Identification

1. Identify all equipment and each valve with numbered and labeled brass discs. Install in readily visible locations, not interfering with insulation. Minimum lettering size; ½ inch.

2. ACCU, FCU, fans, motors, etc.: laminated plastic showing identification number, HP, CFM capacity, service, static pressure, and electrical characteristics.

3. Identify all piping with laminated plastic bands, black with white engraved lettering. Locate bands at supply and discharge connections to equipment.

J. All equipment cleaned, primed and finish painted. All grease and oil spots shall be removed. Any damaged factory applied finishes shall be repainted, including preparation, prime and finish coats in accordance with manufacturer's recommendations. Any exposed surfaces subject to rust shall be wire- brushed and re painted.

#### K. Cleanup:

1. Cover all equipment and machinery to protect from dirt and water during construction. Cap all openings in ducts and pipes during construction.

2. Premises shall be kept reasonably clean and free from debris, dust, cuttings, and waste material. All debris, rubbish, leftover materials, tools and surplus equipment shall be removed from the site prior to final acceptance.

3. Prior to testing and balancing of air and water systems, clean interior of duct systems and air handling equipment, and flush and thoroughly clean inside of all piping systems back to nearest isolation valve of pipe branch.

L. Start-Up: All equipment and systems start-up will be performed by the Contractor. Coordinate with Owner.

M. Testing and Balancing:

1. Testing Organization: Qualified testing firm approved by the Owner and the Consultant shall submit proof that it meets technical standards set forth by applicable codes & standards.

2. Testing: In accordance with specified procedures in applicable codes & standards

3. Includes:

a. Balancing of air systems, supply air, return air, exhaust air, outside air and ventilation air. Air supply to each space shall be on the basis of the proportional area of the space vs. the proportional cfm of the system.

b. Testing of equipment.

c. Adjusting belt drives.

d. Test Reports

e. Retests of air systems, water systems, and sound levels subsequent to corrective construction work.

4. General Test Report Requirements:

a. Each Report: Certified by registered Professional Engineer qualified in testing, balancing, and adjusting of environmental systems.

b. Detailed Agenda: Include following narrative procedures, system diagrams and forms for test results

c. Specific standard procedures required and proposed for each system. Additional procedures for variable flow systems shall be developed by testing organization and included for review and acceptance.

d. Specified test forms for recording each testing procedure and for recording sound measurements. Additional test forms for variable flow systems shall be developed by testing organization and submitted for review and acceptance.

e. System diagrams for each air and water system. Diagrams may be single line.

5. Reports: Submit to Owner (3) copies of reports.

6. Include in report types, serial numbers and date of calibration of instruments.

7. After completion of tests, submit complete test reports for acceptance. Identify in reports each item not conforming to Contract requirements, or obvious mal-operation and design deficiencies of equipment or controls; include explanatory comments in report.

8. Mechanical Contractor: Submit final reports prior to requesting final inspection for Project.

9. Air System Test Reports:

a. Include following installation data: (1) Manufacturer and model. (2) Size. (3) Arrangement, discharge and class. (4) Motor HP, voltage, frequency, phase and full load current. (5) Location and local identification data. (6) Design data for equipment listed in schedules, Drawings and Specifications.

b. Include following recorded fan test data, both at minimum and maximum flow; fan and air handling units. (1) Air volume; actual supply air, outside air, return air and exhaust air. (2) Suction discharge static pressure for each fan. (3) Component pressure drops, coils, filters, sound attenuators, louvers, dampers, etc. (4) Fan speed, RPM (5) Economizer cycle air volume at minimum outside air and 100 percent outside air. (6) Motor operating current and voltage, on each leg if three phase. (7) Motor operating BHP. (8) Pressure profile curves through air handling unit.

c. Variable refrigerant flow: Record flow, pressure and motor load for system at full un-throttled capacity, at design (100 percent) flow and at 10 percent increments down to minimum attainable to verify fan tracking and control. Modulate systems by varying the room thermostat settings or changing internal load.

d. Include following recorded duct system data at the mechanical room: (1) Duct air quantities, at maximum and minimum airflows: outside air, total air and exhaust. (2) Duct size. (3) Number of Pitot tube pressure measurements. (4) Sum of velocity measurements. Do not add pressure measurements. (5) Average velocity. (6) Residual pressures at inlet of variable air volume boxes. (7) Recorded test air volume. (8) Design air volume. (9) Actual pressures at static pressure control points (static pressure controllers).

e. Include following recorded data for VAV boxes installed as part of this scope of work: (1) Terminal identification, supply or exhaust, location, or space served and number



designation. (2) Type, size, manufacturer and catalog identification. (3) Applicable factor for application, velocity, area, etc. and designated areas. (4) Test each VAV box at maximum and minimum flow.

N. Perform final balancing after system has been completed and is in full working order. Put Ventilation & Air Conditioning systems into full operation and continues operation of system during each working day of balancing.

O. Adjust system and components to perform as required, using procedures described in accepted agenda.

P. Conduct operating tests of cooling coils, reheat coils, fans, and other equipment after stabilized operating conditions have been established.

Q. Field Tests: Air Distribution Systems:

1. Balance systems to design ratings. Adjust fan speeds to provide design flows, including system diversifiers, at actual system pressures. V-belt drives, including fixed pitch requirements. Coordinate VAV balancing, including supply and return fan volume controls. Set supply fan static pressure control as low as practicable and still maintain required pressure at the remote terminal units. Damper restriction of system's total flow not allowed.

2. Record pressure drop readings across major system components and significant drops within duct systems.

3. Adjust outside air and return air quantities for systems to within plus or minus 10 percent. Total supply air quantity for the system shall be not less than indicated.

4. Make flow and pressure measurements at each terminal device and each supply, return or exhaust diffuser. Adjust each air outlet unit within plus 10 percent or minus 5 percent of design requirements, but total air for each system shall be not less than shown. Readjust supply air to individual rooms if required to obtain design temperature in each room.

5. Adjust exhaust system to CFM requirements.

6. Test function of automatic dampers and operation of air terminal units. Check controls for proper operation.

R. Pressure Tests

1. Piping: Test refrigerant pipe pressure of at least 24 hours or according to Manufacturer Installation and operation manual to pass gas tightness test.

2. Ductwork: Perform testing in accordance with SMACNA Manual. Pressurize system to 150% of operating pressure and repair significant and audible leaks. Leakage shall be limited to 1% of design cfm from fan to VAV boxes.

#### **PART 4 – PROJECT COMPLETION**

A. Fully instruct the Owner's operating personnel and demonstrate performance, operation and maintenance of equipment. Amount of time allocated for said instruction and demonstration of equipment and systems shall be part of this obligation.

B. Furnish (2) complete reproducible set of as-built drawings, and two computer files, on AutoCAD, latest version, to the Owner.

C. Operating and Maintenance Manuals: Submit (3) hard copies of all operating instructions and maintenance manuals. Manuals shall be hard-cover three-ring binders, containing:

1. Identification, on outside cover, of the project name.
2. Table of Contents.
3. Complete instructions regarding the operation and maintenance of all equipment.
4. Nomenclature of replaceable parts, their part numbers, and location of nearest vendor.
5. Copy of all Warranties and guarantees showing dates of coverage.

D. Operating and Maintenance Manuals

1. Provide a Systems Operations Manual that includes single-line diagrams and schematics for all major systems, controls drawings, sequences of controls, and a table of all set-points, instructions for emergency operations, seasonal adjustments, start-up and shut-down procedures, instructions for energy savings strategies, and recommended trend-logs.

2. Provide three copies for Owners' use, bound in 3-ring binders, and one electronic copy. Provide a Table of Contents and indexed tabs, in the following order:

- a. Sequence of Operation
- b. Control Drawings
- c. Points List
- d. Controller data
- e. Thermostats and times
- f. Sensors and switches

- g. Valves and valve actuators
- h. Dampers and damper actuators
- 3. Provide three copies of all Manufacturers' catalogs for all installed equipment, including schematics, troubleshooting, and maintenance sections.
- E. **Provide three (3) months run kit for testing and commissioning;**
- F. **Provide Preventive Maintenance at least twice (2x) a year for 1 year;**
- G. All items of this section must be furnished to Owner as a condition of final payment.

#### **IV. MATERIAL SPECIFICATIONS**

##### **MATERIAL SPECIFICATIONS ATTACHED IN SEPARATE FILE**

#### **V. PROJECT DURATION**

Participating Contractors will be required to submit a preliminary implementation schedule as part of its proposal. The preliminary implementation plan must already include identified critical paths, and must be submitted using MS Project format/ Gantt Chart.

The project implementation duration for this project is **90 calendar days** to take effect seven (7) days after notice to proceed.

#### **VI. APPROVED BUDGET FOR THE CONTRACT**

The Approved Budget for the Contract (ABC) is **TWENTY- SIX MILLION SIX HUNDRED SIXTY THOUSAND EIGHTY- THREE PESOS AND 92/100 (Php26, 660, 083.92).**

The ABC shall be the upper limit or ceiling for the Bid price. Any bid with a financial component exceeding this amount shall not be accepted and be automatically rejected at opening of the financial bid.