

# **VOLUME 3**

## **TECHNICAL SPECIFICATIONS**

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# ***Technical Specifications: General Preliminaries***

## **A**                      **Preliminary Investigations**

The bidders must examine the drawings and Conditions of Contract, visit the sites and satisfy himself as to local conditions, means of access, necessity for and extent of temporary drainage, location of existing services, the extent and nature of the site and works, the restrictions and limitations, the conditions under which work will be carried out, conditions affecting the supply of labour and materials, storage space for materials and plant and generally of all conditions which may in any way affect his bid, as no claim on the grounds of lack of knowledge and of any such matters will be entertained. The Project Manager shall be informed of any area of the proposed Works which the Bidders can envisage as causing problems during construction.

## **B**                      **Site Restrictions and Limitations**

Bidders must consider their organization and programming carefully for once on the site, the Contractor will be restricted to these areas in carrying out his operations. On no account must the Contractor trespass beyond the boundaries allotted to him.

Bidders are asked to note the close proximity of buildings and busy public roads, which adjoin this site. Activities will therefore be restricted in so far as not to cause a nuisance with heavy equipment. The Contractor must make every endeavour to reduce disturbance of any kind whatsoever to the occupants of the adjoining properties. He must ensure all construction work reduces to an absolute minimum, oppressive noise, dust, fumes or hazards which may in any way inconvenience the amenity or well being of those in close proximity to the Works. Permanent access must be provided to the ongoing operations of the Hospital and Mental Health Centre throughout the entire period of the Contract. Allowance for all costs in connection with this condition must be included in the bid.

All existing services, trees and natural drainage, septic tanks, located on the above mentioned existing site must be protected and maintained during the contract period unless their removal or relocation is required as a result of the new Works. In this case, approved temporary measures must be taken to maintain all services in operation. The Contractor shall allow for all costs in connection with this condition.

**A**                    **Drawings and Specifications**

Copies of all working drawings are supplied with this bid document. Any queries should be communicated to the Supervisor's Representative and if necessary, addenda will be issued. No extras will be allowed due to omissions by contractors.

The specifications shall be read in conjunction with and applied in a well co-ordinated manner with the relevant specifications of all other disciplines and sub-consultants providing associated inputs on this multidisciplinary project. Any areas of ambiguity or conflict should be immediately brought to the attention of the Project Manager for expeditious clarification.

**Definitions**

**B**                    The term 'approved' 'directed' or 'selected' means the approval, direction and selection by the Supervisor's Representative unless otherwise described.

**C**                    Where the term 'allow' occurs in this document the cost of the item is at the risk of the Contractor.

Where the term "Project Manager," "Engineer", "Architects", "Landscape Architect" or "CA" occurs in the Technical Specifications, it shall be read as meaning Supervisor's Representative as defined in the Special Conditions of Contract.

**D**                    The abbreviations 'BS, BNS, CP, BNSCP' and ASTM mean the latest British Standard Specification, Barbados National Standard, British Code of Practice, Barbados Standard Code of Practice, and American Society of Testing and Materials respectively.

**E**                    The term 'local' means St. Vincent and the Grenadines.

**F**                    **One Document**

Read the Conditions of Contract, the Specifications, the Bills of Quantities and drawings as one document and carry out everything for the proper execution of the Works whether or not specifically described or shown therein, provided the same may reasonably be inferred there from.

**G**                    **Ordering of Materials**

Prepare own materials ordering list based on the construction drawings issued and on site measurements where appropriate. Contract drawings and Bills of Quantities will be issued on possession of site. At the first site meeting, the Contractor should indicate what information is outstanding and suggest order or priority of receipt of such information to avoid delay by late ordering.

The Contractor will be required to prepare and update for presentation at every Progress/Management meeting, a Materials Procurement form showing the latest delivery date to site in compliance with the construction programme and the country of origin.

#### **A      As-Built Drawings**

The Contractor will be provided with three sets of Contract Drawings. One set is to be available on the Project Site at all times. The Contractor shall, during the course of the Works, keep a full, neat and accurate record of all changes to the Works from the Contract Drawings and Specifications and shall promptly note these fully on one set of A1 size prints of the Contract Drawings which shall be kept at his site office and be available for inspection by the Supervisor's Representative upon request. These records shall constitute the As-Built Drawings.

The As-Built Drawings shall also include all utility location and relocation information relevant to the site of the Works. The Contractor shall allow, in the Tender Item for As-Built Drawings, for the cost of modifying a digital (CAD) set of Contract Drawings, to be supplied by the Supervisor's Representative, to fully incorporate all of the As-Built changes he has recorded during construction for the approval of the Supervisor's Representative. He shall also allow for the provision of four full sets of A1 size prints of the approved As-Built Drawings, to be distributed as follows:

- Contracting Authority - 2 sets
- Supervisor's Representative - 1 set
- Contractor - 1 set

These drawings shall be completed and supplied to the Supervisor's Representative within thirty days of completion of all of the Works.

Any failure of the Contractor to submit the "As-Built" drawings within the stipulated period will entitle the Supervisor's Representative to have the base digital drawings modified by others at the expense of the Contractor.

#### **B      Contractor's Compounds**

The Contractor shall be responsible for making his own arrangements regarding offices and compounds necessary for executing the Works. Where the Contractor wishes to establish such offices and/or working / storage compounds and / or other temporary facilities within the site he shall first obtain the approval of the Supervisor's Representative. If allowed, when the contract has been completed these buildings shall be removed and the Site restored.

#### **C      Temporary Fencing**

The Contractor shall erect and maintain any temporary fencing on the site and/or around the perimeter of his compounds which may be necessary to ensure site safety and security during the period of the Contract.

Details of proposed fencing shall be submitted to the Supervisor's Representative for approval prior to erection.

**A**                      **Prevention of Obstructions, Pollution and Avoidance of Nuisance**

The Contractor shall ensure at all times that the Site and the approaches thereto are not obstructed or made congested, and that no nuisance is created due to the construction of the Works.

The Contractor shall take sufficient precautions to prevent pollution of the surface water drainage system with oils, bitumen, noxious or floating materials, and all water discharged shall be reasonably free from pollutants. Before commencing any work, which could involve discharge into the system, the Contractor shall consult the Supervisor's Representative and provide such effective anti-pollution measures as may be required to prevent such discharge. The Contractor shall remove from the Site at his own expense any debris therein arising out of the construction of the Works. The disposal site shall meet the requirements of the relevant authorities. All materials shall be covered during transport off the Site to prevent dispersal and related environmental pollution.

**B**                      **Entry on Private or other Property**

The Contractor shall not enter upon, across or through any land, building or place being controlled public property or private property unless authorised to do so by the competent authority.

**C**                      **Construction Services**

The Contractor shall make his own arrangements for and shall pay all charges in connection with providing electricity, water supply, air, telephone, sewage disposal and other services required for the Contract, and remove as required on completion.

The main contractor will provide the following services free of charge to the successful AC contractor:

1. Unloading, storing and hoisting as required
2. Protection of completed work under this P.C. Sum from completion of sub-contract works to practical completion
3. Provide power
4. Provide scaffolding as required

**D**                      **Existing Services**

No responsibility will be assumed by the Employer or Supervisor's Representative for the correctness or completeness of the Drawings with respect to existing utilities and services whether underground, overhead, or on the surface. It shall be the Contractor's responsibility to contact the appropriate authorities or utility companies for further information with respect to the exact location of utilities and services and to take such other precautions as are necessary to safeguard the utilities.

Water lines, service connections, water meter boxes, water hydrants and valve boxes, light standards, cableways, and all other utility appurtenances within the limits of the proposed construction which are to be relocated or adjusted are to be moved by others, unless otherwise provided in the Contract.

Unless directed otherwise the Contractor will pay the utility companies charges for such adjustments and will be reimbursed in the monthly certificates.

It is understood and agreed that the Contractor has considered in his Tender all of the permanent and temporary utility appurtenances in the present or relocated positions and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operations of moving them.

The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

In the event of interruption to water or other utility services as a result of accidental breakage or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with the said authority in the restoration of service. If a utility service is interrupted cooperation will be required until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

Any damage to underground utilities not shown on the plans or identified to the Contractor by the relevant utility companies when requested in writing so to do by the Contractor and due to unforeseeable causes beyond the control and without the fault or negligence of the Contractor, shall be repaired by the proper authority with the full cooperation of the Contractor, and payment will be made in accordance with the Contract.

**A**                      **Temporary Removal of Existing Services**

If it should become necessary for the proper execution of the work temporarily to remove or divert services the Contractor shall obtain permission from the competent authority or owner and shall carry out the work at his own expense in a manner and at times to be approved by such authority or owner and shall subsequently reinstate the work to the satisfaction of such authority or owner. In the event of the owner or responsible authority electing to arrange for the temporary removal of an existing service the Contractor shall pay the cost of his or their doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented the Employer reserves the right to settle the account and deduct the sum paid by him from the moneys due or which may become due to the Contractor.

**B**                      **Restoration of Services**

Unless directed otherwise the cost of permanent relocation of utilities shall be paid to the utility companies by the Contractor and then reimbursed by the Employer. The Contractor will not be paid for any temporary relocation or protection.

**C**                      **Restoration of Ground**

The Contractor shall confine his operations to the minimum area required for the Works and shall at his own expense restore, reinstate or make good the surface of ground disturbed by his operations, restore fences and walls, reinstate temporary accesses and make good damages of any kind to the satisfaction of the Supervisor's Representative.

The Contractor shall maintain trafficked surfaces, accesses and fencing in good condition and undertake all repair to any damage occasioned by him to the satisfaction of the Supervisor's Representative immediately it occurs in order to prevent any cessation of or undue inconvenience to pedestrian and vehicular traffic using the roadways.

**A**                      **Protection of Openings**

The Contractor shall at his own expense ensure that open trenches or pits are so covered and protected that they present no hazard, and that on completion they are completely filled in and consolidated using approved material.

**B**                      **Datum**

Before the commencement of the Works a reference benchmark for all levels on the site is to be established and agreed with the Engineer.

**C**                      **Disposal of Surplus**

The Contractor shall remove all surplus excavated material off the Site and shall arrange for all permissions with the authorities concerned regarding the disposal of the materials.

**D**                      **Telephones**

The Contractor shall within seven days from the date for commencement of the Works or within seven days of early mobilisation provide and install in the office one telephone with a direct external line equipped with a facsimile machine and internet connection. The Contractor shall be responsible for maintaining the equipment.

**E**                      **Quality Control Testing**

The Contractor shall provide an experienced technician qualified in carrying out the testing regime specified for the various aspects of the project. The Supervisor's Representative and his staff shall be afforded the opportunity to witness all field and laboratory tests.

The Contractor may alternatively however elect to have all or certain field tests and all laboratory tests carried out by personnel from an independent laboratory approved by the Engineer, with test results to be sent directly from the laboratory to the Engineer.

**F**                      **Safety, Health and Welfare**

The Contractor is to provide all necessary canteen, medical, latrine and other facilities for the welfare of his employees at the Site. These facilities are to be at least of the standard required by law and local regulations. A high standard of hygiene and cleanliness must be maintained.



The Contractor shall comply with all requirements of safety regulations currently in force in St. Vincent and the Grenadines.

**A                    First Aid Equipment**

The Contractor shall provide and maintain on the Site suitable first aid equipment.

**B                    Telephone Contact with Emergency Services**

The Contractor shall ensure that there is a means of contacting the ambulance, fire and police services at all times to assist with emergencies at all areas of the site. Supervisory personnel shall be equipped with two-way radios or cellular phones to ensure that contact can be made with the Contractor's Office to relay emergency calls and to coordinate the emergency response of the Contractor.

**C                    Fire Fighting Equipment**

Suitable firefighting equipment shall be provided and maintained on Site to the approval of the relevant authority to deal with any outbreaks of fire. All possible precautions shall be taken to provide for the safe storage of petroleum, gas bottles, and all other dangerous goods.

Permits shall be obtained for the storage of such materials wherever this is required by any current regulations of the relevant authorities in St. Vincent and the Grenadines, and the Contractor will be deemed to have included for all such costs in his Tender for the Works.

**D                    Accidents**

The Contractor shall as soon as possible after the event advise the Engineer's Representative of any accident, injury, loss or damage to any workman or to any property of a third party or to property of the Employer. The Contractor shall comply with any regulations currently in force in St. Vincent and the Grenadines regarding procedures to be followed subsequent to any accident or occurrence on site or connected with the construction of the Works which is stipulated in such regulations.

**E                    Clearing and Protection of Existing Roadways**

The Contractor shall ensure that existing roadways within the vicinity of the Site used or traversed by vehicles or plant of the Contractor or his suppliers or sub-contractors are kept clean and clear of all materials, dirt, soil or debris. Appropriate warning signs shall be provided as required.

Positive measures shall be taken by the Contractor to assure that tractor-type equipment does not damage existing roads. If any such damage should occur it shall be repaired by the Contractor without delay and at his expense.

**F                    Setting Out of the Works and Surveys**

At least one bench mark and two horizontal control points will be indicated to the Contractor by the Supervisor's Representative at the Site.

The Contractor is responsible for checking that the basic survey points are in place at the commencement of the Contract, and if any are missing, or appear to have been disturbed, the Contractor shall inform the Supervisor's Representative who shall make arrangements to re-establish the points.

After this basic survey and setting out has been agreed by the Supervisor's Representative, the Contractor shall be responsible for its maintenance and re-establishment of any portion lost or destroyed.

Should the Contractor discover any error in line or level in basic setting out, he shall at once notify the Supervisor's Representative who will then issue amended drawings or instructions regarding the correction of the error.

The Contractor shall establish temporary bench marks at intervals and shall provide the Supervisor's Representative with a schedule of their levels.

Prior to the construction of any earthworks, excavation or other work in any area of the site, the levels of the existing ground above or below water shall be agreed between the Contractor and the Supervisor's Representative. If the Contractor fails to take the requisite levels, then the ground levels shown on the drawings or determined by the Supervisor's Representative shall be taken as correct. The Contractor shall give the Supervisor's Representative not less than 24 hours notice in writing of his intention to set out or take levels for any part of the Works in order that arrangements may be made to carry out any joint measurements or any checks required.

During the progress of the Works, the Contractor shall not remove, damage, alter or destroy in any way any survey controls. Should the Contractor consider that any survey control will be interfered with by the construction Works or will ultimately be above or below the final level of the finished Works, he shall notify the Supervisor's Representative who, if he considers it necessary, will make arrangements for the removal and replacement of the survey control.

If the Contractor removes or disturbs a survey control without the prior permission of the Engineer, he shall be liable for the full cost of its replacement.

In areas involving construction of new road base, stakes to establish lines and grades for subgrade, base, kerb and related items shall be set at intervals along the line of the work no greater than 15 metres on tangents and 8 metres on curves. Adequate grade stakes shall also be set at locations to facilitate checking of subgrade, base and pavement elevations in intersections and irregularly shaped areas.

All pegs, markers, etc., for setting out the Works shall be clearly visible at all times and lights, coloured boards, etc., are to be provided as required.

Any pegs, marks and beacons established by or for the Supervisor's Representative shall be carefully preserved and protected. Working shall be suspended or plant and equipment moved as required to facilitate the checking of lines and levels of any part of the Works.

**A                    Temporary Works**

The Contractor shall submit within two months from the date of the order to commence, for the approval of the Supervisor's Representative, complete drawings of all temporary works including bracings, stagings, formwork and shuttering required for carrying out the Works.

Unless otherwise specified or provided for in the Bill of Quantities the cost of all temporary works shall be included in the rates entered in the Bill of Quantities for the permanent Works.

**B                    Water for the Works**

Provide clean water for the Works including the works of all sub-contractors.

Provide all temporary services, temporary plumbing, storage, etc., as required and pay all fees and charges in connection therewith.

**C                    Fuel and Consumable Stores**

The Contractor shall provide and pay for all fuel, lubricants, gas and other consumable stores required for his construction equipment and transport and for the execution of the Works.

**D                    Dayworks**

If the Supervisor's Representative shall order any work to be carried out on a Daywork basis incidental to the Works, the Contractor shall execute such work and shall be paid in accordance with the rates and terms for Dayworks stated in the Bill of Quantities.

During the incidence of such Dayworks, the Contractor shall render daily to the Supervisor's Representative a return showing the names and descriptions of the workmen, plant and materials involved, and such other details as the Supervisor's Representative may reasonably require.

**E                    Sub-Contractors**

The Contractor shall be responsible for the supervision and administration of all sub-contracts in accordance with the Conditions of Contract and shall arrange a programme with each of the Sub-Contractors for the execution of the A/C work to permit the Works to be completed within the stipulated time. This programme shall be subject to the approval of the Engineer.

The Contractor shall allow sub-Contractors sufficient space and appropriate accommodation for the storage of plant and materials and for fabrication of work prior to fixing. The Contractor shall be responsible for the safe custody and condition of articles or goods provided by specialist suppliers after delivery in good condition.

**A**                      **Method of Operation**

Within two weeks from the date of the order to commence the Contractor shall submit a detailed work method statement for all key aspects of the Works for the approval of the Supervisor's Representative. During the course of construction the Supervisor's Representative may request and the Contractor shall supply any clarifications or amendments to his proposed method statement.

**B**                      **Night Work**

In general, all work shall be performed during the daylight hours. For special operations, night work may be done if so authorized in writing by the Supervisor's Representative. No night work shall be performed unless adequate artificial lighting has been provided and has been approved.

**C**                      **Sequence of Operations**

The Contractor shall not open up work to the prejudice of work already started, and the Supervisor's Representative may require the Contractor to finish a section on which work is in progress before work is started on any additional section.

**D**                      **Interference with Traffic**

The Contractor shall at all times conduct the work in such manner and in such sequence as to insure the least practicable interference with traffic. The Contractor's vehicles and other equipment shall be operated in such manner that they will not be a hazard or hindrance to the travelling public. Materials stored on the site shall be placed so as to cause as little obstruction to the travelling public as possible.

**E**                      **Closure of Roads**

The Contractor shall submit an application to the appropriate authority for the closure of any road stating the length of time and the dates that the closure or partial closure is requested. The Contractor's method of operation shall minimise the area where access is to be restricted. Only authorised closures shall be implemented by the Contractor.

**F**                      **Coordination with other Contractors**

The Contractor shall arrange his work and dispose of his materials so as not to interfere with the operations of other contractors engaged upon adjacent work and to join his work to that of others in a proper manner, in accordance with the intent of the plans and specifications, and to perform his work in the proper sequence in relation to that of other contractors, all as may be directed by the Supervisor's Representative.

**A                    Drainage**

The Contractor shall so conduct his operations and maintain the work in such condition that adequate drainage will be in effect at all times. Existing functioning storm sewers, gutters, ditches, and other run-off facilities shall not be obstructed.

**B                    Fire Hydrants**

Fire hydrants on or adjacent to the Site shall be kept accessible to fire apparatus at all times and no material or obstructions shall be placed within 5 metres of any such hydrant.

**C                    Protection of Structures**

Heavy equipment shall not be operated in such a manner and in such proximity to existing or new structures or other permanent works as to cause their displacement or damage them in any way. New structures shall have attained adequate strength before being subjected to backfilling operations, impacts, vibrations or other such forces.

**D                    Discrepancies between Documents**

The Contractor is to refer to the Supervisor's Representative before the work is carried out, any discrepancy found in or between the Specifications, Drawings or Instructions issued. Written or figured dimensions on the Drawings are in all cases to be preferred to scaled dimensions, and where these have been omitted the Contractor is to refer to the Supervisor's Representative. If there is any discrepancy between Specifications and Drawings, the former shall over- rule the latter. Where an item description is more specific in the Bill of Quantities than in the Specification or on the Drawings the Bill of Quantities shall over-rule the Specification and the Drawings.

**E                    Systems of Measurement**

The Specification and Drawings have been prepared utilising the UK imperial system of measurement. Where components are not locally available to this standard equivalent imperial sizes may be provided and installed. The Contractor shall ensure that the whole is fully co-ordinated.

**F                    Code of Practice/Standards**

The whole of the Works shall be carried out in accordance with the rules, regulations or other requirements of the local and other authorities as outlined in the sections of this Specification. The Contractor shall pay all fees and charges in connection therewith.

Wherever Standards, Codes of Practice and other similar references have been quoted in the Specification, the latest current edition of such Standard, Code of Practice or other similar reference shall apply. The Contractor may propose the use of alternative standards provided that:-

- (a) The alternative is, in the opinion of the Supervisor's Representative, equal to or superior to that quoted in the Specification;

- (b) The Contractor provides the Supervisor's Representative with a copy in English of the proposed alternative standard when he submits his design and calculations or other proposals.

**A** **Progress Photographs**

The Contractor shall supply to the Supervisor's Representative the negative and four unmounted, dated colour prints, approx. 150mm x 100mm size, of each progress photograph, taken of such portions of the work prior to commencement, in progress and completed as the Supervisor's Representative may direct and to a standard acceptable to the Supervisor's Representative. No prints from the negative shall be supplied to any person or persons without the authority of the Supervisor's Representative. Photographs are to be submitted monthly throughout construction in sets of 12 photographs. The Supervisor's Representative shall also utilise, for recording the day to day works, the digital camera supplied under the contract to record all relevant aspects of the construction of the works and archive these on the Supervisor's Representative computer for future reference, as may be called for.

**B** **Progress Reports**

The Contractor shall keep a daily record of the progress of work with complete records of weather conditions; number of men working in each trade; location of each crew or subcontractor; arrival or removal of equipment with items of work undertaken; order or delivery of material. This record shall be made available for inspection by the Supervisor's Representative at the Site.

A typed copy of a weekly progress report summarising the information in the daily reports shall be furnished to the Engineer each Wednesday following that week to which the report relates.

**C** **Sources of Materials**

The Contractor shall be responsible for obtaining and bringing to site materials required for the Works in adequate time to suit his work schedule and of quality meeting the specifications.

**A**                    **Local Weather**

The Caribbean area is prone to heavy rainfall, storms and hurricanes which mostly occur during the months June to early November. The Contractor shall make his own enquiries concerning local weather conditions and take all necessary precautions and follow procedures applicable to the said conditions.

**B**                    **Designation of a Specific Product**

Reference on the Drawings or in the Specification to any proprietary article, device, product, material or fixture, or any form or type of construction, by name, make or catalogue number, with or without words indicating "or equal", shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may use any article, device, product, material or fixture, or any form or type of construction, which in the judgment of the Supervisor's Representative (expressed in writing) is equal, for the purpose intended, to that named and is sourced in accordance with any country of origin stipulations of this Contract..

**C**                    **Transport for Workpeople**

Allow for obtaining an adequate labour force for the Works and include for transporting men to and from the site, as necessary.

**D**                    **Imported Labour**

The Contractor must comply with all immigration and other laws in force in respect of the importation of supervisory staff, skilled and unskilled labour and allow for security bonds and other payments in this connection.

**E**                    **Overtime**

The bid price will be deemed to include any overtime working which the Contractor may consider necessary to complete the Works by the date stated. If work is to be executed out of normal working hours, 24 hours notification must be given and the consent of the Supervisor's Representative must be obtained before commencement.

**F**                    **Safeguarding the Works, materials and plant against damage and theft**

Allow for all necessary watching and lighting and protection of the Works, materials plant, etc., on the site from theft or damage of any kind.

**G**                    **Police Regulations**

The Contractor is to ascertain and comply with all police regulations in regard to access to and from the site and to any works that may be executed in public thoroughfares adjacent to the site.

**A**                    **Protection of Trees**

The Contractor shall carefully preserve and protect all trees on the site from damage until completion of the Works insofar as their removal is not required by reason of the execution of the Works.

Should any tree which it is intended to preserve be uprooted, destroyed or in the opinion of the Supervisor's Representative be damaged beyond reasonable chance or survival in its original shape due to the Contractor's negligence, then the Contractor shall provide and plant a suitable replacement tree of similar type and age.

**B**                    **Contractor's Liability**

The Contractor shall undertake all risks and liabilities arising out of incidental to or connected with the construction, completion and maintenance of the Works. The Contractor's liability shall extend to all risks involved in the execution of the Works with regard to temporary supports, struts, braces, shores and other works of supports, steadying, restraints or upholding and shall, at his own expense, make good damage or defects resulting from the inadequacy or failure of his actions or work in these respects.

**C**                    **Provisional and Prime Cost Sums**

The term 'Provisional Sum' shall mean a sum provided for work or for costs which cannot be entirely foreseen, defined, or detailed at the time the bidding documents are prepared. Such sum shall be used in part or in whole as directed by the Supervisor's Representative and shall be deemed to be inclusive of any profit required by the Contractor unless otherwise indicated.

The term 'Prime Cost Sum' or P.C. sum shall mean a sum provided for work services to be executed by a sub-contractor nominated by the Supervisor's Representative, a statutory authority or a public undertaking or for materials or goods to be obtained from a supplier nominated by the Supervisor's Representative. Such sums may be used in part or in whole as directed by the Supervisor's Representative and shall be deemed to be exclusive of any profit required by the Contractor and provision is made for the addition thereof. When profit is added by the Contractor, the sum so added shall be adjusted in direct proportion to the amount of the PC Sum actually expended.

When a PC sum is given in the description of any item of work, it shall be taken as a price only for the materials or services referred to (delivered to site unless otherwise stated) and the Contractor shall use this price in the build-up of the rate for the supply and installation of that item of work.

The PC price shall be deemed to include the Contractor's cash discount and the Contractor shall be deemed to have allowed in his unit price build-up for the profit, overheads attendance, etc; he may require on the PC price given. A net adjustment shall be made to the Contractor's build-up price should the service or item selected by the Supervisor's

Representative cost more or less than the PC price given.



**A**                    **Attendance**

Provide attendance upon, cut away for and make good after all trades and in all trades performed by own workmen and own sub-contractors and leave perfect on completion.

Provide general attendance on the sub-contractors which shall be deemed to include allocation, for free use by the sub-contractor of suitable areas on site for office accommodation and storage of plant and materials, reasonable and free use of scaffolding and hoisting tackle already erected by the Contractor, free use of mess rooms, sanitary accommodation and their work and cleaning away rubbish.

Provide special attendance on sub-contractors, i.e. cutting chases and the like, only when specifically instructed so to do following the items in the Bills of Quantities which described the particular sub-contract work. When a lump sum price is inserted against this item, it shall be adjusted in direct proportion to the amount of the subcontract sum actually expended.

**B**                    **Removing rubbish and cleaning**

Clear away all rubbish and materials from time to time as necessary or as directed by the Supervisor's Representative and leave the site and premises finally clear.

**C**                    **Costs**

The costs for complying with this Section of the Specification and for complying with instructions to tendered and conditions of contract shall be included in the Contractor's Bid price. (See Bid Summary). A detailed breakdown is to be submitted along with the Contractor's Tender.

**D**                    **Programme**

Within two weeks from the date of the order to commence the Contractor shall submit a detailed programme to be submitted in accordance with Article 17 of the Conditions of Contract. It must be prepared in accordance with the following criteria:

- it should be done using the critical path method (CPM)
- it should be done using Microsoft Project 2000 or equivalent approved software
- all activities which affect the timing of the work must be shown
- for each activity, the predecessors and resources must be shown
- hard copies and digital copies must be supplied to the Project Manager
- the critical path as generated by the software must be shown in red
- time bars shall have activity numbers at the start of each bar.

The programme must be agreed in writing by the Main Contractor and the Supervisor's Representative. The Main Contractor will incorporate the programme into the overall building works programme.

## **SECTION 2**

### **GENERAL CONDITIONS OF CONTRACT**

2.01.00 **MAIN CONTRACT:**

Not used. Refer to Main Contract details.

2.02.00 **ATTENDANCE:**

Not used. Refer to Main Contract details and General Preliminaries.

2.03.00 **CONTRACT**

Not used. Refer to Main Contract details.

The A/C service contractor will be required to enter into a contract with the Main Building Contractor.

2.04.00 **WORK INTER-RELATIONSHIP:**

.01 **PRIME CONSULTANT:**

Where “ENGINEER” is referred to in this document, it shall be interpreted to mean “SUPERVISOR’S REPRESENTATIVE” in relation to the works described herein.

.02 **SUPERINTENDENCE:**

The Contractor shall keep on the works during its progress a competent superintendent and any necessary assistants, all satisfactory to the Engineer. The superintendent shall not be changed except with the consent of the Engineer, unless the superintendent proves to be unsatisfactory to the Contractor or ceases to be in his employ. The superintendent shall represent the Contractor in his absence and directions on minor matters given to him shall be held to be given in writing to the contractor. Important directions shall be given in writing to the Contractor; the Contractor shall give efficient supervision to the work, using his best skill and attention.

.03 **CO-ORDINATION OF WORK AND TRADES:**

In order that all construction and installation work can proceed in a natural and smooth sequence without delay, co-ordinate your work with the work of all other trades and in particular with respect to inter-related work.

.04      **MATERIALS PURCHASE:**

The Contractor shall tie his materials purchase schedule to his installation program of the works allowing sufficient purchase time to ensure with confidence availability of the materials when required. No alternative ex-stock materials will be approved by the Engineer for use because of Contractors failure to properly schedule his material purchases and their consequent unavailability.

2.05.00      **SUBMITTALS:**

.01      **GENERAL:**

The contractual obligations and job management procedures under this item to enable the Engineer to efficiently review the works and the Sub-Contractor to efficiently install the Works to design intent are explicitly defined below. NO DEVIATION from this procedure is allowed unless by prior approval in writing by the Engineer. These obligations and procedures are:-

.02      **DRAWINGS AND INSTRUCTIONS:**

The Engineer shall furnish as he considers necessary for the execution of the work additional instructions, by means of drawings or otherwise. All such additional instructions shall be consistent with the contract documents and the work shall be executed in conformity therewith. In giving such additional instructions, the Engineer shall have authority to make minor changes in the work, not inconsistent with the Contract. If either the Sub-Contractor or the Engineer so request they shall jointly prepare a schedule, subject to change from time to time in accordance with the progress of the work, fixing the dates at which the various instructions will be required and the Engineer shall furnish them in accordance with this schedule; and on like request, a schedule shall be prepared, fixing the dates for the submission of working and shop drawings for the beginning of manufacture and installation of materials and for the completion of the various parts of the work.

.03      **WORKING AND SHOP DRAWINGS:**

The Sub-Contractor shall furnish to the Engineer, at proper times, all shop and working drawings or diagrams which the Engineer may deem necessary in order to make clear the work intended or to show its relation to adjacent work or other trades. The Sub-Contractor shall make any changes in such drawings or diagrams which the Engineer may require consistent with the Contract, and shall submit sufficient copies of the revised prints to the Engineer for approval.

.04      When submitting such shop and working drawings the Sub-Contractor shall notify the Engineer in writing of changes made therein from the Engineer's

drawings or specifications. The Engineer's approval of such drawings or of the revised drawings shall not relieve the Sub-Contractor from responsibility for errors made by the Sub-Contractor therein or for changes made from the Engineer's drawings or specifications not covered by the Sub-Contractor's written notification to the Engineers. All models and templates submitted shall conform to the spirit and intent of the Contract documents.

**.05      WORKING AND SHOP DRAWINGS: (By Definition)**

- a)      **"WORKING DRAWINGS"** meaning detailed installation drawings, in addition to the Tender Drawings, are to be prepared by the Sub-Contractor for his own use as required, to enable him to show details of his proposals for constructing the Works to the design requirements of the Engineer, for example, duct and pipe runs for air-conditioning works.

These drawings must be reviewed by the Engineer before construction of such works. The Engineer will also provide the Sub-Contractor with any outstanding information pertaining to the general design concept necessary to enable the Installation Drawings to be prepared.

- b)      **"SHOP DRAWINGS"** are drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Sub-Contractor, manufacturer, supplier or distributor and which illustrates details of all materials and equipment the Sub-Contractor proposes to use in accordance with the design specifications and drawings.

The Sub-Contractor shall review, stamp with his approval and submit with reasonable promptness and in orderly sequence so as to cause no delay in the Work or in the Work of any other Contractor, three (3) copies of Shop Drawings of all materials and equipment. Shop drawings shall be properly identified, and at the time of submission, the Sub-Contractor shall inform the Engineer in writing of any deviation in the Shop Drawings from the requirements of the Contract Documents.

**.06      CONDITIONS OF SUBMISSION:**

By Sub-Contractor's approval and submission of the Shop Drawings the Sub-Contractor thereby represents that he has determined and verified all field measurements, field construction criteria, materials, catalog numbers, performance specifications and similar data, or will do so and that he has checked and coordinated each Shop Drawing with the requirements of the Work and the Contract Documents.

The Engineer will review the submissions of Shop Drawings only for conformance with the design concept of the project and with the information given in the Contract Documents.

The Engineer's review shall not relieve the Sub-Contractor of the responsibility for any deviation from the requirements of the Contract Documents, for any errors or omissions in the Shop Drawings, nor shall his review relieve the Sub-Contractor of the responsibility for final performances, quality and ability to fit into the available spaces of all material and equipment.

No portion of the Work requiring a Shop Drawing submission shall be commenced until the submission has been reviewed by the Engineer. The Engineer may issue to the Sub-Contractor lists of those works, materials and equipment for which specified technical information and/or shop drawings are essential for submission.

.07      **AS INSTALLED AND RECORD DRAWINGS:**

The Sub-Contractor shall keep one copy of all drawings, specifications and approved shop drawings of the work in good order, available to the Engineer and to his representatives.

As the work progresses, the Sub-Contractor shall record changes to the Project as built. At the completion of the installation and before the final inspection the Sub-Contractor shall have completed an accurate set of "AS INSTALLED DRAWINGS".

.08      The responsibility for the production of these drawings is that of the Sub Contractor. The Sub-Contractor shall therefore allow in his pricing for keeping accurate records of his 'AS INSTALLED' changes to the Contract Drawings, for liaison work, and for their production. The Sub-Contractor shall also allow for the cost of any reproducible sepia/mylar negatives of the Engineer's drawings he may require in order to facilitate him in the preparation of the "AS INSTALLED DRAWINGS". The Engineer shall permit the use of these reproducible drawings as "AS INSTALLED DRAWINGS" providing they indicate the actual installed conduit pipe and duct runs etc. and incorporate the changes to the project as installed.

2.06.00      **THE WORKS:**

.01      **SCOPE:**

Except as otherwise specified, the work under this contract shall consist of furnishing all labour, materials, equipment and appliances for the complete execution of the works as shown on the accompanying drawings and generally described in these specifications to the satisfaction of the Engineer and all relevant public authorities.

.02      **INSTALLATION:**

Furnish and install everything necessary for the completion and successful operation of the work, whether or not herein definitely specified or indicated on the drawings, as faithfully as if so specified and so indicated. Read together all contract documents. Whatever is called for by one shall be deemed to be called for by all.

.03      **ORDER OF WORK:**

The sub-contractor shall execute his work in conformity with a programme agreed with the Main Contractor.

.04      **INSPECTION OF WORK:**

The Owner or the Engineer on his behalf and their representatives shall at all times have access to the work wherever it is in preparation or progress and the contractor shall provide proper facilities for such access and for inspection. If the specifications, the Engineer's instructions, the laws, or the ordinances of any public authority require any work to be specially tested or approved the contractor shall give the Engineer timely notice of its readiness for inspection. The appointment shall be promptly made with the said authority and the Engineer shall be given timely notice of the said appointment. If any such work be covered up without approval or consent of the Engineer, it must, if required by the Engineer, be uncovered for an examination and made good at the Contractor's expense. If such work be found in accordance with the contract, the owner shall pay the cost of re-examination and replacement. If such work be found out in accordance with the contract, through the fault of the contractor, the contractor shall pay such cost.

2.07.00      **BUILDERS WORK FOR SERVICES:**

.01      **GENERAL:**

The Main Building contractor shall install all concrete foundations required by the Service contractor's equipment. The Main Building Contractor shall do all cutting, patching, inserting of sleeves, casting of openings, etc., required by the A/C Service contractor unless otherwise specified in these specifications. It shall be the A/C Service Contractor's responsibility to ensure these works are to his requirement through-out all their stages of preparation and construction.

.02      **STRUCTURAL OPENINGS:**

It shall be the A/C Service Contractor's responsibility to inspect all Structural and Architectural drawings to insure that all openings required by him in structural walls are marked in the drawings and that the reinforcement was checked by the Structural Engineer. The A/C Service Contractor shall

supervise the placing of form work for openings to insure correct size and proper location. Large openings in non-structural walls requiring lintels shall be marked on the drawings as per the above before the wall is built and all other provisions previously specified shall apply.

**.03      CUTTING AND PATCHING:**

Cutting and/or patching of structural elements due to failure to abide by the above will be at the A/C Service Contractor's expense, if allowed at all by the Engineer, whose permission shall be sought prior to any cutting or patching.

The repair of any damage caused to the work of other trades by the A/C Service Contractor, due to the cutting and patching of masonry (within the limitation outlined above) shall be to his account.

Small openings and chases in non-structural walls shall be clearly marked on the wall for cutting and patching by the Main Building Contractor.

**.04      SLEEVES:**

The A/C Service Contractor shall supply all sleeves for openings etc., as required.

Sleeves shall be delivered to the Main Building Contractor who shall position these as instructed by the A/C Service Contractor. It shall be the Service Contractor's responsibility to ensure that these are accurately placed and fixed prior to and during casting.

The type of sleeve supplied and the nature of their installation for the particular application shall be as described in these specifications and the drawings. Allow for installation of 20% spare sleeves as the nature of the work dictates.

**2.08.00      PAINTING - ELECTRICAL/MECHANICAL INSTALLATION**

**.01      GENERAL:**

- a) Clean and paint in a colour approved by the Supervisor's Representative all parts of the installation exposed to view.
- b) Protect from weather and/or oxidation all parts of the installation in non-air conditioned areas.
- c) Provide means of identification of all parts of the installation.
- d) Unless otherwise specified painting in this section shall be by the Contractor.

**.02      EXPOSED TO VIEW:**

- a) Touch up paint of factory finished equipment.
- b) Fill, stone, prime and paint with one coat red lead, and two coats high gloss oil paint, all equipment without factory finish.
- c) Paint concrete equipment plinths, foundation etc. with two coats of cement paint.
- d) Paint raw iron or steel elements, hangers, support structural members, pipe, etc. with one coat of red lead and two coats oil paint.
- e) Paint galvanised sheet metal, equipment, pipe etc. one coat grease dissolving primer, one coat red lead and two coats oil paint.
- f) Size and prime plaster equipment and duct finishes and apply two coats of paint.
- g) Prepare thermal insulation as described elsewhere in these specifications or as recommended by the manufacturers and finish with two coats of decorative paint.
- h) Finish bronze, brass, copper, aluminum, stainless steel, chrome etc. if and as directed by the Engineer.
- i) Clean, dust, varnish, polish, touch up, etc. all of the above for final inspection.

**.03      HIDDEN FROM VIEW:**

Parts of the installation not exposed to view but generally within the air-conditioned building envelope require no finishes except as follows:

- a) Equipment without factory finish - apply one coat, red lead and one coat oil paint.
- b) Plaster size prime and apply one coat of paint.
- c) Iron or steel pipe and major structural members - one coat red lead, one coat oil paint.

**.04      IN HUMID AREAS:**

Parts of the installation not within the air- conditioned building envelope are to be finished as if exposed to view. If hidden from view, concrete and galvanised iron need not be finished. In addition:



- a) All finishes are to be mildew resistant.
- b) All shaft extensions adjusting.
- c) Bolts and screws, slides, etc. to be greased.

.05 **EXPOSED TO WEATHER:**

Parts of the installation exposed to the weather are to be finished as per humid areas and in addition.

- a. All finishes are to be weather resistant.
- b. Caulking, etc., shall be used to prevent water entry.
- c. Drill drain holes or otherwise prevent accumulation of rain water on finished surfaces.

2.09.00 **ELECTRICAL WIRING FOR MECHANICAL EQUIPMENT:**

.01 **GENERAL:**

Except for such items as are normally wired up at their point of manufacture and so delivered and unless specifically noted to the contrary herein or on the drawings the *Electrical Contractor under the Main Building Contract shall do all the electric wiring of every character for power supply as described on the drawings and in the specifications. His work shall normally terminate at suitable isolators placed within the mechanical spaces served or as other-wise indicated on the drawings or in these specifications. His work excludes control wiring of other contractors unless specified to the contrary.*

.02 **MOTOR AND STARTER EQUIPMENT:**

All motors furnished under any of the several sections of these specifications shall be of recognised manufacture, of adequate capacity for the loads involved, and wound for current characteristics noted, and suitable for tropical ambient temperature and use.

Starters shall be furnished with all motors, unless otherwise noted. These starters shall be of the totally enclosed type with capacity rating within the required limits of the motors which they are to serve, shall be suitable for the motor current characteristics and shall be provided with suitably sized thermal overload protection.

.03 **MOTOR AND STARTER WIRING:**

Each Contractor will furnish and set in place, ready for connection his motor driven equipment.

.04      **ELECTRICAL WIRING RESPONSIBILITIES:**

*Each Contractor shall be responsible for the energization, continuous and safe operation of his electrically operated equipment. No claim for payment arising out of equipment burn-out damage or malfunctioning due to faulty electrical components, wiring or fluctuating voltages, etc., will be allowed until such time as the equipment is taken over by the owner or his representative at the date of issue of the final Certificate.*

.05      **SPECIFIC REQUIREMENTS:**

The responsibility for specific elements of electrical wiring for mechanical equipment shall be as follows:-

(a)      **ENERGY MANAGEMENT SYSTEMS (CONTROLS):**

All control wiring, trunking, conduit, boxes etc shall be installed by the A/C Contractor or his specialist domestic sub-contractor to form a complete and operational system. This work shall comply with the N.E.C. and best practice in the industry.

(b)      **AIR-HANDLING UNITS:**

Wiring up to and including isolators by the Main Building Contract Electrical Contractor. Wiring from isolators including starters shall be by specialist Air-Conditioning Contractor.

(c)      **EXHAUST & INTAKE FANS:**

Wiring by Main Building Contract Electrical Contractor is indicated on drawings. Final connections at fans shall be by specialist Air-Conditioning Contractor.

**The Main Building Contract Electrical Contractor to install a suitable disconnect switch next to each fan for maintenance purposes.**

(d)      **MOTORISED DAMPERS:**

Power wiring to junction box by Main Building Contract Electrical Contractor who shall terminate at disconnect switch in ceiling void for final connection to damper motor with flexible cable by the specialist Air-Conditioning Contractor.

(e)      **DUCT HEATERS:**

Power wiring shall be by Main Building Contract Electrical Contractor to isolator or receptacle. Control wiring by specialist Air-Conditioning

Contractor.

(f) **ROOF TOP UNITS:**

Wiring up to and including isolators by the Main Building Contract Electrical Contractor. Wiring from isolators including starters shall be by specialist Air-Conditioning Contractor.

(g) **AIR TERMINAL UNITS & MOTORISED DAMPERS:**

The electrical contractor will provide, wiring up to such points in proximity to the terminals and motorised dampers as indicated in the drawings or specifications or according to the manufacturer's directions. Final connections shall be by the Air-conditioning Contractor.

2.10.00 **PROJECT COMPLETION:**

.01 **GENERAL:**

In addition to all other stated requirements pertaining to the period of maintenance, comply in total with the requirements below to qualify for final inspection of the installation at the end of the period of maintenance (Defect Liability Period.)

Default by the Contractor gives the Engineer the right to make the necessary arrangements to meet the requirements at the Contractor's cost before entertaining the Contractor's final inspection application.

.02 **GUARANTEE AND MAINTENANCE:**

The Sub-Contractor shall guarantee all work and new equipment installed under this specification against any defects in workmanship and material for a period of one (1) year after acceptance of the installation by the Owner.

The Sub-Contractor shall allow for maintenance of the complete installation to the end of the period of maintenance. Maintenance shall be as detailed in the relevant technical specifications and in general shall include:

- a) Cleaning, lubrication and adjustment, etc., of the equipment and accessories in accordance with the Manufacturer's recommendations on a regular basis but at least every thirty (30) days.
- b) Repair and/or replacement of any part or parts of the installation which malfunction or prove to be defective whether under manufacturer's guarantee or not. Repairs are to be made with minimum downtime for the equipment.
- c) No charges whatsoever arising out of the maintenance will be accepted by the Owner. Duties, transport, and all other costs will be to the Contractor's

account.

- d) Engineers certification of the maintenance undertaken at least monthly.

.03 **MANUFACTURER'S GUARANTEE AND WARRANTIES:**

All outstanding manufacturer's guarantee and/or warranties shall be transferred to the Owner at the end of the period of maintenance.

.04 **DEMONSTRATION:**

Allow for a demonstration at the beginning of the period of maintenance or at the time of occupancy of the works by the Owners, of the completed installation to be held in the presence of the Owner and/or his designated representative at a mutually agreed time. Demonstration shall include start stop of all machinery, emergency procedures and operation of all controls.

.05 **AS INSTALLED AND RECORD DRAWINGS:**

Comply with the requirements as previously detailed under "AS INSTALLED AND RECORD DRAWINGS" as no final inspection at the end of the Period of Maintenance will be considered until requirements are met.

.06 **MAINTENANCE MANUAL:**

- a) Two copies of a Maintenance Manual shall be assembled in plastic covered three-ring binders and delivered to the Engineer before expiry of the Period of Maintenance.
- b) The Manual shall include the following:-
  - 1. Manufacturer's catalogue and shop drawings.
  - 2. All manufacturers' installation and maintenance instruction packed with equipment, electrical and control wiring diagrams etc.
  - 3. Lists of spare parts.
  - 4. A copy of these Specifications.
  - 5. A copy of "AS INSTALLED AND RECORD DRAWINGS".
  - 6. Manufacturer's test result if such required by equipment specifications.
  - 7. Recommended control settings.
  - 8. Any other information considered useful by the Contractor.

9. System performance, test results and final settings as specified in these specifications.

.07 **TAGS, CHARTS, INSTRUCTIONS:**

Provide proper identification of the systems and their components as specified in the relevant technical specifications.

.08 **PERMITS, NOTICES AND INSPECTIONS:**

The Sub-Contractor is responsible for making all applications, obtaining all permits and arranging testing as necessary for the installation and placing into operation the works where required by the Authority Having Jurisdiction.

**AIRCONDITIONING SPECIFICATIONS**

**SECTION 3**

**GENERAL REQUIREMENTS GOVERNING BUILDING SERVICES**

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3.03.00	BALANCING AND TESTING

## **SECTION 3**

### **GENERAL REQUIREMENTS GOVERNING BUILDING SERVICES**

3.01.00      **QUALITY ASSURANCE REQUIREMENTS:**

.01           **CODES-STANDARDS:**

**GENERAL:**

Meet and/or exceed the requirements of national codes in current practice, and codes and regulations named elsewhere in these specifications. In the absence of local codes and standards of the Caribbean community, codes and standards of the USA, UK or Canada are acceptable, unless specifically requested otherwise in these documents.

**MATERIALS:**

In the supply of materials from sources where the above named standards are not applicable, submit evidence that they are at least equal to the above standards. The Engineer's decision shall be final.

Unless otherwise specified only termite and fungus proof materials are acceptable. Supply only materials suitable for tropical ambient temperature conditions and use, whether supplied as individual components or component parts of a system.

Use only prime grade and new materials and equipment.

3.02.00      **DEVIATION AND ALTERNATIVES:**

- a)      Unless specifically requested and agreed to in writing by the Engineer, no deviation from or alternatives to the drawings and/or specifications are permitted.
- b)      Replace with acceptable equipment and/or materials and at no additional cost to the owner during the Contract Period all items which in the opinion of the Engineer do not meet with the specifications.

Equipment and materials incorporated in the Works are only accepted at the date of issue of the Final Certificate.

- c) Remove forthwith from the installation and from site any work, materials equipment etc., which in the opinion of the Engineer is defective, imperfect, inadequate or not in accordance with the terms of the contract. Replace and/or re-execute such items to the satisfaction of the Engineer and at no additional cost to the Owner.

3.03.00 **BALANCING AND TESTING:**

.01 **Evaluation of System:**

- a) The contractor shall furnish all materials and equipment necessary to properly measure the air capacity of the system, the electrical voltage and current, fan speeds, static pressures, air velocity, water pressure drops, refrigeration pressures, and all readings normally necessary to evaluate the performance of a system, adjust the quantities to those called for, and test the system.

.02 **System Performance:**

- a) The Contractor is responsible for the performance of the equipment and the system they install. Contractor cannot assume that suppliers will ship equipment adjusted to meet the job requirements.

.03 **Equipment Operation:**

- a) All equipment shall be checked for proper operation as soon as electrical power is available to do so. Any malfunction shall be reported to the manufacturer, and corrective action taken as soon as possible to prevent delay of the acceptance of the work.

.04 **Equipment Problems and Adjustments:**

- a) Required adjustments and minor problems with mechanical equipment are to be expected to some extent, and it is this contractor's responsibility to determine if there are any in the work and to correct them without causing any undue alarm on the part of the owner and without delay of the job.

.05 **Balancing - Air Systems:**

- a) As soon as electrical power is available, the contractor shall check all equipment for electrical problems, check rotation of motors, read voltage and current in each leg of each motor, heater, etc., and check the readings against the nameplate.



- b) Complete ductwork as soon as possible and operate the evaporator fan(s) (with filters in place); adjust the units for maximum air supply by reading motor power. Supply outlets shall be adjusted to the required air quantity. If air quantity is in great excess, the fan speed shall be reduced until the noise level is acceptable. If the air quantity at this point is not up to the design, the contractor shall notify the manufacturer and the engineer!
- c) The return air system shall then be adjusted to design capacity with the proper outside air.
- d) Check and balance each exhaust system to the design air quantity. Excess exhaust air will not be permitted since this wastes energy.
- e) After supply and return air are in balance and the quantity correct, adjust the outside air dampers to the air quantity shown on drawings (if not shown, use 10% of the supply air quantity). If economizer control is specified, check for proper setting of the controls and for proper operation of the dampers (outside air and relief).

.06

**Readings Required To Be Reported:**

- a) The following readings shall be made and reported to the engineer after the building is balanced and all equipment is operating properly.
- b) All readings shall be recorded on a print of the Mechanical system giving the actual raw data read for each supply and return opening, including exhaust hoods and openings. All readings made shall be recorded, and if any readings are invalid, they shall be identified as such. Any readings out of line shall be explained by a note on the print. (The original print shall be submitted to the engineer for review.) If additional copies are required, they may be transcribed from this print on to other copies.
- c) Air quantity readings shall include:
  - 1. Actual measured air quantity of each supply and return outlet shall be read and recorded. Measurement shall be made with a cone with a calibrated outlet and velometer equal to Alnor.
  - 2. Same for each return or exhaust inlet.
  - 3. Same for each hood, giving supply (if any) and exhaust.

- d) Temperature readings required as above are:
1. Outside air at equipment.
  2. Return air at unit.
  3. Supply air leaving unit.
  4. Mixture of outside and return air BEFORE entering the cooling or heating coil or heater. Readings 1, 2, and 4 allow the determination of the outside air/return air ratio.
- e) Electrical readings required are:
1. Measured voltage and amps on EACH phase of each major (compressor, evaporator fan, condenser fan(s), roof exhaust fans, etc.) while the equipment is under maximum normal load.
  2. The nameplate voltage and current for each of the above motors.
- f) Refrigeration readings required are:
1. Suction and discharge pressure of each compressor or, in the case of packaged condensing units, the suction and liquid line pressure.
- g) Water readings required are: (if applicable)
1. Water pressure on the inlet and outlet of each pump as close to the pump impeller as is possible.
  2. Water pressure drop across the suction strainer of each pump.
  3. Water pressure drop across the outlet valve and check valve on the pump discharge.
  4. Water pressure drop each chiller, or boiler producing energy for the system. These readings shall be at the flanges of the equipment.
  5. Water pressure drop across every coil, heating element, etc., using energy from the system.
  6. The pressure drop calculations shall be applied against the manufacturers' rating sheets to determine the actual flow

through the system and the equipment. These readings give the owner the basic information to determine at a later time if the equipment is fouled and if the water flow is being maintained at the design conditions.

7. Any flow-measuring devices in the system shall be read and reported.
8. Should any readings made above indicate that the flow in the system is below design; the contractor shall determine the reason for the difference and correct the problem so that the flow will be up to design conditions when the system is turned over to the owner.

.07

**System Difficulties:**

- a) The above readings shall be made on each unit or piece of equipment and these readings sent to the engineer for review as early as possible so that any apparent difficulties can be resolved before the anticipated close of the job. Minor problems, such as the necessity to adjust a fan sheave, often raise questions and doubts about the system. Such problems are normal, and if corrected without delay lead to a much smoother installation process.

.08

**Review by Engineer:**

- a) After the above information is received by the engineer, it will be reviewed and compared against the design. The engineer will generally review the job for the owner and recommend final acceptance or the holding of funds pending additional work. Such review will not be scheduled until the above information can be reviewed and accepted. The work required under this contract is not complete until this information is accepted as accurate and complete.

## **SECTION 4**

### **BASIC MATERIALS AND METHODS**

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## **SECTION 4**

### **BASIC MATERIALS AND METHODS**

#### **4.01.00 CODES AND STANDARDS AIR-CONDITIONING:**

- a) The latest editions of ASHRAE Handbooks
- b) SMACNA HVAC Duct Construction Standard – Metal and Flexible. Third Edition
- c) ANSI/ASHRAE Standard 62.1-2010 Ventilation for Acceptable Indoor Air Quality.
- d) NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilation Systems, 2009
- e) NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, 2011

#### **CODES AND STANDARDS ELECTRICAL:**

- a) Comply with the requirements of the local “Authority Having Jurisdiction” in the inspection and acceptance of the installation.
- b) The latest edition of BS 7671 – Requirements for Electrical Installations as published by the British Standards Institution (BSI) and the Institution of Electrical Engineers (IEE).

#### **4.02.00 NOISE AND VIBRATION CONTROL**

##### **.01 GENERAL:**

The Contractor shall ensure that all equipment is adequately isolated and that acceptable sound levels exist in the occupied areas (ASHRAE Guide average NC levels and 2012 HVAC SYSTEMS AND EQUIPMENT ASHRAE HANDBOOK). The Contractor shall minimise vibration from rotating or reciprocating equipment to other building elements.

Noise measurements shall be made at a distance of not less than 6 feet, from the equipment, duct or terminal device. If required, the manufacturer's representative, through this Contractor, shall make recommendations covering any necessary alterations required, in order that the design criteria be obtained.

#### 4.02.02 Vibration Isolation - Applications:

- (a) All concrete foundations, pads and supports will be furnished and installed in accordance with shop drawings and details. The Contractor shall furnish and set all anchor bolts and all vibration isolating devices as well as do all final grouting.
- (b) All structural steel and pipe supports for equipment piping, etc. shall be furnished and installed by this Contractor.
- (c) All floor mounted equipment shall be erected on 4" high concrete pads over the complete area of the equipment unless specified to the contrary herein.
- (d) Furnish and install all necessary supports for equipment furnished under this Contract. To meet the varying conditions in each case, these supports shall consist of pipe stands, steel angle or strap hangers, saddles, brackets, etc as shown or approved.
- (e) All wiring and other connections to vibration isolation equipment shall be made flexible with a minimum 180 loop of flexible conduit in order to avoid restraining the equipment and short circuiting the vibration isolators.
- (f) Unless otherwise indicated on the drawings all equipment mounted on vibration isolation bases shall have a minimum operating clearance of 25-mm between the base and the floor or housekeeping pad beneath. Clearance space shall be checked to ensure that no scrap, rubbish, hardware, etc., has been left to possibly short circuit the isolated base.

#### 4.03.00 ELECTRICS:

##### .01 Motors And Starters:

- (a) All electric motors shall be high efficiency type and installed in accordance with NEMA Standards for 40°C temperature rise. Motors located on air handling units shall be mounted in rubber supports, or the fan shall be independently supported on spring isolators. Motors located in or adjacent to the air-conditioned space shall be selected for quiet operation and shall not produce an objectionable "motor noise" in the space.
- (b) Motor starters shall be properly sized and shall have overload trip element in each phase.

#### 4.04.00

#### **EQUIPMENT:**

.01

##### **Packaged Air-Cooled Liquid Chiller:**

Supply and install factory assembled, microprocessor controlled, air-cooled liquid chiller utilizing scroll compressors, low sound fans and integral hydronic dual pump system. The chiller shall be rated in accordance with ARI 550/590, its construction shall comply with ASHRAE 15 and it shall be certified UL, CSA, or CE. Contained within the unit cabinet shall be all factory wiring, piping, controls refrigerant and special features required.

Compressors shall be fully hermetic scroll type compressors. Compressors shall be mounted on rubber-in-shear vibration isolators to minimise vibration and noise. Rotating parts shall be statically and dynamically balanced at the factory to minimise vibration. Lubrication system shall be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater shall be provided if standard or if available as an option. If provided, the crankcase oil heater shall be controlled as recommended by the manufacturer. Staging of compressors shall provide unloading capability. Digital compressor unloading control shall be available as an option. Direct drive, 2900 rpm (50 Hz), protected by motor temperature sensors, suction gas cooled motor. Compressors shall be entirely coated with the manufactured standard epoxy, vinyl or glass coating for corrosion protection.

Each chiller shall contain multiple compressor and not less than two (2) independent refrigerant circuits shall be provided. Circuits shall include as a minimum, a replaceable-core filter drier, moisture indicating sight glass, electronic expansion device, discharge service valve and liquid line service valves, and complete operating charge of both refrigerant R-410A and compressor oil. The refrigerant shall have an ozone depletion potential of less than or equal to 0.05. R-134, R-407C and R-410A all meet this requirement.

The evaporator shall be of the shell and tube design and performance shall be based on a water velocity not less than 3FPS nor more than 12FPS and a fouling factor of 0.0001. The condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless (copper) tubes with compatible aluminum fins. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of three degrees C five degrees F subcooling and full pump down capacity. Coil shall be factory leak and pressure tested after assembly in accordance with ASHRAE 15. Coil shall be entirely coated with the manufacturer's standard epoxy, vinyl or glass coating for corrosion protection.

Chilled water circuit shall be rated for 150 psig (1034 kPa) working pressure. Thermal dispersion proof of flow switch shall be factory installed and wired.

Field pipe connections shall be Victaulic type. Primary/stand-by operation pump systems. Dual pump systems shall have a pump discharge check valve. Pumps shall be single stage design, for installation in vertical position and capable of being serviced without disturbing piping connections.

Pump casing shall be of class 30 cast iron. The impeller shall be of cast bronze, closed type, dynamically balanced, keyed to the shaft and secured by locking cap screw. The hydronic kit will be provided with a flush line connection to ensure lubrication at the seal face and allow for positive venting of the seal chamber. Each port shall be fitted with an isolation valve that allow the units to operate in parallel or standby, yet may be used to isolate one pumping unit for servicing or removal with the other pump still running. Pump shall be rated for 150 psig (1034 kPa) working pressure. The pump case shall have gage tappings at the suction and discharge nozzles and include drain ports. Dual pumps shall allow for the servicing of one pump without draining the chilled water loop. Motors shall totally enclosed 3-phase type with grease lubricated ball bearings. Each pump shall be factory tested per Hydraulic Institute Standards.

Pump motors shall be VFD (variable frequency drive) compatible with operating time balancing and automatic changeover to the back-up pump if a fault occurs. The pump system shall have dynamic suction and discharge piping support, minimizing vibration transmission. High-capacity membrane fluid expansion tank shall be factory installed within the chiller cabinet insulates, pre-charged and rated for a maximum working pressure of 150 psig (1034 kPa). Water pressure taps (2) shall be factory installed across the cooler and rated for 150 psig (1034 kPa). Balancing valve shall be factory installed to set flow gage ports shall be factory installed and rated for 300 psig (2068 kPa). Hydronic assembly shall have factory-supplied electric freeze protection to – 20 F (–29 C). Piping shall be Schedule 40 black steel. Cast iron or ductile iron body strainer with 8 mesh screen. A factory-installed, removable fine mesh clean-out strainer for initial run period shall be included.

Chiller shall be provided with a complete factory mounted, pre-wired electric or microprocessor based control system.

This shall include the following adjustable operation controls as a minimum.

- (a) Leaving chilled water temperature control.
- (b) Adjustable timer or automated controls to prevent a compressor from short cycling.
- (c) Automatic lead/lag controls (adjustable) for multi-compressor units.
- (d) Load limiting



- (e) System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle on power interruption.
- (f) Fan sequencing for air-cooled condenser

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters.

- (a) Entering and leaving chilled water temperatures.
- (b) Self diagnostic
- (c) Operation status
- (d) Operating hours
- (e) Number of starts
- (f) Compressor status (on or off)
- (g) Refrigerant discharge and suction pressures
- (h) Oil pressure

The control system shall be capable of being reprogrammed directly at the unit. No parameters shall be capable of being changed without first entering a security access code. The programmable setpoints shall include the following as a minimum.

- (a) Leaving Chilled Water Temperature
- (b) Time clock/calendar date

The chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

- (a) Low chilled water temperature protection
- (b) High condenser refrigerant discharge pressure protection
- (c) Low evaporator pressure protection
- (d) Chilled water flow detection
- (e) High motor winding temperature protection

- (f) Low oil flow protection if applicable
- (g) Motor current overload and phase loss protection

The chiller shall be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

- (a) Over/under voltage protection
- (b) Chilled water flow interlock
- (c) Phase reversal protection

During the initiation of a safety shutdown, a chiller's control system shall be capable of activating a remote alarm bell. In coordination with the chiller, the Contractor shall provide an alarm circuit (including transformer if applicable) and a minimum 100mm (4 inch) 4 inch diameter alarm bell. Alarm circuit shall activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell shall not sound for a chiller that uses low-pressure cutout as an operating control.

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as minimum all system operating conditions, capacity controls and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operation commands.

- (a) Remote Unit Start/Stop
- (b) Remote Chilled Water Reset

.02

Warranty:

The contractor shall provide a 5 year parts only (excludes refrigerant) parts manufacturer's warranty on the air-cooled chiller compressor (s). This warranty shall be directly from the chiller manufacturer to the Client and shall be in addition to the standard one-year warranty of construction. The manufacturer's warranty shall provide for the repair or replacement of the chiller compressor (s) that become inoperative as a result of defects in material or workmanship within 5 years after the date of final acceptance. When the manufacturer determines that compressor requires replacement, the manufacturer shall furnish new compressor (s) at no additional cost to the Client. Upon notification that a chiller has failed under the terms of the warranty, the manufacturer shall respond in no more than 48 hours. Response shall mean having a manufacturer-qualified technician onsite to evaluate the extent of the needed repairs. The warranty period shall begin on the same date as final acceptance and shall continue for the full product warranty period.

The Contractor shall furnish with each manufacturer's multi-year warranty the name, address, and telephone number (day, night, weekend, and holiday) of the service representative nearest to the location where the equipment is installed. Upon a request for service under the multi-year warranty, the service representative shall honor the warranty during the warranty period, and shall provide the services prescribed by the terms of the warranty.

At the time of installation, each item of manufacturer's multi-year warranted equipment shall be tagged with a durable, oil – and water-resistant tag, suitable for interior and exterior locations.

4.04.02      **LEFT INTENTIONALLY BLANK**

4.04.03      **LEFT INTENTIONALLY BLANK**

4.04.04      **MINI SPLIT SYSTEM ROOM AIR-CONDITIONERS:**

(a)      **General:**

These systems shall consist of ceiling concealed (CCU), ceiling mounted cassette (CMCU), or wall mounted (WFCU) indoor expansion fan coil units connected via refrigerant piping to outdoor air cooled condensing units. The capacity of the systems shall be as listed in the equipment schedule. Refrigerants such as R-410A or R-407C which, do not contribute to ozone depletion, shall be used. Units shall be installed so that their interior is easily accessible for routine inspection, maintenance and removal of major components.

(b)      **Fan Coil Units:**

The interior fan coil units shall be the wall mounted (WFCU) type as indicated in the drawings and schedule.

All units shall comply with the requirement of ASRAE 62.1 in achieving acceptable IAQ. Main and auxiliary drain pans are to be positively sloped, removable for cleaning, externally insulated and constructed of epoxy coated, heavy gauge galvanised steel.

Controls shall be wall mounted and include fan speed control and automatic temperature control. The air filter shall be washable and easily accessible. The units shall be quiet in operation and shall have an attractive finish.

(c) **Air Cooled Condensing Units:**

The condensing units shall be air cooled and shall be compatible with and approved by the manufacturers as an acceptable match for the fan coil units to which they are connected. Units shall be completely weatherproof and corrosion resistant and shall incorporate heat exchangers (coil) of copper tubes and aluminium fins.

(d) **Refrigerant Piping and Control Wiring:**

Refrigerant piping shall consist of copper tubing, insulated as necessary to enable efficient operation and prohibit condensation on the cold refrigerant pipes. The route of refrigerant and condensate piping shall generally be as shown on the drawings. The Contractor is to ensure that suitable lengths of inter-connecting piping are provided for each system. Power will be provided by the electrical contractor via a weatherproof isolator at each condensing unit. The air-conditioning contractor shall make the necessary provisions for inter-connecting control wiring between the indoors and outdoor sections of the various split systems.

Ensure that any requirements in the structure to accommodate the installation such as sleeves, holes etc. are provided by the Main Contractor and thus avoid the need for any cutting and patching of walls, floors and roofs. All condensate piping shall be PVC as shown on the drawings.

05 **FINNED TUBE COATING:**

Finned tube coils shall be protected with a clear siloxane which chemically bonds to the surface. Metal preparation to provide a surface profile shall include treatment with a suitable Coil-fin cleaner and a final rinse.

The coating shall be applied using a pot and spray wand assembly. The fluid and air pressure gauges can be set at 15psi. Spray from both sides of the coil, working from top to bottom until total penetration is realized.

The coating shall show a heat resistance up to 900°F and show no sign of attack after 6,000hours of salt spray test to ASTM Specification B117.

4.04.06 **FANS:**

Fans shall be high efficiency at the conditions shown on the Schedule. Install units as recommended by the manufacturer, using the proper supports.

Proper rotation of the fan shall be verified and its speed adjusted to provide the design system air quantity.

All roof mounted fans are to be certified and approved to the equivalent of the Miami-Dade Building Code Compliance office and Texas Department of Insurance for use in hurricane zones

Fans shall be the model/number shown on the schedule or approved equivalent.

4.04.07 **REHEAT COIL:**

**General:**

Provide electric reheat coils with low watts density. The electric reheat coils shall be enclosed in 304 stainless steel tubes and 304 stainless steel fins. Provide modulating control of the electric reheat coils by Silicon Controlled Rectifier (SCR). Provide UL or ETL listed safety switches to protect system from overheating.

4.04.08 **DEDICATED OUTSIDE AIR SYSTEM - (DOAS), PACKAGED UNIT & AIR HANDLER UNITS**

The units shall be capable of temperature and humidity control and shall have the capabilities listed in the schedules. The units shall be suitable for both indoor and outdoor installation.

The units shall have microprocessor control and shall be capable of communicating with the operating theatres' control system. Control shall include stages of reheat, cooling and dehumidification required to maintain space conditions when an "enable" command is given via the control system, or direct control via commands issued from the control system.

100% outside is filtered through a minimum of a G4/EU 4 (MERV 8) disposable filter and then cooled and dehumidified through (1) a chilled water coil (2) a DX coil and (3) a Desiccant wheel. The wheel is recharged by the condenser heat from the internal DX units which has scroll compressors and R410A refrigerant. The recharged air is also filtered using G4/EU 4 (MERV 8). All coils shall have a corrosion resistant coating. The units shall have a NEMA 3R electrical control cabinet with indicators for Power On, Unit Running, Desiccant Wheel rotation fault, high condensing pressure and Motor Overload. The system shall also have a BMS interface, to accept BACNET. Warranty on Desiccant wheel shall be a minimum of five (5) years and one (1) year warranties standard on all other parts.

Available Power: 400V 3-phase 50Hz.

**4.05.00****FILTERS**

All medium efficiency air filters shall be listed as Class 1 in accordance with UL 900 and shall be tested and reported in accordance with ASHRAE Test Standard 52.1 and ASHRAE Test Standard 52.2. Dust spot efficiencies listed are results when tested by ASHRAE Standard 52.1. MERV values listed are results when tested by ASHRAE Standard 52.2. Refer to the equipment schedules which indicates the grade of filter required.

- A. G4/EU 4 (MERV 8): Disposable, dry type, high efficiency, supported media filter.

Media: Microfine glass laminated to a reinforcing backing formed into a lofted media blanket with a uniform radial pleat. Provide industry standard sizes as required for installation.

Frame: Provide filter media in permanent removable frames with corrosion resistant welded wire grid bonded to the downstream side of the media. Media shall be fully bonded to frame to prevent air leakage. Frame shall be steel alloy with media support stabilizers mechanically fastened to diagonal support members. Filter shall be capable of withstanding 10 inches wg pressure

Rating: Initial resistance no greater than 0.38 inches wg at 500 fpm face velocity. Thickness: 4-inch thick (nominal) frame.

- B. F9/EU 7 (MERV 13): Disposable, dry type, high efficiency, supported media filter.

1) Media: Microfine glass laminated to a reinforcing backing formed into a lofted media blanket with a uniform radial pleat. Provide industry standard sizes as required for installation.

2) Frame: Provide filter media in permanent removable frames with corrosion resistant welded wire grid bonded to the downstream side of the media. Media shall be fully bonded to frame to prevent air leakage. Frame shall be steel alloy with media support stabilizers mechanically fastened to diagonal support members. Filter shall be capable of withstanding 10-inches wg pressure

3) Rating: Initial resistance no greater than 0.50-inches wg at 500 fpm face velocity. MERV 13, dust spot efficiency of 80-85 percent. Thickness: 12-inch thick (nominal) frame.

- C. H 14/EU 14 (MERV 17): High capacity, HEPA (IEST Type A) filter.

- 4) Media: Media shall be HEPA Grade high capacity with waterproof micro glass pleated media, tapered corrugated aluminum separators with a hemmed edge, urethane sealant, and one-piece seamless gasket. Provide industry standard sizes as required for installation.
  - 5) Frame: Provide filter media in permanent removable frames. Media shall be fully bonded to frame with a urethane sealant to prevent air leakage. Frame shall be 16-gage steel alloy bonded to the media pack. A poured-in-place sealing gasket shall be installed downstream of the enclosing frame.
  - 6) Rating: 1.35-inches wg initial resistance at rated capacity. Minimum Efficiency shall be 99.97 percent when evaluated under the guidance of IEST RP-CC01. Filter must carry UL 900 Class 2 rating.
- Thickness: 12-inch thick (nominal) frame.

4.05.01

#### **FILTER GAGES AND MANOMETERS**

Provide air-filter gages or manometers for each type filter assembly.

Provide dial-indicator type gages, graduated to read 0 to 500 Pascal (0 to 2 inches wg), except that gages for HEPA filters are to read 0 to 750 Pascal (0 to 3 inches wg). Provide manometers measuring from minus 125 to 750 Pascal (0.5 to 3 inches wg), equipped with a built-in indicator bubble. Connect gage or manometer to static-pressure ports of approved design and located so that resistance to airflow will be correctly indicated.

Provide a dedicated DDC pressure differential sensor for each filter section to register the actual pressure drop. The DDC sensors shall interface with the building ECC system to remotely provide a maintenance alarm capability.

4.05.02

#### **EXTRA MATERIALS**

Provide fit for purpose filters for temporary use during construction.

Replace filters at start of Commissioning and again at final acceptance by Owner, Practical Completion.

Furnish one (1) extra set of new filters for each filter bank after Practical Completion.

#### **4.06.00      PIPING AND INSULATION:**

##### **4.06.01      Condensate Drains:**

Condensate drain pipes shall be PVC. A static trap shall be provided in each pipe. Traps and pipes shall be arranged for easy rodding and shall be accessible. Size shall be as indicated on the drawings or shall be the same size as the unit drain connection whichever is larger.

All internally run condensate pipes should be properly insulated to avoid condensation. Condensate pipe shall have a minimum slope of 1:100

##### **4.06.02      Refrigerant Piping:**

Each Refrigerant Circuit shall include a refrigerant reservoir, a filter and refrigerant access valves on both low and high side of the compressor. A sight glass shall be installed on all liquid lines; a moisture indicator must be installed and may be combined with the sight glass. The refrigerant circuit of each unit shall be as shown in drawings.

Refrigerant mains shall be as short as possible, with a minimum number of bends and run in a neat fashion, parallel to the main building lines. Pipe supports shall be installed where required. Hangers supporting insulated pipes shall be provided with saddles.

Provision shall be made for proper oil return and prevention of liquid return.

Joints in the refrigerant piping shall be brazed using a high temperature alloy, i.e. silver solder. Compression couplings, packed joints or low temperature solder will not be permitted. No pipe shall be smaller than the larger of the compressor or evaporator coil connection.

Pipe shall be seamless copper tubing of the proper grade TYPE 'K' or 'L' - Hard Copper) for the installation. Low pressure temperature pipes shall be insulated with minimum 3/4" wall thick elastomeric flexible tubing with maximum thermal conductivity 23.1 btu/ft.h.F. All joints shall be sealed with the manufacturers recommended adhesive.

##### **4.06.03      Chilled Water Pipes:**

###### **General:**

All chilled water piping shall be schedule 80 PVC pipe to ASTM D1785, pre-insulated with minimum of 40mm (1.5 inches) polyurethane foam. The insulation shall be void free, covering the entire pipe surface and bonded directly to the entire pipe surface.



All joints, fittings, transitions and flanges shall be of the same material as the piping and pre-insulated built and finished to manufacturer's specifications.

All joints shall be of the solvent weld type.

**Internal:**

All internal piping shall be finished with polyethene outer jacket 1.27mm (0.05 inches) thick. Internal joints, fittings, transitions and flanges shall be finished with the polyethene to manufacturer's specifications.

**External:**

All external piping shall be finished with factory jackets with 18 gauge, galvanized steel, four ply spiral lock seam jacket. External joints, fittings, transitions and flanges shall be finished as per manufacturer's specifications with the "spiwrap".

4.06.04

**Pipe Hangers & Supports:**

Provide hangers and supports for mechanical piping systems. Hangers and supports shall be sized to fit the outside diameter of the insulated pipe or pre-insulated pipe supports.

Either pre-insulated pipe supports shall be furnished and installed on all insulated piping and tubing or a support saddle or shield shall be provided to prevent the pipe support from crushing the insulation. See Piping Insulation Specification Section.

Hanger rods for all pipe sizes shall be as per manufacturer's specification and shall be capable of handling the weight of piping when it is filled with chilled water.

The maximum allowable spacing for pipe hangers shall be in accordance with accepted practice for CAICC Naibre piping. Where concentrated loads of valves, fittings, etc. occur, closer spacing will be necessary and shall be based on the weight to be supported and the maximum recommended loads for the hanger components.

4.06.05

**Insulation of Equipment, Fitting and Accessories**

All exposed equipment subject to condensation shall be insulated with the flexible closed-cell elastomeric insulation, to ASTM C534 specification, for preformed elastomeric cellular thermal insulation in sheet and tubular form. Insulation material shall have a maximum thermal conductivity of 0.27 Btu-

in./h-ft<sup>2</sup>-F°, when tested in accordance with ASTM C177 OT ASTM 518. All joints should be sealed according to the manufacturer's instructions.

**4.07.00      FITTINGS & ACCESSORIES FOR CHILLED WATER SYSTEM:**

**4.07.01      Fittings: Ells, Tees, Crosses, Bushings:**

Material for fittings shall match the pipe system category for pressure and temperature. Fitting for the chilled water piping shall be scheduled 80 PVC, solvent welded type.

**4.07.02      Unions & Flanges:**

Material for unions and flanges shall match the pipe system category for pressure and temperature. All equipment shall be connected to the piping by unions or flanges. Unions and flanges shall be easily accessible for easy removal of equipment.

Control valves shall be connected to the pipe work via flanges, while other equipment shall be connected to the pipe work via unions or flanges.

**4.07.03      Valves:**

**General:**

Furnish and install valves specified herein and/or necessary for the control and easy maintenance of piping and equipment. Valves generally should be installed at the following locations:

- (a) On the inlet and outlet connection of each piece of equipment, including chillers, pumps, reducing valves, control valves, tanks, coils and other equipment that requires periodic maintenance.
- (b) On the supply and return branch lines at the point of connection to the main supply and return piping headers.
- (c) Drain valves are installed at low points in the water distribution system to facilitate draining of the system.
- (d) Vent valves should be installed at all high points in the chilled water piping system for manual venting of air from the system and to help in the draining of the piping.
- (e) The base of each hydronic riser shall be provided with a shut off valve.

Valves should generally be installed with the stem in the vertical up or horizontal position. Check valves shall be installed in the horizontal position unless specifically designed for vertical installation.

Valves shall comply with the requirements of ASME and ASA codes, as to their dimensions, identification, material and service for which they are intended. All valves, unless noted otherwise, shall be of the same manufacturer and shall be clearly marked. Valves shall be clearly marked on the outside of the body or with brass valve tags of the manufacturer's name, the valve's pressure rating and the "N.O" or "N.C." normal operating position. All valves shall be rated at 125 psi or higher. All valves shall have screwed ends which observe the same system of threading as that established for all the pipes and fittings in this project. All valves must be approved by the Engineer.

#### Ball Valves:

Ball valves for shut off services shall be full port with extended stems to accommodate insulation. Valves to be manufactured out of BRASS.

#### Check Valves:

Check valves shall be horizontal swing type with disc. Valves shall be of bronze construction.

#### Balancing and Bypass Valves:

The modulating control valves shall be pressure independent. The flow through the valve shall not vary more than  $\pm 3\%$  due to system pressure fluctuations across the valve in the selected operating range. The control valves shall accurately control the flow from 0 to 100% full rated flow. A flow performance curve shall be furnished with each valve. The flow performance curve shall list flows at all the valve positions in 10 degree rotation increments. A maximum of 5 psi shall be required to operate the valve pressure independently through the complete operating range.

The rangeability of the control valves shall be 100:1 minimum. This rangeability and turndown shall be at full differential pressure provided by the pump serving the hydronic loop where that particular control valve is located. The close off pressure of all control valves shall be the full body rating of the valve.

The valve bodies shall be of cast iron, steel or bronze and rated at 150 psi working pressure. All internal parts shall be stainless steel, steel, Teflon, brass or bronze. Plastic internal parts are not acceptable. Valve flow characteristics shall be able to be changed without removing the valve from the piping system in all valves 8" and smaller.

The valve actuators shall be mounted on the valves at the factory. The valve actuators are to be specified by the controls install/manufacture/vendor. Where DDC proportional actuators are utilized, the end stroke of the actuator shall be set with the software (limit control signal) at full design flow from data off the performance curves.

The control actuator for all valves shall modulate the control valve from 0 to 100% design flow while rotating the valve stem a maximum of 90 degrees.

The control valve flow adjustment stem shall extend up from the control valve. The control valve shall have mounting holes tapped into it for mounting the control actuator bracket. This valve stem is rotated by the actuator to provide the required flow. Please contact the valve manufacturer for torque requirements.

Three pressure/temperature ports Peterson Co. (Pete's Plugs) shall be installed at the factory in each valve. Two ports shall be used to measure inlet and outlet pressure to the valve. The third port is used to measure internal pressure within the valve.

Flow rate through the valve shall be determined by the valve stem position. Flow through the valve shall be verifiable with the use of a differential pressure meter.

#### Strainers:

There shall be approved self-cleaning strainers in the inlet connections to each branch line to equipment and make-up connection and each automatic control valve.

For the latter the intention is to protect by strainer all apparatus of an automatic character, whose proper functioning would be interfered with by dirt on the seat or by scoring of the seat.

All strainers shall have cast iron or bronze bodies of ample strength for the pressure to which they shall be subjected and suitable flanges or tappings to connect with the piping they serve.

Strainer basket screens shall be stainless steel and shall be ample strength to prevent collapsing the basket under shock loading. All strainers shall be provided with a valve blow-down line run to the nearest open drain.

#### Blow Down Lines & Surface Drains:

Supply and install all necessary blow-down and surface drain lines from relief valves, automatic air vents, pump glands apparatus drain pans etc. and run to the nearest drain.

**Air Vents:**

Manual air vents shall be Nickel-plated screw driver operated vent check type with 13-mm O.D. copper tubing to air chamber. Air Chamber shall be 50-mm diameter x 150-mm long.

**Drain Valves:**

Drain valves shall be the hose end type, double disc inside screw, non-rising stem. Unless otherwise shown on drawings, drain valves shall be sized according to the following schedule.

<b>MAIN PIPE SIZE</b>	<b>DRAIN VALVE SIZE</b>
Up to and including 25-mm	13-mm
32-mm to 100-mm	20-mm
125-mm and over	25-mm

**4.08.00      **DAMPERS****

**4.08.01      Motorised Dampers:**

Supply and install Motorised Modulating Opposed Blade Dampers in the supply ducts where shown on drawings. Modulating Opposed Blasé Dampers shall be compatible with dead-band, Type Floating control Wall Thermostat Type T-312 for cooling application or approved equal.

Suitable 240-Volts/24-V Control Transformers shall be provided for each damper motor. Alternative: motor connected to OBD and controlled by proportioning wall thermostat.

**4.08.02      Manual Balancing Dampers:**

Manual Opposed Blade duct Balancing Dampers shall be installed where shown and shall have a manual quadrant type operator.

#### 4.08.03 Fire and Smoke Dampers:

Combination Fire Smoke Dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall meet the requirements of the latest edition of NFPA.

Dampers shall be tested, rated and labeled in accordance with the latest edition of UL Standards 555 and 555S. Dampers shall have a fire rating of 1½ hours.

Dampers actuators shall be factory mounted. Dampers actuators shall be electric type for 120 volt operation. Manufacturer's submittal data shall indicate actuator space requirements around the damper.

Dampers blades shall be 16 gauge galvanized steel 3 Vee type with three longitudinal grooves for reinforcements. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper.

#### 4.08.04 Pressure Relief Dampers

Industrial grade pressure relief dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall consist of: a 14 gauge galvanized steel channel frame with 8 in. minimum depth and 2 in. flanges; double V type blades fabricated from 16 gauge galvanized steel; 0.5 in. diameter plated steel axles turning in galvanized steel ball bearing press fit into frame; and external (out of the airstream) heavy duty linkage with counterbalance and pressure set weights. Dampers manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval showing damper suitable for back pressures to 8.5 in. wg, relief pressure to 2 in. wg, velocities to 5,150.0 ft./min and temperatures to 250°F. Testing and ratings to be in accordance with AMCA.

#### 4.08.05 Access Doors:

Access door shall be provided for maintenance of each fire damper, fire door or motorized damper. Access shall be 12 x 12-in. (31 x 31-cm) minimum, except for smaller ducts, where access shall be as large as practical. Duct access shall be double wall type with hinged door. Access through ceiling, if required, shall be provided to match the ceiling. Ceiling access shall be coordinated with the ceiling.

#### 4.09.00 AIR PRESSURE STABILISERS:

Air pressure stabilizers shall be used to control pressure differential between adjacent spaces and shall fit into walls of 100mm or greater. It shall have

stainless steel frames and blades and shall have RAL 9010 white powder coating with antimicrobial protection. The bearings shall be sealed stainless steel ball roller type. The pressure control range shall have a setting accuracy of +/- 1Pa. The manufacturer shall be **approved equal to APRECO APS FSD 123**.

#### **4.10.00      DIFFUSERS/GRILLES/REGISTERS:**

Generally, diffusers, grilles and registers shall be factory fabricated corrosion resistant extruded aluminium. Flexible duct shall be used to connect the duct into the diffuser, the sizes of which shall be indicated on the drawings.

The air distribution and particulate control system(s) for the operating/surgical room(s) on the **first floor** shall consist of a laminar outlet ensuring excellent air flow in the operating zones. The construction for these diffusers shall be **304 stainless steel**. They shall consist of an air outlet frame and an air discharge element on the underside, with two housings on the top side each with a built-in HEPA filter H14 to DIN-EN 1822-1. These diffusers shall have the capability of supplying air velocities not to exceed 40 fpm at operating table height, and the option of a feedthrough for the built-in surgical lighting in the air discharge element.

The air discharge element shall have the capability of being removed or folded downwards. This allows the housing interior to be easily accessible for cleaning and disinfection, as well as removal and replacement of the HEPA filters. The sealing frames for the filter cells shall have a test grove (to DIN 1946, Part 4). These filter frames shall have easily accessible leakage test points and the measurement points for the filter pressure loss from below, with downfoldable air discharge elements. The connection spigots of the filter frames shall have air-tight shutoff dampers with an electric servomotor. On power loss, the dampers shall close automatically.

These air distribution and particulate control system(s) for the operating/surgical room(s) on the first floor shall be supplied be approved equal to **KRANTZ KOMPONENTEN**.

The low level exhaust grilles in the operating/surgical room(s) on the first floor shall have a **316 stainless steel construction**.

#### **4.11.00      DUCTWORK:**

##### **4.11.01      Internal Ductwork:**

Ductwork, unless otherwise noted, shall be galvanized sheet metal, ASTM A653, Coating G90, and shall be built in accordance with the `LOW

VELOCITY AND DUCT CONSTRUCTION STANDARD' issued by SMACNA.

Specified corrosion resistant ductwork shall be stainless steel ASTM A480, Type 304 with No. 2B finish for concealed ductwork.

Ductwork 18" (36 cm) width and over shall be cross-braced, ribbed and stiffened, so that it will not "breathe," rattle, vibrate, or sag.

Square elbows shall have double-thickness turning vanes, unless single-thickness vanes are clearly indicated on the drawings.

Sheet gauges shall be as follows:

<u>Largest Side of Rectangular Duct</u>	<u>U.S. Gauge</u>	<u>Round Diameter.</u>
Up to 12"	26	Up to 14"
13" to 30"	24	15" to 26"
31" to 42"	22	27" to 36"
43" to 60"	20	37" to 48"
61" and over	18	48" to 60"

All rectangular sheet metal supply and return duct shall be insulated externally with 1" thick duct board and shall be painted where it is installed in an area with no ceiling.

#### Insulated Flexible Ductwork

- A. Provide where indicated on drawings Flexmaster Type MGA-TLMR6 UL 181 Class 1 Air Duct or approved equal.
- B. The duct shall be constructed of a triple locked aluminum perforated core.
- C. The internal working pressure rating shall be at least 6" wg positive and 2" wg negative with a bursting pressure of at least 2½ time the working pressure.
- D. The duct shall be rated for a velocity of at least 4000 feet per minute.
- E. The duct must be suitable for continuous operation at a temperature range of -20°F to +250°F.
- F. Factory insulates the flexible duct with fiberglass insulation. The R value shall be least 4.2 at a mean temperature of 75°F.
- G. Cover the insulation with a fire retardant polyethylene vapor barrier jacket having a permeance rating of not greater than 0.10 perms when tested in accordance with ASTM E96, Procedure A.
- H. Installation shall be in accordance with SMACNA and local building code standards.
- I. Flexible duct runs shall be a maximum of 8 feet.



- J. A 1½ minimum strap shall be used to support the flexible duct at a distance not greater than 5'-0". Maximum permissible sag is ½" per foot of spacing between support.

#### 4.11.02 External Ductwork:

External Ductwork, unless otherwise noted, shall be galvanized sheet metal and shall be built in accordance with the 'LOW VELOCITY AND DUCT CONSTRUCTION STANDARD' issued by SMACNA.

Ductwork 18" (36 cm) width and over shall be cross-broken, ribbed and stiffened, so that it will not "breathe," rattle, vibrate, or sag.

Square elbows shall have double-thickness turning vanes, unless single-thickness vanes are clearly indicated on the drawings.

Sheet gauges shall be as follows:

<u>Largest Side of Rectangular Duct</u>	<u>U.S. Gauge</u>	<u>Round Diameter.</u>
Up to 12"	26	Up to 14"
13" to 30"	24	15" to 26"
31" to 42"	22	27" to 36"
43" to 60"	20	37" to 48"
61" and over	18	49" to 60"

The ductwork shall be externally insulated with one (1) layer of 2" thick duct board and finished with two (2) 3mm coats of white mastic and 10 x 10 glass MGS fabric as per manufacturer's specification.

#### 4.11.03 Sealant and Gaskets:

- A. Indoor ducts or external ductwork with weather proof insulation shall be sealed with a water-based joint and Seam Sealant as follows:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg (2500 Pa), positive and negative.
8. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.

Acceptable product Duct-mate, type Pro-Seal or approved equal.

B. Outdoor ducts without insulation shall be sealed with a Solvent-Based Joint and Seam Sealant.

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. U V resistant.
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10 inch wg (2500 PA), positive or negative.
11. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum, sheets.

C. Flange Joints shall be sealed with a flange joint Mastics consisting of one-part, acid-curing, silicone, elastomeric joint sealants, complying with ASTM C929, Type S, Grade NS, Class 25, Use O. Gaskets in flanged joints shall be soft neoprene.

#### 4.11.04 Flexible Connections:

Flexible connections on supply and return at the fan coil units shall be 3/32" Neoprene approximately 6" long. At least 1" slack shall be allowed in these connections. Connections may be in pre-fabricated form such as DURO-DYNE "DUROLON" with two (2) strips of 3", 24" gauge galvanised metal firmly attached to each end of fabric.

#### 4.11.05 Access Doors:

Provide airtight access panels at each elbow and at 20 Foot [6 Meter] intervals in straight duct runs for cleaning and access. Access doors shall be equipped with continuous gaskets and shall be 18" x 18" minimum, except for smaller ducts, where access shall be as large as practical.

#### 4.11.06 Hangers:

Ducts shall be supported using steel angles and hanger rods only. Hangers for horizontal ducts shall be spaced at not more than 6ft centres. The method of fastening to the structure must be approved by the Structural Engineer.

**Note:** Steel angles with wire hangers will be accepted for fiberglass ducts.

#### 4.11.07 Curbs for Roof Penetrations:

All services passing through the roof shall be provided with a curb or other means of weatherproofing the passage. Flashing collars shall be properly sealed to ducts so that water cannot penetrate the seal even when driven by high wind. Allow for expansion and contraction on all installation.

4.11.08

Riser Supports:

Rectangular risers shall be supported where they pass through floor slabs, i.e. 12 ft (3.66m) with 1-1/2" x 1-1/2" x 1/4" angle brackets for ducts up to 60" (1524mm) wide.

4.12.00

**DUST CONTROL:**

Appropriate methods shall be used to control the migration of dust particles from the construction area to the occupied areas of the health care facility. Dust control methods vary depending on factors such as proximity to the construction project. The personnel responsible for dust control shall do the following:

- a) Personnel shall check for leakage paths between the construction area and adjacent areas of the health care facility. Wind and stack effects shall be considered, and steps shall be taken to plug holes in spatial separations (walls, partitions, floors, and floor slabs) and to seal gaps.
- b) Windows, doors, and air intake and exhaust vents in areas of the health care facility adjacent to construction areas shall be sealed, especially around buildings that are going to be demolished. Areas housing patients who are most susceptible to infections shall be sealed off from the construction area to prevent air leaks into the patient care areas.
- c) The top and bottom of plastic barriers that reach from the floor to the ceiling shall be sealed off to isolate the construction area from the adjacent areas of the health care facility.
- d) High-efficiency exhaust fans with High-Efficiency Particulate Air (HEPA) filters shall be used.
- e) Air movement from all adjacent occupied areas of the health care facility into the construction area shall be monitored to ensure that it exceeds 10 m/min (30 ft/min) and that the negative pressure differential with respect to all adjacent building areas is no less than 7.5 Pa (0.03 in wg).

f) Ensure that the dedicated elevator is vacuumed with a HEPA filter–equipped vacuum cleaner and damp mopped daily (or more often if necessary) to remove dust.

**4.13.00      INSTRUMENTATION:**

**4.13.01      THERMOMETERS:**

Thermometers shall be stem type, cast aluminum case, nine inch scale, clear acrylic window, red indicating fluid, black lettering against a white background with 0-100°F scale range and 1°F scale division. Thermometer shall have swivel nut on stem and thermometer wells are to be extension stem type to clear insulation. Wells to extend into pipe one quarter of the diameter. Install wells in vertical position in piping tees where thermometers are indicated.

**4.13.02      PRESSURE GAUGES:**

Pressure gauges shall be cast aluminum case of not less than 4.5 inches diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube, mowell rotary type, nylon gear movement. Scale to be 0 to 150 psi.

Supply and install gauge with snubber and isolating ¼” ball valve.

**4.13.03      PRESSURE/TEMPERATURE TEST PLUGS:**

Furnish and install plugs in piping tee and provide and handover to client one readout meter kit including double hoses with 4½” dial differential pressure gauge as shown on the drawing. Gauge shall read 0.60 psig and have an end connection to match plugs. Include in kit, one pocket thermometer (25°F-125°F), one pocket gauge (0 to 160 psig) and one gauge adapter.

**4.13.04      LEFT INTENTIONALLY BLANK**

**4.14.00      WATER TREATMENT**

**Pre-commission cleaning**

Upon completion of the installation each of the chilled water systems in this specification shall thoroughly flushed through with clean water prior to the introduction of chemicals for the pre-commissioning cleaning to remove all traces of large debris i.e. pebbles, welding slag, small pieces of wood and metal etc. that cannot be dissolved safely by the chemicals.

The process of pre-commission cleaning shall then proceed, the chemicals used being designed to thoroughly clean the internal surfaces of the systems removing surface rust, mill scale, oil, grease, swarf and other light debris.

During the initial flushing and the cleaning process all items of plant and equipment i.e control valves, filters, heater transfer coils etc. which could become blocked or damaged by the cleaning process shall be isolated and the water/chemical solution circulated through the bypass pipes provided.

After the introduction of the inhibited discolour/degreasing agent the solution shall be recirculated throughout the system for a period of up to 24 hours. The systems shall then be thoroughly flushed through and drained on a continuous basis until traces of chemical and sediment have been removed.

The cleaning process shall be completed by filling the systems with clean water to achieve a ph level of not less than 7 in preparation for the commencement of the water treatment programme.

4.14.01 Protection from corrosion and electrolytic action:

Following the pre-commissioning cleaning and hydraulic testing, the systems indicated in this specification and drawings shall be provided with permanent protection from corrosion and electrolytic attack by the introduction a chemical inhibitor. The water treatment shall also include an agent to remove dissolved oxygen from the water.

This shall be introduced via a chemical dosing pot installed on a valved bypass line on main supply chilled water line. Correct dosage of the inhibitor shall be made by simple ph checks. Chemical dosing pot shall have 1 gallon minimum capacity, 125 psig working pressure, a valved funnel opening to feed chemical into the system, prime coat of paint.

Additional chemical shall be provided and shall be agreed with the engineer upon analysis of a sample of the final water to be introduced into the system.

.02 Method Statement

The sub-contractor shall prepare and submit for comment a method statement outlining in details the intent with regard to water treatment of the installation to be provided under this sub-contract.

The statement shall clearly outline the following:

- a) Manufacturer, type and quantity of chemicals;
- b) Method of cleaning;
- c) Level of dosing;

- d) Health and Safety precautions

**4.15.00 CONTROL SYSTEM:**

**4.15.01 GENERAL:**

Provide an operational control system, including all software and equipment necessary for standalone operation on the ventilation and air-conditioning systems.

All materials and equipment used shall be new, standard components and all components and software shall have been previously tested and proven in regular use.

*Note: Minimum in-use requirements are 24 months for hardware and 12 months for major software (whole number revision) releases.*

The ventilation and air-conditioning control system shall possess a modular architecture, permitting expansion through the addition of more distributed processing units, input/output units, sensors, actuators and operator stations.

The vendor shall submit and receive approval for all submittals including material, floor plan, schematics and programming prior to installation.

**4.15.02 APPROVED MANUFACTURERS/VENDORS:**

The approved controls vendor should have demonstrated previous experience in the design, installation and commissioning of control systems for variable pumping chilled water systems.

Design, component selection, installation, custom programming, documentation, testing, training and warranty service shall be the direct responsibility of the manufacturer or their local representative.

**4.15.03 SUBMITTALS:**

Provide sequences of operation detailing all control strategies, including initial setpoints and referencing all points by the point name used in the DDC controls programming.

Provide a complete set of reproducible control drawings using computed aided design and drafting (CADD) technology. Include the following information:

1. Show general physical arrangement of component devices installed in the panels. Indicate applicable detailed drawing reference.

2. Identify equipment and devices by the reference designations shown on the drawings and by unique point identification used in system software. Provide material list with or on each drawing.
3. Supply block diagrams and schematics showing riser diagrams, the layout of equipment, communication cabling and wire type.
4. Provide schematics showing the general mechanical system layout with all sensors/devices of each mechanical system.
5. Supply floor plan drawings showing the general location of all controlled equipment and devices used for sensing and control.
6. Provide a schematic drawing of each control circuit, complete with individual wire identifications. Typical drawings are acceptable.

Provide a complete list of equipment to be furnished, which includes a manufacturer's catalog sheet for each item on the material list. Care shall be taken in the preparation of catalog cut sheets.

Provide a detailed test plan describing the specific procedures used to complete and document the "Owner-witnessed Testing".

Test plans shall include a complete schedule for tracking each phase of the testing, e.g. zone testing by floor, fan testing by system, chiller interface testing, etc. The controls vendor is required to supplement the planned work effort to meet the progress dated given in the schedule.

As part of the submittal process, the controls vendor shall meet with representatives of the Owner's engineering and operations divisions, giving them a thorough briefing on the DDC programming design. This briefing shall describe in detail the methods the control programmer has used to meet the requirements of the sequence of operations.

#### 4.15.04

#### **POST-INSTALLATION INSTRUCTION & MATERIALS**

The manufacturer and Control Contractor shall instruct operating personnel in the operation of the system as follows:

Provide a minimum of eight hours of classroom and on-site training in the operation and maintenance of the installed system. Training shall address the following subjects:

- (a) System log-on procedures
- (b) Review of sequence of operations

- (c) System troubleshooting
- (d) Emergency service support
- (e) System restart after power failure
- (f) System backup and restoration procedures
- (g) Replacement procedures of each system component
- (h) Calibration and initialization procedures
- (i) Regeneration procedures on all installed programming at operator's control stations
- (j) Operation of maintenance service programmes

#### 4.15.05 **SYSTEMS ARCHITECTURE:**

Operator station shall not be necessary to sustain building operation. The Operator Station shall be a computer selected to meet all specifications for operation of control system software and provide additional unused disk store space for operational requirements such as trending and totalisation. Disk storage shall be no more than 20% utilized by the initial installation.

#### 4.15.06 **ENERGY REDUCTION & SPECIAL OPERATION SOFTWARE**

The system shall be designed to control energy-consuming loads. Provide engineering, consulting and programming to develop and set up the following energy reduction software:

1. Time schedules: Software should provide at least 16 time schedules. Each schedule is to be an 8-day type, capable of six entries minimum per day. Time programme shall provide ON/OFF commands and reset SETPOINTS capabilities.
2. Holiday time programmes. Provide a holiday time schedule capability.
3. Optimal start/stop: Provide the ability to optimise start/stop times to attain and maintain temperature setpoint only during occupied times. The system shall be self tuning with compensation for weekends and holidays.
4. Setpoint reset: Provide a means of automatically resetting cooling water and ventilation air temperatures, volumes and pressures.
5. Provide a programme to automatically restart all DDC controlled



equipment upon the resumption of power or return from fire alarm condition. Equipment shall be restarted according to a prearranged, prioritised and staggered restart schedule.

6. For loads that have been turned off at the MCC controller, either by positioning of the Hand/Off/Auto (HOA) switch or the line disconnect; provide a restart strategy that automatically restarts load upon the reset of switched to their normal on-line positions.
7. Provide capability to adjust the setpoints of main mechanical systems from the operator station using simple 'point and click' command windows. This requires acknowledgement by operator and print occurrence if directed by Owner.

#### 4.15.07 **LOGS:**

Trend log: As a minimum, provide capacity for 50 trend logs. Store time segments. Provide for review of data on monitor and printer. Each trend log shall have assignable individual start/stop time/dates.

Operator activity log: Record operator activity by operator account identification and work performed during a minimum of the last 10 log-in sessions or last 20 commands.

#### 4.15.08 **ACTUATORS:**

Select electronic actuators from the controls vendor standard product line.

- (a) All electronic actuators shall be 24 VAC. The use of any other actuator must be approved by the Owner.
- (b) Proportional electronic actuators shall use 0 to 10 VDC, 4 to 20 ma. Or floating point control.
- (c) Multiple electronic actuators may be powered by one separately fused 24 VAC transformer, providing the transformer size does not exceed 100 VA.
- (d) Where an actuator is to fail open or fail closed, provide spring return. Actuators shall not be dependent on batteries or capacitors to stroke to the power fail position upon loss of power.

4.15.09

**CONTROL RELAYS:**

1. Panel relays shall be plug-in type with contacts rated at twice the amperage rating of circuit requirements: Minimum temperature range - 25°C to +70°C.
  - (a) Enclosure: Clear dust cover and shock resistant, rated for minimum 2.5 million mechanical operations and 100,000 electrical operations at full load.
2. Remote/interposing relays shall be used for all remote switched loads.
  - (a) They shall be housed in a NEMA-rated enclosure. Where two or more relays are mounted in the same enclosure, provide a hinged cover.
  - (b) Besides meeting panel relay requirements, they shall have 24 VDC coils and form C dry contacts with a minimum rating of five amps @ 240 VAC.
  - (c) Relays controlling inductive loads shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.

4.15.10

**INSTALLATION STANDARDS & DEVICE TAGGING:**

1. The DDC control system described here shall only control equipment while the HOA switch is in the Auto position. Where equipment is controlled by both the fire alarm system and DDC controls, separate start/stop contacts shall be provided and the fire alarm system shall always override the DDC controls.
2. Wall mounted temperature sensors shall be mounted on electrical boxes and all wire penetrations shall be sealed to prevent thermal convection.
3. It is the responsibility of the controls vendor to ensure that all sensors are placed in the measurable flow path so as to accurately measure the sensed variable.
4. Sensors installed for outside air measurement and pressurisation shall be located to optimise the accuracy of the measurement. Coordinate with Mechanical Consultant.
5. Valve actuators shall be installed directly above the controlled valve whenever possible unless rotation is needed to permit maintenance

access. However, in no case shall the operator be rotated to or beyond horizontal.

6. Fan coil unit discharge temperature sensors shall be mounted a minimum of 36 inches downstream from the coil.
7. All devices shall be mounted within enclosures. Cable trays and external cabinet surfaces shall not be used as mounting surfaces.
8. Proof of run for both fans and pumps shall be by current sensing devices rather than differential pressure switches.
9. All pressure indicating/measuring devices shall be installed with capped tee devices to permit attachment of test meters.

#### **4.16.00      GENERAL CONTROL STRATEGIES:**

##### **4.16.01      TIME CONTROL:**

The control system incorporated a real time clock and calendar and provides a schedule that can be programmed to define when an operational signal is to be sent to the controlled plant. This allows different plan control strategies to be defined for occupancy periods, out of occupancy period, weekend and holidays. Based on this platform:

1. some plants will shut off outside of occupancy period
2. some plants will remain operational but shift control points or conditions during unoccupied periods, and
3. some plants will function without change during occupied or unoccupied periods.

During unoccupied periods if a manual push button is activated the BMS shall then signal for normal operation of the related plant as for periods of occupancy. The period of override shall be one (1) hour. A table listing, day of week, zone/plant time and signal will be provided by the mechanical consultant.

4.16.02

**TEMPERATURE SHIFT:**

At the end of the occupied period the designated room set point shall rise 5°F over a maximum period of two (2) hours to the set back set point. Two (2) hours before occupancy the room set point shall decrease gradually to the set back set point temperature.

4.16.03

**PUMP CONTROLS:**

1. Variable speed pumps shall be provided operating on a primary operation.
2. During plant shutdown periods the pump shall be off and the appropriate valves serving the loads shall be fully closed. The pump shall be enabled when a plant operation signal is active and each valve shall be modulated under Product Integrated control to obtain the served zone temperature setpoint.
3. The pump operates when started by any of the following signals:
  - (a) Normal plant operation.
  - (b) Any associated plant items with a 'Hand/off/auto(HAO)' selector switch being switched to 'hand'.
4. Pump shall operate for a five minute run-on period after the plant operation signal is removed.
5. The variable speed pump shall be modulated under PI control to obtain a design differential return across the modulating valve at the hydraulically furthest point from the pump of 5 psi minimum.
6. The pumps shall operate on a duty basis. The lead pump shall change on a daily/weekly basis or on pump failure. The duty pump shall be proven, allowing for a suitable start up delay, by a current sensor. In the event that the flow rate is not proven in 15 seconds, the standby pump shall start and an alarm shall be raised at the BMS central supervisor (local operator interface/PC). In the event that the standby pump flow is not proven, the system shall be shut down and a further alarm shall be raised at the central supervisor. A software reset shall be provided at the central supervisor to reset the pump fail indication on rectification of a fault.
7. In the event that the plant is shut down for longer than three days the pump(s) shall be run automatically for 5 minutes on a daily basis. All valves shall be positioned as appropriate to facilitate this.

**FAN COIL UNIT - AHU, FCU, CCU, CMCU, FMFCU, WFCU**

All Air Handler/Fan Coil units are to be controlled and monitored by the BMS. This shall be done via programming thermostat controller with stand alone operation in the event of a BMS failure. **Where rooms are served by groups of air handlers (DOASs) /fan coil units, each group shall be controlled by one (1) controller as indicated on drawings.**

The thermostat controller shall be wall mountable with “LED” display and it should have a minimum two (2) hour set back override. The display screen shall have a minimum size of **7” x 5” (178mm x 127mm)**. The override shall be adjustable in 30 minutes intervals and return the system to unoccupied mode when override expires.

During periods of occupancy or during an override, the outside air damper for each air handler is opened to its set position. Outside the period of occupancy air dampers are closed. Note in systems with fans supplied ducted outside air, the fan is switched on during occupancy and off outside of room occupancy.

1. A specified pressure independent 2-port valve shall be provided to control the chilled water flow rate through the cooling coil and hence the supply air temperature.
2. The control valve shall fully open when the supply fan is proven and the BMS signals a normal start operation.
3. The valve position shall be modulated when a normal operating period is signaled by the controller, the supply fan is proven, the zone air temperature is above the setpoint. The valve is positioned in response to a PI control signal in order to obtain the zone air temperature setpoint. This cooling demand signal shall enable the main cooling plant if it is not operational.
4. The zone air temperature setpoint is determined according to the strategy selected.

The following indicates the minimum that shall be monitored, referenced and managed by the BMS:

- i. Supply air temperature
- ii. Space (room) temperature
- iii. Setpoint temperature adjust
- iv. Supply fan status (filter integrity)
- v. Supply fan (on/off)
- vi. Fan speed (low, medium, high)
- vii. Fresh air damper
- viii. Cooling coil valve

ix. Zone override

4.16.05

**MULTIPLE PACKAGE CHILLER OPERATION**

1. On receipt of a controller chiller operation signal and with chilled water pump proven, the lead chiller isolation valve shall open slowly on reaching minimum chiller flow rate, the chiller shall be enabled. The refrigerant solenoid valve shall be opened according to a control signal provided from the chillers' own controls whenever the temperature of the water entering the chiller is above the set point.
2. The compressor stages shall be controlled by the chillers own internal controls according to the pressure of refrigerant gas suction line. There shall be a delay of 30 minutes before restarting compressors.
1. The controller shall monitor chilled water temperature and flow thru the operating chiller. When the demand required by the load is less than the minimum flow required by the chiller, the controller shall signal a slow acting bypass valve to open to maintain minimum flow to the chiller.
2. When the flow thru the chiller and the chilled water temperature indicates that the chiller is at the manufacturers suggested fully loaded level, the controller shall signal the start-up sequence for the second chiller as follow:
  1. Unload operating chillers by imposing a demand of 50%.
  2. Open the lag chiller isolation valve at a rate commensurate with the chiller controller.
  3. Enable the lag chiller. The chiller controller should now allow loads on each chiller to equalize and to ramp up to the required load together.
5. The BMS shall monitor the flow thru each chiller to ensure it is above the required minimum. If flows are low the controller act to shut down a chiller. The controller shall monitor the power draw of the operating chillers Rated Load Amps (RLA). When the sum of percentage RLA divided by two (2) is less than the desired capacity for the remaining chiller, the controller send a signal to shut down a chiller.
6. When two (2) chillers are operating and the flow thru the chillers and the chilled water temperature indicates that the two (2) chillers are at the manufacturers suggested fully loaded level, the controller shall signal the start-up sequence for the third chiller as follow:

1. Unload operating chillers by imposing a demand of say 60%.
  2. Open the lag chiller isolation valve at a rate commensurate with the chiller controller.
  3. Enable the lag chiller. The chiller controller should now allow loads on each chiller to equalize and to ramp up to the required load together.
7. The BMS shall monitor the flow thru each of the three (3) chillers to ensure it is above the required minimum. If flows are low the BMS act to shut down a chiller. The controller shall monitor the power draw of the operating chillers Rated Load Amps (RLA). When the sum of percentage RLA divided by three (3) is less than the desired capacity level for the two (2) remaining chillers, the controller sends a signal to shut down a chiller.

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4.16.07 **LEFT INTENTIONALLY BLANK**

#### **4.17.00 WARRANTY**

ALL mechanical equipment must be guaranteed free from defects in workmanship and material for a minimum period of one (1) year from date of acceptance of the installation by Engineer. Hand over copies of all outstanding warranties to the Owner's representative on completion of the installation.

#### **4.18.00 MAINTENANCE DURING THE TWELVE (12) MONTHS DEFECTS LIABILITY PERIOD:**

On completion of the installation hand over to the Engineer for onward transmission to the Owner, three bound Maintenance Manuals including Operating Instructions, Equipment Catalogues and As-Installed Drawings.

Maintenance in general should include:-

- (a) Cleaning, lubrication and adjustment etc of the equipment and accessories in accordance with the Manufacturer's recommendations on regular basis but at least every thirty (30) days.
- (b) Repair and or replacement of any part or parts of the installation which malfunction or prove to be defective whether under Manufacturer's guarantee or not. Repairs are to be made with a minimum of downtime

for the equipment.

- (c) No charges whatsoever arising out of the maintenance will be accepted by Owner. Duties transport and all other on costs will be to the Contractor's account.
- (d) Owner's certificate of the maintenance undertaken at least monthly.

Allow for a demonstration at the beginning of the Period of Maintenance or at the time of occupancy of the Works by the Owners, of the completed installation to be held in the presence of the Owner and or his designated representative at a mutually agreed time. Demonstration shall include start-stop of all machinery, emergency procedures and operation of all controls.



### **DEDICATED OUTSIDE AIR UNITS ( Typical of 3) POINT SCHEDULE**

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Outside Air Temp	x								x		x
Reactivation Air Temp	x								x		x
Desiccant Wheel Discharge Air Temp	x								x		x
Return Air Temp	x								x		x
Prefilter Differential Pressure	x								x		
Supply Air Temp	x								x		x
Cooling Valve		x							x		x
Freezestat			x						x	x	x
Smoke Detector			x						x	x	x
Outside Air Damper Status			x						x		x
Desiccant Wheel Status			x						x		x
Supply Fan Status			x						x		x
Reactivation Fan Status			x						x		x
Outside Air Damper				x					x		x
Desiccant Wheel Start/Stop				x					x		x
Desiccant Wheel Bypass Dampers				x						x	x
Supply Fan Start/Stop				x					x		x
Reactivation Fan Start/Stop				x					x		x
Supply Air Temp Setpoint					x				x		x
Outside Air Temp					x						x
Emergency Shutdown						x			x	x	x
Outside Air Damper Failure										x	
Outside Air Damper in Hand										x	
Desiccant Wheel Rotation Failure										x	
Desiccant Wheel in Hand										x	
Desiccant Wheel Runtime Exceeded										x	
Supply Fan Failure										x	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
Reactivation Fan Failure										x	
Reactivation Fan in Hand										x	
Reactivation Fan Runtime Exceeded										x	
Prefilter Change Required										x	x
High Supply Air Temp										x	

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Low Supply Air Temp										x	
<b>Totals</b>	<b>6</b>	<b>1</b>	<b>6</b>	<b>5</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>19</b>	<b>18</b>	<b>21</b>
<b>Total Hardware (18)</b>						<b>Total Software (40)</b>					

### **AIR COOLED CHILLER (Typical of 3) POINT SCHEDULE**

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Chilled Water Differential Pressure	x								x		x
Chilled Water Flow	x								x		x
Chilled Water Return Temp	x								x		x
Chilled Water Supply Temp	x								x		x
Chilled Water Pump 1 VFD Speed		x							x		x
Chilled Water Pump 2 VFD Speed		x							x		x
Chilled Water Bypass Valve		x							x		x
Emergency Shutdown			x						x	x	x
Refrigerant Leak Shutdown			x						x	x	x
Chilled Water Isolation Valve Status			x						x		x
Chilled Water Pump 1 Status			x						x		x
Chilled Water Pump 2 Status			x						x		x
Chilled Water Pump 1 VFD Fault			x							x	x
Chilled Water Pump 2 VFD Fault			x							x	x
Chiller Status			x						x		x
Chilled Water Isolation Valve				x							x
Chilled Water Pump 1 Start/Stop				x					x		x
Chilled Water Pump 2 Start/Stop				x					x		x
Chiller Enable				x							x
Outside Air Temp					x						x
Chilled Water Differential Pressure Setpoint					x				x		x
Chilled Water Flow Setpoint					x				x		x
Chilled Water Isolation Valve Failure										x	
Chilled Water Isolation Valve in Hand										x	

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Chilled Water Isolation Valve Runtime Exceeded										x	
Chilled Water Pump 1 Failure										x	
Chilled Water Pump 2 Failure										x	
Chilled Water Pump 1 Running in Hand										x	
Chilled Water Pump 2 Running in Hand										x	
Chilled Water Pump 1 Runtime Exceeded										x	
Chilled Water Pump 2 Runtime Exceeded										x	
High Chilled Water Differential Pressure										x	
Low Chilled Water Differential Pressure										x	
Low Chilled Water Flow										x	
Chiller Failure										x	
Chiller Running in Hand										x	
Chiller Runtime Exceeded										x	
High Chilled Water Supply Temp										x	
Low Chilled Water Supply Temp										x	
<b>Totals</b>	<b>4</b>	<b>3</b>	<b>8</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>17</b>	<b>21</b>	<b>22</b>

**Total Hardware (19)**

**Total Software (41)**

## **EXHAUST FANS (Typical of 4) POINT SCHEDULE**

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Fan Status			x						x		x
Fan Start/Stop				x					x		x
Fan Failure										x	
Fan in Hand										x	
Fan Runtime Exceeded										x	
<b>Totals</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>2</b>

Total Hardware (2) Total Software (5)

### **4.19.00 KITCHEN VENTILATION**

#### **.01 KITCHEN HOOD**

##### **Type I Hood**

Hood AH-1: 168in x 54in and 24in high (Back to Wall Canopy)

Kitchen ventilation hoods shall be of the Type I, full compensating wall canopy and island group. The hood shall be U. L. Listed with fusible link fire damper for 700 °F rated cooking appliances.

**The hood shall be fitted with a Fire System Cabinet on one end.** The restaurant fire suppression system for the hoods shall be of the full hood type. Temperature Sensors shall be mounted in the exhaust collar and the Optic Sensors shall be mounted inside the ends of the hood. The hood shall contain a factory engineered and pre-piped, U.L. Listed, **Dual Agent, Wet Chemical and Water Assisted, Restaurant Fire Suppression System.** The system piping shall be installed in the hood at the time of construction.

Piping shall be installed above the hood. Overlapping spray from multiple nozzles shall create a totally protected cooking zone no matter how the cooking equipment is arranged. No exposed piping is acceptable, with the exception of appliance drops. A certified local distributor shall be selected by the factory for final system hook-up. The hood manufacturer shall be responsible for the coordination between the contractor and the distributor for the final field hook-up and certification of the fire suppression system.

The system shall be capable of automatic detection and actuation and/or remote manual actuation. When activated, the system discharges a fixed amount of wet chemical agent followed by water through the same nozzles.

The regulated release assembly shall contain an anti-siphon valve to prevent back-siphonage of possible contaminated water into the potable water supply. The system shall have the fire suppression capabilities to protect the duct, filter areas and cooking equipment.

A 2" mechanical and electrical gas line shut-off valve shall be supplied and installed, which will form part of and be linked to the hoods fire system. A remote pull station shall also be supplied and installed as part of the hoods fire system. The systems shall also send a signal to the building fire alarm system. The system shall also include the release assembly, agent tank, detectors, fusible links, liquid tight fittings, remote manual pull station, and schedule 40 black iron pipe with optional chrome sleeving for exposed areas.

The hood shall be supplied with a controller, which is designed to control the exhaust fan and lights for the kitchen ventilation system. The controller is interlocked with the fire suppression system. It signals the exhaust fan to start-up if it is off. The panel shall have two sets of dry contacts that can be used to signal a shunt trip breaker (supplied by others) or an electric gas valve (supplied by others) for appliance and outlet shutdown. The enclosure is constructed of 18 gauge 304 stainless steel.

The hood's exterior shall be constructed of a minimum of 18 ga. stainless steel with a #4 finish. The hood shall be constructed using the standing seam method for optimum strength. All seams, joints and penetrations of the hood enclosure shall be welded and/or liquid tight. Lighter material gauges, alternate material types and finishes are not acceptable. All unexposed interior surfaces shall be constructed of a minimum 18 ga. stainless steel including, but not limited to ducts, plenum, filters and brackets.

The hood shall include a filter housing constructed of the same material as the hood. There shall be sufficient number filter and sizes to ensure optimum performance. The filter housing shall terminate in a pitched, full-length grease trough, which shall drain into a removable grease container.

Vaporproof, U. L. Listed LED light fixtures shall be prewired to a junction box situated at the top of the hood for field connection. Wiring shall conform to the requirements of the National Electrical Code (NFPA #70- Latest Edition).

The canopy hood shall be constructed shall be built in accordance with

- International Mechanical Code (IMC)
- International Conference of Building Officials (ICBO)
- Building Officials and Code Administrators (BOCA)
- National Sanitation Foundation (NSF) Seal of Approval
- National Fire Protection Association (NFPA)

.02 **GREASE EXHAUST FAN**

Roof grease exhaust fans shall be upblast centrifugal belt driven type. **Fans are to be suitable for high wind and extreme weather applications.** Structural bracing on the interior and exterior of the fan combined with reinforced joints and high strength materials provide the added strength required to withstand winds of up to 150 mph. The fans are to be tested in accordance with Miami-Dade standards TAS-201/202 and approved.

Fan inlet sound power shall not be more than 20 sones.

The fan wheel shall be centrifugal backward inclined, constructed of aluminium and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminium with a rigid internal support structure with a protective coating on the exterior exhibiting good mechanical and chemical resistance properties, and excellent mar and chip resistance and toughness along with long-term resistance to humidity and corrosion. Windbands shall have a rolled bead for added strength and shall be joined to curbcaps with a leakproof, continuously welded seam. Fan shall be supplied with grease trap with drain connection and absorbent material and complete with galvanized steel insect screen.

Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators. Fan shall bear the UL/Cul-762 mark

Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum catalogued operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.

ALL mechanical equipment must be guaranteed free from defects in workmanship and material

## **SECTION 5**

### **PROJECT DESCRIPTION AND SCOPE OF WORK**

#### **TABLE OF CONTENTS**

5.01.00	PROJECT DESCRIPTION
5.02.00	SCOPE OF WORKS

**SECTION 5**  
**PROJECT DESCRIPTION**  
**AND**  
**SCOPE OF WORKS.**

**5.01.00      PROJECT DESCRIPTION:**

The project under consideration consists of the provision of new Air-Conditioning and Ventilation systems for the repairs to the Milton Cato Memorial Hospital (MCMH) located in St. Vincent and the Grenadines.

The air-conditioning system will be a chilled water system. The three operating theatres on the first floor are being refurbished with a new air conditioning plant, ductwork, and the air distribution and particulate control systems.

As a temporary measure, three operating theatres are being set-up on the ground floor utilizing different air distribution and particulate control systems compared to the permanent theatres on the first floor.

The ground floor theatres will be served in the short-term by one of the dedicated outside air systems, which will be located within the ground floor ceiling void with its corresponding chiller on the ground outside. When the first floor operating theatres are ready to function, the working dedicated outside air system and its chiller are to be relocated to the roof.

A twenty-five ton DX commercial split unit will be installed on the ground floor when the chilled water system is removed. The refrigerant pipework will generally follow the same route as the previous chilled water pipework

Tenderers are cautioned to offer equipment which works within the spatial constraints as this will be evaluated on tender submission and not at the time of installation. Failure to meet the spatial requirements will likely result in the disqualification of the tender.

**PROCUREMENT OF MATERIALS AND EQUIPMENT**

**According to the European Union guidelines for procurement, the source and origin of all materials and equipment used for the project must be from an eligible member country of the European Union. Procurement guidelines detailed in the Main Contractors documents take precedence and, if at variance, supersede the above.**



**5.02.00****SCOPE OF WORKS:**

The Works of this project must be executed in a manner which:

1. Establishes a new A/C system which is measurably consistent in performance and reliable as required for a facility of this nature.
2. Meets acceptable standards for indoor air quality.
3. Allows for phasing of the installation.

The works are described on the drawings and in the specifications and include but not necessarily limited to:

1. Communication with the Hospital's health and safety team to execute the works in such a manner as to support dust and infection control during the construction phase.
2. The supply installation of all fan coils, outside air units, fans, chillers, heaters and other equipment
3. The supply and installation of all pipe work including chilled water, condensate pipe, drains etc.
4. The supply and installation of all ductwork, insulation, fittings and accessories.
5. The supply and installation of all diffusers, grilles, registers and dampers complete.
6. The supply and installation of the complete building management and control systems.
7. The supply and installation of all valves, gauges, thermometers and other devices indicated on the drawings, schedules or specifications or otherwise necessary to complete the system.
8. The supply and installation of water treatment.
9. Commissioning and testing of the total air-conditioning system inclusive of all air side, water side and control systems to meet the requirements of the design.
10. Removal and safe disposal of ductwork on floor levels as well as on the roof, DX equipment inclusive of pipework, and condensers on the roof.
11. The provision of a record of the measurements taken.

# **MILTON CATO MEMORIAL HOSPITAL**

## **SCHEDULE OF DIFFUSERS, GRILLES, REGISTERS**

<b>DRAWING DESIGNATION</b>	<b>DESCRIPTION</b>
A	Laminar flow perforated supply diffuser with drop face for installation in a T-Bar lay in ceiling. The diffuser shall be of aluminium construction and provide a 4-way air pattern. The diffuser shall have a 16" x 16" neck size and 24" x 24" face size and shall be supplied complete with an opposed blade damper.
B	Laminar flow perforated supply diffuser with drop face for installation in a T-Bar lay in ceiling. The diffuser shall be of aluminium construction and provide a 4-way air pattern. The diffuser shall have a 14" x 14" neck size and 24" x 24" face size and shall be supplied complete with an opposed blade damper.
C	Exhaust air grille with ½" x ½" x ½" cubed core for 24" x 24" T-bar laying ceiling. Grille shall be of aluminum construction with a 14" x 10" neck size and shall be supplied complete with opposed blade damper.
D	Exhaust air grille with ½" x ½" x ½" cubed core for 24" x 24" T-bar laying ceiling. Grille shall be of aluminum construction with a 10" x 10" neck size and shall be supplied complete with opposed blade damper.
E	Exhaust air grille with ½" x ½" x ½" cubed core for 24" x 24" T-bar laying ceiling. Grille shall be of aluminum construction with an 8" x 8" neck size and shall be supplied complete with opposed blade damper.

## **MILTON CATO MEMORIAL HOSPITAL**

### **SCHEDULE OF DIFFUSERS, GRILLES, REGISTERS**

<b>DRAWING DESIGNATION</b>	<b>DESCRIPTION</b>
F	Laminar flow perforated supply diffuser with drop face for installation in a T-Bar lay in ceiling. The diffuser shall be of aluminium construction and provide a 4-way air pattern. The diffuser shall have a 12" x 12" neck size and 24" x 24" face size and shall be supplied complete with an opposed blade damper.
G	Return air grille with ½" x ½" x ½" cubed core for 24" x 24" T-bar laying ceiling. Grille shall be of aluminum construction with an 12" x 12" neck size and shall be supplied complete with opposed blade damper.
H	Exhaust air grille with ½" x ½" x ½" cubed core for 24" x 24" T-bar laying ceiling. Grille shall be of aluminum construction with an 8" x 8" neck size and shall be supplied complete with opposed blade damper.
J	Exhaust air grille with ½" x ½" x ½" cubed core for 24" x 24" T-bar laying ceiling. Grille shall be of aluminum construction with a 20" x 20" neck size and shall be supplied complete with opposed blade damper.
K	Ceiling mounted supply air diffuser incorporating a "high induction" feature for installation in a T-Bar lay in ceiling. Diffuser shall be of aluminum construction, providing 4-way air pattern and supplied complete with opposed blade damper. The diffuser to have a 9" x 9" neck size.

## MILTON CATO MEMORIAL HOSPITAL

### SCHEDULE OF DIFFUSERS, GRILLES, REGISTERS

DRAWING DESIGNATION	DESCRIPTION
L	Exhaust single deflection air grille of 316 stainless steel construction shall have individually adjustable deflection blades on ¾" centers. The grille shall have horizontal front blades and shall have 20" x 6" neck size and shall be supplied with a stainless steel opposed blade damper that is operable from its face. It shall have countersunk screw holes.
M	Laminar outlet ensuring excellent air flow in the operating zones. The construction for these diffusers shall be <b>304 stainless steel</b> . They shall consist of an air outlet frame and an air discharge element on the underside, with two housings on the top side each with a built-in HEPA filter H14. The air flow requirements indicated on the drawings shall be satisfied.
N	A wall mounted air grille with 45° deflection horizontal vanes. Grille shall be constructed of aluminum with an 8" x 8" neck size. Grille shall be supplied complete with an opposed blade damper.
P	A wall mounted air grille with 45° deflection horizontal vanes. Grille shall be constructed of aluminum with a 20" x 18" neck size. Grille shall be supplied complete with an opposed blade damper.
R	A wall mounted air grille with 45° deflection horizontal vanes. Grille shall be constructed of aluminum with a 32" x 20" neck size. Grille shall be supplied complete with an opposed blade damper.

## **MILTON CATO MEMORIAL HOSPITAL**

### **SCHEDULE OF DIFFUSERS, GRILLES, REGISTERS**

<b>DRAWING DESIGNATION</b>	<b>DESCRIPTION</b>
S	A wall mounted air grille with 45° deflection horizontal vanes. Grille shall be constructed of aluminum with a 46" x 14" neck size. Grille shall be supplied complete with an opposed blade damper.
T	Exhaust single deflection air grille of 316 stainless steel construction shall have individually adjustable deflection blades on ¾" centers. The grille shall have horizontal front blades and shall have 40" x 18" neck size and shall be supplied with a stainless steel opposed blade damper that is operable from its face. It shall have countersunk screw holes.
DG-A	Door grille shall be made of extruded aluminum and shall be of the double flanged type providing a surface mounted finish on both sides of a solid core door. The door grille core shall be 24" x 24".

**MILTON CATO MEMORIAL HOSPITAL**  
**SCHEDULE OF DIFFUSERS, GRILLES, REGISTERS**

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<b>DRAWING DESIGNATION</b>	<b>DESCRIPTION</b>
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**Note: Unless indicated otherwise all diffusers and return air grilles are to be white.**

**MILTON CATO MEMORIAL HOSPITAL**

**PACKAGE CHILLER SCHEDULE**

DESIGNATION	E.W.T	L.W.T	DELTA TEMP.	G.P.M	NOMINAL CAPACITY	AMBIENT TEMP.	COIL PRESSURE DROP
CHILLER BANK-1	57	45	12°F	75.2	100 kW	91°F	15ft. max
CHILLER BANK-2	57	45	12°F	46.9	80 kW	91°F	15ft. max

Available voltage: 415V 3-phase 50Hz

**MILTON CATO MEMORIAL HOSPITAL**  
**COMMERCIAL EQUIPMENT SCHEDULE**

UNIT	LOCATION	COOLING COIL PERFORMANCE								BLOWER PERFORMANCE			
		TOTAL CAPACITY (MBH)	SENSIBLE CAPACITY (MBH)	WATER FLOW (GPM)	ENTERING WATER TEMP. (F)	WATER TEMP. RISE (F)	MAXIMUM PRESSURE DROP (FT. WATER)	ENTERING AIR TEMP. (F)		AIR FLOW (CFM)	OUTSIDE AIR FLOW (CFM)	STATIC RESISTANCE AT DISCHARGE (IN WG)	MINIMUM (HP)
								DB	WB				
DOAS-1	ROOF	271.00	103.5	45.9	45.0	12.0	15.00	84.60	80.40	-	2,720	4.00	7.5
AC-1	ROOF	372.5	165.7	75.2	45.0	12.0	15.00	81.90	72.50	5600	3,400	4.00	10.0
AHU-1/ACCU-1	GROUND FLOOR	133.1	99.8	-	-	-	-	78.50	68.30	2000	360	4.00	10.0

AVAILABLE POWER: 415 V, 50HZ, 3 PHASE



**MILTON CATO MEMORIAL HOSPITAL**  
**EQUIPMENT FILTER SCHEDULE**

UNIT	LOCATION	FILTER PERFORMANCE									
		MAXIMUM FACE VELOCITY	PRE-FILTER			FINAL FILTER			TERMINAL FILTER		
			MERV Value	Initial Resistance (in. wg.)	Final Resistance (in. wg.)	MERV Value	Initial Resistance (in. wg.)	Final Resistance (in. wg.)	MERV Value	Initial Resistance (in. wg.)	Final Resistance (in. wg.)
AHU-1	GROUND FLOOR	500	8	0.15	1.00	-	-	-	17	1.35	2.70
AC-1	ROOF	500	8	0.15	1.00	-	-	-	17	1.35	2.70
DOAS-1	ROOF	500	8	0.15	1.00	-	-	-	17	1.35	2.70

MILTON CATO MEMORIAL HOSPITAL  
PRESSURE STABILISER SCHEDULE

DESIGNATION	PRESSURE (Pa)	AIR FLOW RATE (CFM)	BLADE LENGTH (mm)	QTY. of BLADES
PS-1	11	990	400	6
PS-2	14	1335	350	8
PS-3	14	466	250	4
PS-4	30	1000	300	5

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## ELECTRIC DUCT MOUNTED HEATER SCHEDULE

[illegible]

**MILTON CATO MEMORIAL HOSPITAL**  
**FAN COIL EQUIPMENT SCHEDULE**

UNIT No.	LOCATION	DX EVAPORATOR COIL PERFORMANCE			BLOWER PERFORMANCE		
		TOTAL CAPACITY	SENSIBLE CAPACIT	TEMPERATURE OF AIR ENTERING EVAPORATOR (F)	SUPPLY AIR FLOW	FAN RESISTANCE AT DISCHARGE	MIN. H.P
		(BTU/HR)	(BTU/HR)	WB	(cfm)	( IN W.G )	EACH
	Ground Floor						
CCU-1 / CU-1	ICU Room	15,380	12,470	73.3	400	0.25	0.30

**AVAILABLE POWER : 240V SINGLE PHASE 50Hz**  
**OUTSIDE AIR CONDITION: 90 F (D.B.)**

**MILTON CATO MEMORIAL HOSPITAL**

## ROOM DATA SHEET - SURGICAL SUITE

[illegible]

MILTON CATO MEMORIAL HOSPITAL										
FAN SCHEDULE										
FAN No. OR SYMBOL	Location	AIR QTY (cfm)	EXTERNAL STATIC IN WATER (in. wg.)	CONTROL	ACCESSORIES	SERVICE / LOCATION	AVAILABLE ELECTRICAL SUPPLY		SUGGESTED MANUFACTURERS (SEE SPECIFICATION)	
							VOLTAGE ( V )	PHASE	MAKE	MODEL
Fan - 1	<b>Ground Floor</b> Exhaust for Operating Theatres  <b>Roof</b>	1160	0.40	Interlocked with AHU-1		SIDE BLAST ROOF FAN	240	1		
Fan - 3	Corridor & Preparation #2	415	0.15	Interlocked with AC-1		ROOF	240	1		
Fan - 5	Operating Theatre #3, Plaster Room & Preparation #4	1950	0.9	Interlocked with DOAS-1		ROOF	240	1		
Fan - 6	Kitchen	4550	2.0	Switch		ROOF	400	3		