MECHANICAL ENGINEERING REQUIREMENTS FOR BUILDING PROJECTS

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1.0 GENERAL SCOPE OF WORK

1.1 All works with respect to investigation, design, construction, maintenance, etc. shall comply with the Governments Requirements.

1.2 All designs must optimally satisfy the requirement of visual aesthetic, functional adequacy, safety, robustness, ease of maintenance and cost effectiveness. ***The mechanical systems shall be design with the characteristic of an energy efficient and energy reusable building.***

1.3 Contractor's submission shall include but not limited to the ***Bill of Quantities*** (the contractor shall list down the individual breakdown item and costs according to the system designed), ***Design Drawings***, ***Technical Specifications/Data***, ***Original Catalogues***, ***Summary of Tender Prices***, ***Schedule of Unit Rates***, and ***Design Calculations***.

1.4 The Specifications and Requirements under this section of the document cover only the general scope of works for the mechanical services for the project.

The design shall comply with the standards of a modern Energy Efficient administrative office complex as stipulated in MS 1525:2001 or the latest edition.

Design principles, equipment selection and material specifications shall be in line with good engineering practice and shall give due regards to the following issues:

- Simplicity of design and installation
- Ease of operation and maintenance
- Energy conservation and impact on the environment
- System flexibility and adaptability
- Recognised and acceptable design criteria
- **Surrounding Ambient Conditions (coastal areas)**

The scope of work for mechanical installations and engineering services shall include (where necessary), but not limited to the following:-

No	Services	Applicable
1	Air Conditioning, Ventilation and Exhaust Systems	Yes
2	Fire Protection Systems	Yes
3	Kitchen Equipment Installation	Yes
4	L.P.G. System	Yes
5	Internal Cold Water & Sanitary Plumbing	Yes
6	Electric Lift Installations	Yes
7	Centralised Compressed Air System	Yes
8	Dust/Fume/Smoke Hood Extraction System	Yes
9	Overhead Travelling Cranes	Yes
10	Building Supervisory System	Yes
11	Energy Efficiency Requirements	Yes
12	Other Mechanical Requirements	Yes

1.5 The Contractor shall design, supply all materials, equipment, plants and labours, and perform all installation, testing and commissioning works required for the complete systems and satisfactory completion, functional and operational of the whole installation, repair and replace all defective and faulty materials, equipment, plants and perform all breakdown schedule and preventive maintenance works during the maintenance period as specified in the contract.

1.6 All materials and works, except those clearly defined, specified and stated not necessarily, shall be deemed to be included in the project and shall be supplied / performed by the Contractor. The above are complete fixed installations. The Contractor shall provide all materials and necessary fittings and perform any work which is obviously necessary for the proper and efficient functioning of these installations even though such material or work may not be explicitly mentioned in the specification.

1.7 The Contractor shall use local material, equipment, plant or product in his design, construction and installation for the mechanical services. Where local item is not available and imported item should be used in the design, the Contractor shall apply from MITI (Ministry of International Trades and Industries) and obtain written approval from the Treasury Department before any design and installation of imported items can proceed. The Contractor shall be responsible for any surcharge or penalty imposed by the Government for installing imported item and failing to obtain written approval from the Treasury of Malaysia.

1.8 Apart from the pre-bid for the individual installation, the Contractor shall also comply with the general instructions and conditions of Contract attached.

1.9 To prepare and submit conceptual design and detailed design drawings, detail design calculations, shop/construction drawings and as-built drawings as required. The above design documents and drawings endorsed by Professional Engineers and shall be submitted in both hardcopies and softcopies to JKR. Softcopy file format shall be as per JKR requirements. All the above deliverables shall be submitted according to agreed manner and as per schedule set out by JKR. The detail design report shall be compiled and submitted to JKR in a proper reporting format and in stages. The design report shall be neatly typed. All standards and reference used to support the design calculation shall be attached as appendix in design reports. All the design reports shall be submitted before submission of design drawings. Please refer to design submission requirements for each service in the relevant sections applicable for more detail.

2.0 GENERAL INSTRUCTIONS TO CONTRACTOR

2.1 The work to be tendered shall include the supply, delivery of all materials, appliances, labour and necessary incidentals for the complete installation, testing, painting, commissioning, operation and maintenance of the mechanical systems specified.

2.2 The Contractor must give sufficient breakdown tender prices and summaries of prices so that proper computation and assessment of his tender for each of the mechanical installations can be made individually.

2.3 All equipment quoted shall include all charges for transport, handling, Malaysian Government taxes and duties applicable. No tax exemption certificates shall be granted.

2.4 All installations quoted shall include a guarantee and maintenance for a period as stipulated in the condition of contract from the date of issuance of Certificate of Practical Completion.

2.5 The Contractor is required to give sufficient details such as the Name of manufacturer, country of manufacture, name of agent, model number for all the major equipment offered. Sufficient details such as the number of units, their capacities and relevant technical specification shall also be supplied so that an accurate assessment can be made.

2.6 All equipment offered shall also be of reputable make with an established local agent in this country. Adequate spare parts must be maintained by the local agent and trained local personnel made available to handle the subsequent maintenance of these equipment.

2.7 It shall be noted that where in the pre-bid a manufacturer's name and material or equipment is quoted followed by the phrase "or equivalent" such reference is intended as a guide to the type of construction, performance, general appearance and quality standard of manufacture and shall not exclude the offer of suitable alternative of similar standard and characteristics.

Submission of equipment / machine brand and model - All equipment/machines to be installed shall be of reputable make with an established local agent in Malaysia. Adequate spare parts must be maintained by the local agent and trained local personnel must be made available to handle the subsequent maintenance of these equipment. The contractor shall first submit to the Cawangan Kejuruteraan Mekanikal a list of all equipment brands and models for acceptance, prior to the issuance of purchase orders. In the event this condition is not adhered, the Project Director reserve the right to instruct the contractor to remove and replace any item not acceptable to the Cawangan Kejuruteraan Mekanikal and the contractor shall take immediate action and the contractor shall be entitled to any claim. However this clause shall not relief the responsibility of The Contractor under clause 3.14 of the “General Condition of Contract” or prevents the Project Director from exercising his right under clause 3.16 of the same section.

2.8 Should the Contractor consider there be any advantage by modification to any specification in the need statement, he shall draw attention to such.

2.9 The Contractor shall furnish together with his tender, such details as technical literature, brochures, schematic & layout drawings etc., and all information which are necessary for the complete assessment of the tender. All drawings shall be endorsed by professional mechanical engineers.

2.10 The Contractor shall also submit a schedule of rates. The price quoted shall include cost of materials, cutting, fixing in position, labour, supervision, profit and everything else necessary for the completion of the installation. This schedule shall be part of the tender and on the event of the Contract being awarded the net rates in the said schedule shall be used for the measurement and valuation of any alteration for addition to or omission from the works.

2.11 The Contractor shall also give a list of manufacturer's recommended essential spares together with the prices. However the prices for these spare parts shall not be included in the main tender offer. Notwithstanding this all spare parts required within maintenance and guarantee period as specified inside the contract would have already been built into the main tender offer.

2.12 Any updating, modification or alteration necessary for a comprehensive and functional mechanical system(s) as a whole **shall not be treated as variation** (s) to the contract.

2.13 Whenever there is any variation to the scope of work, the Contractor shall submit the drawings and schedule of quantities which describe the variation, and the schedule of rates of the respective quantity. The price quoted shall include cost of materials, cutting, fixing in position, labour, supervision, profit and everything else necessary for the completion of the installation. This schedule shall be part of the tender and shall be used for the measurement and valuation. In this respect, any instruction to update or modify any system, to achieve acceptable level of operation efficiency, reliability and maintainability, shall not be treated as variation to the contract.

2.14 The Contractor is required to submit manufacturer’s recommendations on Schedule of Service and Maintenance for all mechanical equipment in his submission.

2.15 *Percanggahan.*

i) *Jika berlaku percanggahan di antara kehendak Kerajaan dengan Cadangan Kontraktor, kehendak Kerajaan akan mengatasi Cadangan Kontraktor tanpa pelarasan kepada harga kontrak.*

ii) *Jika percanggahan berlaku di dalam kehendak Kerajaan, maka Pengarah Projek dikehendaki membuat keputusan dan mengeluarkan arahan sewajarnya.*

iii) Jika berlaku percanggahan di dalam Cadangan Kontraktor, Kontraktor dikehendaki memaklumkan kepada P.P.. akan Cadangan pindaannya untuk keputusan P.P. Kontraktor dikehendaki mematuhi keputusan P.P tanpa tambahan kos kepada harga kontrak.

2.16 *Perubahan Kerja*

P.P boleh mengarahkan perubahan kepada kehendak Kerajaan atau

Cadangan Kontraktor dan harga kontrak diselaraskan sewajarnye kecuali jika perubahan kepada Cadangan Kontraktor adalah disebabkan oleh kesilapan/kekurangan pihak kontraktor. Kontraktor boleh juga mencadangkan perubahan dengan persetujuaan P.P. tetapi hanya jika P.P berpendapat perubahan tersebut perlu untuk tujuan kesesuaian, fungsi dan keselamatan Kerja

(*Rujukan daripada* ***: Garispanduan Pengurusan Tender Bagi Projek Yang Dilaksanakan Secara Design And Build Atau Turnkey : 2006****)*

3.0. GENERAL CONDITIONS OF CONTRACT

3.1 Regulations and Rules

All work to be performed under this Contract shall be in accordance with the best commercial and engineering practice and shall comply to the regulations and bylaws of the following authorities:-

Jabatan Kerja Raya
Jabatan Keselamatan dan Kesihatan Pekerjaan
Jabatan Bekalan Air / Syarikat Bekalan Air Tempatan
Suruhanjaya Tenaga
Tenaga Nasional Berhad
Jabatan Alam Sekitar
Jabatan Bomba Dan Penyelamat
Lembaga Pembinaan dan Pembangunan Industri (CIDB)
Jabatan Perkhidmatan Pembentungan (JPP)

3.1.1 All other authorities having jurisdiction over the whole or part of the mechanical installation in the locality.

3.1.2 The Contractor shall obtain and fill in all notices when required by above mentioned authorities and shall obtain all approvals necessary for the various works to be executed by him and shall pay all fees in connection therewith.

3.1.3 All electrical equipment shall conform to the electrical supply characteristics as stated in the electrical section of The Pre-bid Document.

3.1.4 The Contractor shall double ensure with the manufacturer especially of equipment imported from USA or Europe that the working voltage range is 415V +5%,-10% or 240V +5%,-10% and not something like 380V min to 415V max as commonly happened to most equipment imported from USA

(NB: The 380V - 415V range equipment give_ rise to frequent overheating, tripping -and electronic parts burn-out problems)

3.2 Schedule of Work

The Contractor shall prepare a schedule of work. This schedule of work shall indicate clearly the sequence of operation required to complete the works of the Contract and also the commencement and completion dates of each section of the work.

A detailed schedule of work indicating the sequence of design, preparation of drawings, fabrication, construction, execution, installation, testing and commissioning, etc. of each type of services and works shall be **submitted within one month** after the award of contract.

3.3 Protection of Plant and Material

This protection shall include covers, crating, stores, sheds or other means to protect the apparatus, equipment and materials from the weather and the ingress of dirt, grit, plaster or other foreign substances. Special care shall be taken to keep all open ends of pipes, ducts, etc., closed while in storage in

the course of installation.

3.4 Protection of Property and Personnel

The Contractor's workman will be required to conform to the general regulations governing personnel on site. All precautions shall be taken for the safety of personnel on site. Barriers shall be erected and warning notices displayed.

3.5 Supervision

The Contractor shall have in his direct employ at all times an adequate team of qualified and experienced supervisory staff.

3.6 Site Meetings

3.6.1 The Contractor shall conduct regular meeting amongst the various trades of works to coordinate the installations of the services. Such meetings shall also be attended by the consultant engineers.

3.7 Workmanship

3.7.1 The Contractor shall furnish all labour skilled in their respective trades to carry out the work under this Contract in accordance with good engineering and commercial practices.

3.7.2 The Contractor shall furnish names of skilled labours, their trade certificates, experience, jobs that have been carried out and comments from the past job's owner or supervising consultant if any.

3.7.3 The skill labour shall wear identification card bearing name and trade while working at site.

3.7.4 All works performed and executed shall be of good engineering practices and with good workmanship. They shall be carried out and supervised by qualified, competent and skilled personnel.

3.8 Materials.

3.8.1 All materials and equipment to be supplied shall be new and unused and shall generally be of the best quality as regards to design, manufacture and performance.

3.9 Patent Rights

3.9.1 The Contractor shall fully indemnify the government against any action, claims or demands, costs or expenses arising from or incurred by reason of infringement of letters, patent rights and design, trademark or name, copyright or other protected means in respect of any machine, plant, work, materials or things, systems, method of using, fixing working or arrangement used, fixed or supplied by him.

3.9.2 All payments or royalties payable in one sum or by instalments or otherwise shall be included by the Contractor in his tender and shall be paid by him to

whom they may be due or payable.

3.9.3 In the event of any claims being made or action brought against the government in respect of such matters as aforesaid, the Contractor shall immediately be notified there of, and he shall at his sole expense, conduct all negotiation for the settlement of the same or any litigation that may arise there from.

3.10 Variations

3.10.1 For variations, refer to Main Contract Conditions.

3.11 Operating Instructions and Tuition

3.11.1 After completing the installation and before handing it over the Contractor shall arrange to instruct, free of charge, one or more client operators, in all aspects of correct operation and maintenance of the installation, including checking and fault finding in case of breakdown during normal working hours. This period of instruction shall-extend for minimum of four (4) weeks with the plant in continuous normal operation or period specified by P.D/S.O.

3.11.2 In conjunction with the above tuition, the Contractor shall supply in quadruplicate, printed sets of operating instructions which shall clearly indicate the sequence of operation for starting and stopping the entire plant and shall include the precautions to be taken. The operating instruction shall be complete with an "As completed wiring diagram and a schematic layout of the complete installation and control system". One copy of the operating instructions shall be supplied permanently mounted in a glazed frame to be hung on the plant room wall adjacent to the electrical switchboard. The instructions shall be in both English and Bahasa Malaysia.

3.12 Repair Manuals and Spare Parts.

3.12.1 The Contractor shall supply in quadruplicate complete sets of repair manuals and spare parts books for all the equipment comprising the complete installation installed by him. In addition, the Contractor shall submit in quadruplicate, a detailed and itemised list of equipment and spare parts, which the manufacturers of the supplied equipment consider as essential to be kept in ready stock for the purpose of yearly services and maintenance. Each item shall be as priced in the original Contract submission.

3.12.2 For imported and some locally made equipment, the operating and repair manuals spare parts are usually shipped in and attached together with the equipment. On arrival, the contractor shall immediately mark in 'type', 'model' and especially 'serial number' on the manual and keep one (1) set by himself for future binding and handing over. He shall make a Photostat copy of the manual and pass it to the PD for reference and relevant action. If more than one equipment of the same type and model are supplied, the contractor shall still keep one original set but required to pass one (1) Photostat copy of that particular set and also original manuals of the rest of the same equipment to the PD for the same mentioned purpose. All Photostat copy and original copies passed over to PD shall not be returned to the contractor. The contractor shall make master list of the manuals handed over and obtain acknowledgement from the relevant P.D/S.O's representative.

3.13 Testing and Commissioning

3.13.1 Testing and Commissioning

All services after installation shall be properly tested and commissioned. Where available, testing and commissioning procedures shall follow the recommended procedures laid by the manufacturer.The Contractor shall carry out pretest and tests on all individual sections of each system to prove that the individual capacities specified for all equipment can be produced and maintained. He shall also carry out tests on each system as a whole to prove that the equipment has been properly adjusted and calibrated to produce the required guaranteed performance and efficiency as offered.

The Contractor shall arrange for the whole installation to be completed, tested, certified safe to use according to the rules, regulations and requirements of the authorities having jurisdiction over the installation works and the equipment installed. The tests shall be carried out and with test results wholly endorsed by qualified and competent personnel and according to the local laws.

For the major equipment such as Chillers, pumps, air handling units, fans, lifts, etc., the Contractor shall arrange and provide all expenses for the four (4) representatives of *JKR* to witness the performance/load test either locally or at some other locations having the testing facilities. The testing facilities shall preferably be of internationally accredited. The Contractor shall also submit testing procedures (shall be approved by Consultant and in accordance with international recognized test standards) and valid calibrated test certificates of all measuring instruments used in the test lab to the JKR, 6 weeks prior to the testing date.

When the above tests have been completed to the satisfaction of the Contractor, the Contractor shall arrange with the *JKR* for a joint inspection so that the JKR shall be present to witness the testing and commissioning. The Contractor shall certify the satisfactory completion of the mechanical and plumbing works systematically and respectively.

The Contractor shall also submit commissioning manuals/ procedures to the JKR before the commencement of testing and commissioning. Brief lectures on the testing and commissioning procedures shall be conducted for the *JKR and their delegates* before the testing and commissioning.

A complete record of the tests and results of such tests (whether successful or otherwise) shall be kept up-to-date by the Contractor. At the conclusion of all the tests, these records shall be collected, bounded and submitted to the JKR.

Should the whole or part of the installation or equipment fail to produce the required performance as offered, the Contractor shall be required to carry out the necessary modifications or even replace the same at his own cost with an alternative agreed by the JKR.

All energy, chilled water, water, fuel, natural gas and fire extinguishing agent etc. consumed during the testing and commissioning shall be paid for and included in the tender pricing by the Contractor.

All equipment after installation shall be properly tested and commissioned. The Contractor shall carry out test on all individual section of the system to prove that the individual capacities specified for all equipment can be produced and maintained. He shall also carry out test on the plant as a whole to prove that the equipment has been properly adjusted and calibrated to produce the required guaranteed performance as offered.

3.13.2 The testing and commissioning shall be carried out and endorsed by qualified and competent mechanical engineers. The contractor shall also notify the Project Director where and when these tests are to be conducted so that a representative (s) may be present for observation and satisfaction.

3.13.3 Prior to the actual testing and commissioning carried out, the contractor shall put forward testing format with all information on make, type, model ,serial numbers, etc already printed in and a list of tests to be performed and empty column or spaces for results when actual test have been carried out. A copy of each testing format shall be viewed and modified to PD's acceptance and satisfaction.

3.13.4 Further adjustments to the controls shall also be made whilst the building is occupied and the installation is in use .during the defects liability period. No additional cost shall be charged in carrying out these adjustments.

3.13.5 For outstanding works and defects recorded during the handing over or defects liability period.

3.13.6 The Contractor shall also perform all other commissioning tests which may be specified elsewhere in this tender.

3.13.7 A complete record of the tests and results of such tests (whether successful or. otherwise) shall be kept up-to-date by the Contractor. At the conclusion of all the tests, these records shall be collected and two bound sets provided to the Project Director.

3.13.8 Prior to section 3.13.6 and for ease of monitoring, the contractor shall sent in test result in loose forms in stages to P.D/S.O for Viewing and satisfaction, such as hydrostatic test, duct air tightness test which are to be carried out during early stages

3.14 Failure to Achieve Guaranteed Performance

Should the whole or part of the installation fail to produce the required performance on test as offered, the Contractor shall be required to carry out the necessary modifications or even replace the work/equipment with an approved alternative at his own cost.

3.15 Upgrade or Modify

Any instruction to upgrade or modify any system to achieve acceptable level of operation efficiency, reliability and maintainability shall not be treated as variation to the contract.

3.16 Handing Over

Upon satisfactory completion of all the tests, a certificate shall be issued by a

competent and independent professional engineer. However the handing over of the works shall be on the date of practical completion of the services concerned or of the whole project, which ever is later.

3.17 Record Drawing and Particulars

The Contractor shall furnish a complete set of all as built drawings in **CD-ROM** and in reproducible transparent prints and submit **four** sets of bound ordinary prints of the as built drawings on practical completion of the whole project.

3.18 Maintenance and Guarantee

3.18.1 The maintenance and guarantee period shall be from the date of handing over the completed project. This guarantee shall include those provided by the manufacturer of the equipment installed and all materials and workmanship supplied by the Contractor.

3.18.2 During this period, the Contractor shall at his own expense, remedy and supply/replace all defective parts or items, inclusive of all consumable items so that the complete mechanical system is maintained in a first-class running order. This maintenance shall include regular and systematic checking, cleaning and necessary adjustments to the equipment.

The Contractor shall also provide adjustments to the service as required in the event of a breakdown of the plant. Any spare parts required for breakdown repairs shall also be included during this period.

3.18.3 Replacements made during the maintenance and guarantee period may be subjected to a similar maintenance and guarantee period from the date of replacement.

3.18.4 A Record Book shall be attached to each equipment or kept in every plant room for purpose of recording services or repairs carried out and acknowledgements by both contractor and user. This record book is an important and essential documentation in ensuring proper and regular attentions & maintenance at least once a month on each and every mechanical equipment or plant.

3.18.5 A check list on types and intervals of servicing and maintenance to be carried out shall be displayed and attached to each equipment or kept in every plant room for ease of reference and ensuring proper and adequate maintenance. A copy of it shall be forwarded to PD within a month after Testing & Commissioning for his viewing and satisfaction. This checklist forms part of the maintenance schedule as stated in section 3.18.8 to follow.

3.18.6 The contractor shall write-up Service Report at site on each time maintenance or repairs being carried out and gets it endorsed by the user. A copy of it shall be forwarded to PD at least once a month during the free maintenance & warranty period for his viewing and satisfaction.

3.18.7 Contractor's Maintenance Team

The Contractor shall set up its own maintenance team responsible for carrying out maintenance work and also to develop and implement a suitable

maintenance management system (see section 3.18.5). The team shall be headed by an experienced engineer supported by clerical/computer staff. All staff assigned to the team will be subjected to the approval of the P.D.

3.18.8 Maintenance Management System

A suitable computerized maintenance management system shall be provided for the Project. The Contractor shall provide all necessary hard and software for the system.

The system shall be effective to provide feedback to facilitate quick decision making including the ability to generate the following:-

Maintenance schedule for each and every equipment

Maintenance tasks

Plant/equipment history

Labour and material cost

3.18.9 Tools and Apparatus

The Contractor shall provide adequate tools and other apparatus necessary to carry out periodic maintenance after defects liability period. A list of proposed tools shall be forwarded by Contractor to P.D for approval.

3.19 Power Factor Requirement.

The power factor of all the equipment supplied shall not be less than 0.85.

The above condition is to be achieved by power factor improvement equipment or devices. However, if the power factor correction is done other than at the load, then the cabling, electrical switching protection devices between the load and the point of correction shall be rated according to the worst power factor condition that may be subjected to.

The Contractor shall be liable to pay any surcharge levied by TNB as a consequence of low power factor of the installed equipment.

3.20 Factory Test Certificate.

Test certificates (certified copy in lieu) for tests done in the manufacturer's factory for any equipment and compliance to standards mill certificate for materials shall be submitted to the P.D.'s office as soon as possible and shall be before the commissioning of the system.

3.21 Pre-delivery Inspection / Performance Tests.

The Contractor shall provide at his own expense for government personnel (3 persons) to inspect all major equipments and materials of high value at source prior to delivery. The objective of such inspections is to check compliance to quality standards as stipulated in the Contract. Performance tests witnessing should be included in the inspection programme wherever possible.

Expenses shall include accommodation, fares, subsistence and any other incidentals required for the occasion shall be included in the tender sum.

3.22 Defects and Outstanding Works

A master list shall be kept for mechanical defects and outstanding works recorded on handing over and during the defect liability period. Each listing shall be made specific as to exact locality, which equipment and what defects or outstanding works and 'empty spaces' shall be provided for updating whether 'DONE' or 'NOT DONE' and endorsement and chop by the user. Those defects or outstanding works already declared 'DONE' and accepted by the user shall be erased off in the next updating. A copy of it shall be forwarded to P.D monthly for viewing and satisfaction.

3.23 Installation

3.23.1 The contractor shall put up Master Working Drawings on M&E with all services indicated in the same drawings. These drawings shall be endorsed by qualified and competent M&E engineers. A set(s) of which shall be forwarded to P.D for viewing & satisfaction

3.23.2 In term of priority, air-conditioning duct shall be given top priority followed by big pipes, sprinkler pipes and finally electrical wiring.

3.23.3 In term of safety considerations, electrical installation shall be placed at the highest top, below piping or air condition ducting.

(NB: A clearance of at least 150mm gap is required for between air conditioning duct & ceiling to facilitate grille connection)

3.23.4 Installation Progress Report shall be put up specifically in terms of Block, Floor, Room or specific areas like corridor, lobby, catwalk etc, with involved M&E services and also civil work like brickwork, plastering, flooring, ceiling work, painting listed down. The sequence of listing shall follow priority as stated in section 3.23.2 i.e. firstly mechanical services, then electrical services and finally civil works.

3.23.5 Under the installation progress report, there shall be columns for percentage completion, signatures of trade contractor in higher priority permitting other trade contractors to carry out works (e.g. when air-conditioning contractor has completed his duct works or feel that certain trades like wiring work is not affecting his air duct installation, he will make signature in the column same
row with the concern trade like wiring, signifying trade contractor of lower priority may commence their respective works) and also for special comments and remarks.

3.23.6 This installation progress report shall be monitored and acknowledged by qualified and competence M&E engineer. A weekly report of such shall be forwarded to P.D for observation and satisfaction.

3.23.7 Prior to commencement of M&E installation, the contractor shall make reference to the Working Drawings and mark the position of various M&E

points, like power points, cold water points, hot water points, etc exactly and precisely at site for each and every room and areas. The qualified and competent M&E engineers shall inspect and confirm the points before the various trade contractors are allowed to commence works. The contractor shall also notify the P.D on services points already marked and certified so that a representative(s) may be present for observation and satisfaction.

3.23.8 The contractor shall refer-any discrepancies found in the mechanical requirements to the P.D. for final decisions.

3.24 Training

After the completion of the installation and prior to handing over, the Contractor shall train operators nominated by the JKR on all aspects of correct operation and maintenance of the installations, including checking and troubleshooting.

The Contractor shall arrange for a proper training and courses, both classroom lectures and on site practical or hands-on training, for *JKR and their delegates* on the operation and maintenance of the installations and equipment at a suitable time before and/or after the commissioning and acceptance tests. Proper notes, instructions, manuals etc. shall be provide for the trainees. The duration of test shall be subjected to JKR's final approval.

4.0 AIR-CONDITIONING, VENTILATION AND EXHAUST

4.1 General

4.1.1 The air conditioning, ventilation and exhaust system apart from creating comfort conditions is required to:-

- Remove particulate or gaseous contamination and airborne micro-organisms by ventilation and filtration for spaces which require such degree of cleanliness.
- Achieve close tolerances in the various temperatures and humidity requirements for various areas.
- Allow for accurate control of environment conditions.

4.1.2 Areas requiring air conditioning shall have the specific air changes, temperature control, humidity control, air treatment and relative pressurization where applicable to ensure proper function for these areas.

4.1.3 The latest edition of the following standards shall generally be applicable to the design of the air conditioning and mechanical ventilation systems. Where there is difference in standards or requirements between two documents or between a document and the specific requirements of the local authorities having jurisdiction, the more stringent standard or requirement shall be applicable.

- Uniform Building By-Laws
- Code of Practice for Fire Precautions in the Design of Buildings – Smoke Control in Protected Escape Routes Using Pressurisation – MS 1472 for pressurisation system.
- Outdoor Air Quantities – Latest version of ASHRAE 62 “Ventilation For Acceptable Indoor Air Quality”
- Fire mode operation and smoke control – BS5588 Part 4 and AS 1668 Part 1 “Fire Precautions in Buildings With Air Handling Systems”
- Noise levels in occupied spaces – AS 2107 “Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors”
- Legionella control
- AS 3666 “Air Handling And Water Systems of Buildings
- Microbial Control”
- Latest Edition of SMACNA, ASHRAE AND ARI standards and its recommendations.
- Code of Practice on Indoor Air Quality of Jabatan Keselamatan dan Kesihatan Pekerja.

It is to be noted that the standards as stated in section 4.1. 3 shall however be not lesser the one as stipulated in the latest edition of the Malaysian Uniform Building By-Laws.

4.1.4 Air side design

The air side system shall be designed to provide air conditioning only when the user of the space requires it, i.e. it shall be demand driven rather than

system driven (decentralised Air Handling Unit/Fan Coil Unit) . Wastage of energy shall be avoided such as using big Air Handling Unit to serve few areas whereas the areas are not occupied at the same time. Factors such as cross contamination, noise, etc. shall be considered in compartmentalising the air side.

4.1.5 Fibreglass in whatever form, shall not be used in contact with air stream.

4.1.6 Special Requirements for Room with Temperature and Humidity Control

The Contractor shall take precaution to prevent condensation on the external surfaces of the walls, floors and ceilings of the rooms being air-condition for 24 hours or where the design temperature is 20°C or below. The minimum specification for the construction of such room shall be:-

floor located at ground	- proper waterproofing, moisture proofing shall be provided.
wall and partition	- sandwich wall with insulation of class "O" Polyurethane Foam, minimum thickness of 2in., in between. The wall shall be painted with class "O" polyurethane paint.
floor and ceiling	- ceiling shall be of moisture proof material and shall be insulated with at least 2in. class "O" sprayed Polyurethane Foam and to be painted with polyurethane paint. Except for ground floor, the bottom part of the floor shall be insulated with at least 2in. class "O" sprayed Polyurethane Foam and to be painted with polyurethane paint.
doors and windows	- to design for air tightness, properly insulated and double glazed. Air lock zone shall be provided.

4.1.7 The Contractor is also required **to provide air conditioning system with standby** for rooms which housed components / parts sensitive to high temperature, high humidity and dust, such as UPS room, server room, PABX room etc., and mechanical ventilation in case both of the air conditioning system fail. Where humidity is critical to the equipment / parts, humidity control system with stand by unit shall also be provided.

4.1.8 To provide cold room system and the other requirement of cold room system such as insulation and etc.

4.2 Scope of Work

The scope of work under the air conditioning, ventilation and exhaust shall be as follows:-

i. To design, supply, deliver, install, test and commission to successful operating conditions the complete air conditioning, ventilation and exhaust system.

ii. The Contractor shall propose a system which is energy efficient and will enables cost saving on operation and maintenance of the system. A full detail of the study shall be submitted together with the tender submission for government's considerations.

iii. All systems and equipment installed (e.g. hydrophilic coated fins for condensing and cooling coil) shall be suitable for tropical conditions.

iv. Mechanical ventilation system for toilet (where applicable), M & E utility room, basement and other areas as required.

v. Water treatment shall be provided for chilled & condenser water against rust and sludge accumulation.

vi. Where necessary interfacing requirement for tripping the AHU at the air- conditioning control point, mechanical fans, fire panels and booster pumps.

All assumption and reference used shall be clearly stated and substantiated with extracts of relevant standard used.

4.3 Pressure Differential and Ventilation Guidelines.

4.3.1 Listed below relates the general pressure relationships and ventilation of certain areas.

No (s)	Areas	Pressure Relation-ship	Minimum Outdoor air change per hour (ach)	Minimum air changes to room	All air exhausted directly to outdoors
1	All Clean Rooms	P	20	20	Yes
2	All Computer Rooms	P	6	6	No
3	Lecture Theatre	P	6	10	No
4	Laboratory	N	6	12	Optional
5	Laboratory, media transfer	P	15	15	Yes
6	Repositories	P	6	6	No
7	Patient Room	E	2	6	Optional
8	Examination Room	E	2	6	Optional
9	Pharmacy	P	2	6	Optional
10	General Areas ie. Office etc	P	6	6	No
11	Circulation Area ie. Lobby etc	E	6	6	No
12	Toilet	N	-	10	Yes
13	Kitchen	N	-	10	Yes
14	Workshop	N	-	10	Yes

No (s)	Areas	Pressure Relation-ship	Minimum Outdoor air change per hour (ach)	Minimum air changes to room	All air exhausted directly to outdoors
15	Chemical Stores	N	6	10	Yes
16	Gas Store Rooms	N	-	10	Yes
Where P = Positive, N = Negative, E = Equal					

4.3.2 The pressure difference measured between the positive pressure areas and their surrounding shall be about 0.06" w.g or above. In this respect, the Contractor shall supply and install Pressure Differential Gauge for confirmation.

4.3.3 Exhaust system shall be provided where toxic and fume are to be extracted out.

Also all mechanical exhaust systems, where necessary shall be provided with fan silencers to maintain noise level acceptable to PD.

4.3.4 **Energy saving features shall also be incorporated in the design as much as possible.**

4.4 Temperature and Humidity for Air Conditioned Spaces

Areas	Temperature	Humidity
Office Rooms	$75^{o}F \pm 2^{0}F$	55% RH ± 5% RH
Clean Rooms	$68^{o}F \pm 2^{o}F$	50% RH ±5% RH
Computer Rooms	$68^{o}F \pm 2^{o}F$	50% RH ±5% RH
Lecture Theatre	$75^{o}F \pm 2^{o}F$	55% RH ±5% RH
Laboratory	$75^{o}F \pm 2^{o}F$	55% RH ±5% RH
Special Equipment Rooms	$68^{o}F \pm 2^{o}F$	50% RH ±5% RH
General Areas	$75^{o}F \pm 2^{o}F$	55% RH ±5% RH
Archive Rooms	$72^{o}F \pm 2^{o}F$	40% RH ±5% RH
Circulation Area ie. Lobby etc	$79^{o}F \pm 2^{o}F$	55% RH ±5% RH
(NB: Fahrenheit scale is used because its scale is smaller and more precise. In this respect, the Contractor shall supply to the Project Director and also the user one set of sling Psychrometer Dry and Wet-bulb thermometer in Fahrenheit scale each for his permanent usage and monitoring)		

The air conditioned spaces shall be designed to give the temperature and humidity above.

Any other rooms which required specific temperature and humidity, the contractor shall refer to the system specialist and shall be designed to give the temperature and humidity required.

4.5 Controls

4.5.1 **Soft starter** - Reliable brand soft starters shall be used instead of conventional star-delta or auto-transformer starter for any motor of 3hp and above. **All soft starter/inverters used shall be designed for building services application only and the power factor shall remain unity at any condition. Soft starter/ Inverters designed for general purpose shall not be used.**

4.5.2 **Sensor** - Universal type sensors of reliable brand shall be used: 0-10V DC, 4-20 mA, 0-1000 ohms.

4.5.3 Humidity control shall be provided where necessary such as at:-

(i) Clean Rooms
(ii) Computer Rooms
(iii) Archive Rooms
(iv) Lecture Theatre
(v) Laboratory
(vi) Special Equipment Rooms
(vii) Other rooms, subject to Original Equipment Manufacturer (OEM) and where specified by the Project Director.

The contractor shall take precaution to prevent condensation on the external surfaces of the walls/floors of the rooms served by 24hr. air-condition.

Frontal toilets and other designated spaces (i.e. dark room, etc.) that are not naturally ventilated shall be provided with mechanical ventilation system in accordance with code requirements.

Piping systems shall comprise of:-

- Complete drain piping system
- Instrumentation for the various piping systems

4.6 AIR-CONDITIONED SPACE ZONING AND BACK-UP SYSTEMS

4.6.1 The air conditioning design shall follow the following guidelines:-

All office areas are to be provided with air conditioning system, zoned according to floors or areas, different types of usage, etc. and a limit to the size of AHU selected in the zones to a manageable level.

Individual rooms such as conference hall, meeting rooms, restaurant, lecture rooms, etc. are to be provided with separate air conditioning system / AHU's with individual control.

All Senior Officer rooms are to be provided with additional split unit as back-up apart from central air conditioning system.

Areas that require 24 hours air-conditioning system shall be provided with a back up air-conditioning system.

4.7 General Criteria for Selection of Type of Air-Conditioning Equipment

Nos.	Capacity (T.R.)	*System Type
1	0-5	Window/ Split
2	5-20	Air-cooled split / VRV
3	20-40	Water Cooled package / VRV
4	40-100	Water cooled package
5	100 - 400	Water cooled package / Air cooled Chilled water system
6	Above 400	Water cooled chiller system

*The above schedule is intended as a guide and the design of air-conditioning system shall also depend on the situation, space requirement and building type and usage, layout of the complex, etc.

Types of air conditioning system selected shall be governed by the following criteria:

a) The system selected shall generate minimum noise level due to the nature of the existing surrounding.
b) The availability of plant room space and AHU rooms sizes.
c) Existing local air and water ambient temperature.
d) The economics, maintenance and the practicality of having the system in the area.

4.8 Air Filtration for Air-Conditioned Spaces.

4.8.1 This shall cover both filtrations of supply air to rooms and of objectionable exhaust to atmosphere.

CSSD-prep area: 2 stage air filtration of not less than 90- 95% to ASHRAE Std 52-76 dust spot test.

General Area: Standard washable prefilter at fresh air intake to not less than 30% efficiency and secondary filter located before the coil efficiency of 80% based on ASHRAE 52-76 dust spot test.

Other areas not specifically mentioned shall be designed to meet the functional requirements.

4.8.2 The Contractor shall supply Test filters for use during Testing & Commissioning stages. The Test Filters shall be removed only when the system has been fully run-in with all dust and particle in the air removed to satisfactory level.

4.8.3 As stated in section 3.18.2, the Contractor is required to replace all filters at no extra cost, or if they are already loaded with dust or static loss reached or exceeded the manufacturer's recommendation limits during the maintenance & Guarantee period as mentioned in the condition of contract.

4.8.4 The Contractor is not permitted to test or commission each and every system until his own mechanical consultant has inspected and certified the air-tightness of each stage of filter banks.

4.8.5 The design calculations should generally be in accordance to the requirements of ASHRAE design guides.

4.9 Mechanical Ventilated Spaces.

Mechanical ventilation shall be provided for the following:-

All areas with 100% fresh air
All internal corridors
Underground areas
Kitchen /Cooking area.
Corrosive stores.
Internalised disposal / sluice.
Gas stores rooms
Toilets.
All plants/machine rooms.
Lift motor room.
General stores
Switchboard / Generator room /TNB rooms etc.

The above list is not exhaustive. Any other space which requires ventilation for its proper functioning shall be provided accordingly.

4.10 Equipment

4.10.1 Chillers.

Chillers shall be a complete factory package including compressor motors, water coolers, condenser refrigerant, flow control devices and other necessary auxiliaries. Each unit shall be factory assembled, checked and tested.

Compressor shall be of the centrifugal or screw type.

Refrigerant shall be R22/R134a.

Cooler and condenser shall be selected to have 0.0005 and 0.001 fouling factor respectively.

Capacity control, operating and safety controls and control sequence shall be completely fail-safe.

The configuration of the chillers shall include one identical standby unit.

Each chiller shall be selected to have a Kwh/Ton of refrigeration not more than 0.65.-0.75 depending on type of chiller.

The operation of the chiller group shall be automatically controlled according to the system load demand.

A sufficient number of chiller-sets shall operate on standby generator to cater for essential requirement.

4.10.2 Water Pumps

The water pumps shall be of a reputable make and the installation shall follow the recommended **Good Engineering Practice**.

4.10.3 Cooling Towers.

They shall be a single tower having multi-cells or the same number of separate single cell towers.

Water treatment plant shall be a complete package incorporating proportioning metering equipment, feed tanks, mixing tanks and other accessories.

The cooling tower fan-drive shall be direct-coupled type or driven by long-shaft.

Cooling tower shall be of square and super low noise type.

To facilitate entry into the cooling tower for inspection and maintenance, FRP inspection door & internal walkway shall be provided.

4.10.4 Air Handling Units (AHU) / Fan Coil Units (FCU).

Each unit shall be complete with blower and motors, high quality V-pulley (equivalent to Japanese or UK made), drive guards, cooling coils, drain pan and pipes, air-filters, face and by pass dampers etc.

Standard filters having a dust extraction efficiency of not less than 30% as measured by ASHRAE standard 52-76 dust spot test shall be provided generally for all areas.

Whenever two stage air filtration is used, it shall include the standard filter and secondary filter having an efficiency of not less than 90-95% to ASHRAE standard 52-76 (atmospheric dust).

Whenever three stage air filtration is used, it shall include the standard filter and secondary stage filter having an efficiency not less than 85-90% based on ASHRAE Standard 52-76 (atmospheric dust) and the third stage shall be HEPA filters with efficiency not less than 99.97% on 0.3 micron particles by the DOP Test Method.

The Contractor is required to furnish AHU room sizes (Width, Depth and Height) with allowance for servicing bays and head room.

Rooms must be provided for all AHUs and the rooms must be fully insulated, vapour sealed, sound-proof and airtight. A test on air-tightness is a must for each and every AHU room and the test must be conducted by qualified & competent engineer. A copy of the test report must be forwarded to Project Director for viewing and satisfaction.

The Contractor must provide bib-tap and waste point for each and every AHU room. Lighting and plug-point shall also be provided. The drain pipes of not less than 19mm diameter shall be insulated with superlon or equivalent.

The Contractor must also provide one (1) no. flushing valve and one (1) no.

fine mesh type strainer, balancing valve, modulating valve and isolation valve, flexible pipe joints, in the chilled water piping to each AHU/FCU and also one (1) no. flushing valve at chilled water outlet from each AHU/FCU. The flushing valve shall be insulated with superlon or equivalent, tapped from the top of the piping and bent down with extension for hose connections. Both AHU/FCU must be provided with temperature sensors for automatic capacity control, thermometers & heavy duty industrial type pressure gauges at supply and return.

All AHU's shall be of double skin type with minimum of 50mm PU insulation or equivalent. AHU shall be installed on a concrete plinth, where the height of the plinth is sufficient to form an S- trap in the condensate drain pipe. Generally the height shall not be less than 4 inches.

4.10.5 Piping.

Chilled water
Heavy grade galvanised steel heavy gauge class "C" pipes to BS 1387:1985 and JIS G3452 for bigger size. Pre-insulated with rigid PU & spiral lock seam outer jacket for above ground and HDPE outer jacket for underground application.

Condenser Water
Heavy grade galvanised steel heavy gauge class "C" pipes to BS 1387:1985 and JIS G3452 for bigger size. Factory coated / wrapped externally with bituminous compound to BS 534/1981 for corrosion protection for underground application.

Refrigerant Piping
Above 60mm to be black steel heavy gauge to BS 1387:1985

Hot Water Piping
Up to and including 50mm shall be seamless copper pipes to BS EN 1057: 1996, BS EN 12449:1999, BS EN 12451: 1991

Drain Piping
Seamless copper to to BS EN 1057: 1996, BS EN 12449:1999, BS EN 12451: 1991 or class D uPVC not less than 20 mm diameter and to be insulated.
Balancing Valves
Tour Anderson, or of equivalent quality.

Modulating Valves.
Tour Anderson, or of equivalent quality.

Other Valves
Approved makes include Crane, John Newman, Hender, Toyo, Miyairi or equivalent.

Gate and globe valves shall be flanged cast iron body for over 75mm dia. Flanged bronze body for 60mm dia. to 75mm dia. Screwed bronze body for 50mm dia. and below.

The Contractor must provide one (1) no flushing valve and one (1) no. fine mesh type strainer at the take-off to each zone of chilled water system and

also one (1) no. flushing valve at the return. The flushing valve shall be insulated with superlon or equivalent, tapped from the top of piping and down with extension for hose connection.

4.10.6 Ductwork Grilles

All diffusers, registers and grilles shall be best quality of anodised aluminium sheet construction. All exposed metal surface above the supply air grilles must be insulated with Superlon or equivalent to eliminate condensation

4.10.7 Ductwork

4.10.7.1 All air ducts shall be as follows:

(a) Ductwork - galvanised steel sheets
The ducts shall be fabricated from good quality galvanised steel sheets.

The thickness of sheet metal, type of transverse joint and types of bracing shall be in accordance with the following table :-

Max. Size of Duct (inches)	Thickness of Sheet Metal (mm)		Type of Transverse Joint Connection	Type of Bracing
	Steel	Aluminium		
Up to 12	0.550	0.700	S. Drive, pocket or bar slips, on 7' 10 " centres.	None
13 to 18	0.700	0.880		
19 to 30	0.700	0.880	S. Drive, 1" pocket or 1" bar slips of 7' 10" centres.	1" x 1" x 1/8" angle, 4'0" from joint.
31 to 42	0.880	1.000		
43 to 54	0.880	1.000	1½" angle connection, or 1½" pocket, or 1½" bar slips with 1 3/8" x 1/8" bar reinforcement on 7' 10" centres.	1½" x 1½" x 1/8" angle, 4'0" from joint
55 to 60	1.000	1.350		
61 to 84	1.000	1.350	1½" angle connections, or 1½" pocket or 1½" bar slips with 1 3/8" x 1/8" bar reinforcement on 3' 9" centres	1½" x 1½" x 3/16" diagonal angles or 1½" x 1½" x 3/16" angle, 2'0" from joint
85 to 96	1.350	1.600		
Above 96	1.350	1.600	2" angle connection or 2" pocket or 2" bar slips with 2" x 1/8" bar reinforcement on 3' 9" centres	2" x 2" x ¼" diagonal angles or 2" x 2" x ¼" angle, 2'0" from joint

4.10.7.2 Longitudinal joints shall be made grooved, Pittsburgh or double seams, or double row riveted and soldered.

4.10.7.3 Angle flanges shall be fixed to the ductwork by means of rivets spaced at not

more than 51mm centres and shall have mastic compound between the angle and sheet metal.

4.10.7.4 Joints between flanged connections shall be fitted with approved type of mastic compound or 3mm rubber gaskets.

4.10.8 **Air-cooled Split Unit / Air-cooled Ducted Split Unit**

a. Split type air-conditioners offered shall be of reputable brand, completely local-factory assembled.

4.10.9 **Operation and control system**

Each air cooled split system shall be independently controlled within the respective area served. Unit shall be equipped with thermal and current sensitive overload device to protect the compressor and provide facilities for local control on starter panel. Automatic temperature control by means of thermostat located at the return air inlet to the fan coil unit.

4.10.10 **Air-cooled Condenser Unit**

a. The units shall contain sufficient refrigerant R-22 charged for complete system and be equipped with refrigerant line fitting which permit mechanical connection. Fittings shall be located on exterior of unit.

b. Compressor shall be of welded hermetic or rotary types with respect to the individual unit with internal vibration isolation. Operating sound shall be attenuated by means of acoustic absorbents.

c. Condenser coil shall be vertical flat piece construction. Tubes shall be copper with mechanically bonded aluminum plate fins. The condenser fan shall be of propeller type statically and dynamically balanced and directly couple to a motor and protected by heavy gauge metal guard.

d. Fan motor for condensing unit shall be of the totally enclosed fan-cooled weather proof type with inherent protection suitable for operation on 240V/1 phase/50 Hz or 415V/3 Phase/50 Hz supply. Fan motor shall be factory lubricated inherently protected and mounted on vibration isolators. The motor bearings shall be permanently lubricated type.

e. Controls shall be factory wired and located in readily accessible location on unit and protected from outside environment. Compressor motor shall have both thermal and current sensitive overload devices. The control system shall be factory pre-wired and tested. It shall consist of compressor contractor, compressor and overload protection, high / low pressure cuts-out, fan motor relays, starting and running capacitors, timer delay relay to prevent compressor from frequent start/stop, control circuit fuses and terminal blocks.

f. The refrigerant shall be properly charged into the system with the use of pressure gauges. Ensure sufficient oil to be present in the system.

g. The location of condensing unit shall be coordinated with architect.

4.10.11 **Fan Coil Unit**

a. Cooling coil shall be suitable for DX use and constructed of copper tubing with mechanical bonded aluminum fins.

b. Fan shall be of the forward curved type with double inlets and statically and dynamically balanced with permanently lubricated bearings. All fan coil units shall be of low noise type. The noise level of the fan coil unit at high speeds election shall not exceed 35 NC measured from a position of 2 meters from the fan coil unit.

c. The fan speed should not exceed 1450 rpm at high selection. Fan motor shall have built-in overload protection, factory lubricated and is mounted on resilient support. It shall be of three pole type with permanent lubricated bearings, built-in inherent overload protection with automatic reset.

d. Casing shall be of galvanized steel bonded and finished with baked enamel. Unit shall be properly vibration isolated.

4.10.12 **Refrigerant Pipe**

a. Use copper pipe and fittings complying with British Standard. Copper must be free from burrs and other defects.

b. Open end of copper pipes shall be blanked off with plugs during construction. Horizontal pipes shall be parallel to floor slabs and vertical pipes parallel with walls and columns. Allow sufficient space between the pipes and the surrounding for installation and maintenance. Silver solders all piping. No acid base flux or fluid to be used.

4.10.13 **Pipework Insulation**

a. Refrigerant suction pipework shall be insulated with armaflex of 3/8” thickness and tapped.

4.10.14 **Automatic Control**

a. Good quality modulating wall mounted thermostat made by Honeywell or approved equivalent shall be fitted to control the operation of the refrigeration compressors in sympathy with the fluctuations of temperature within the air-conditioned space.

b. The compressors/ condenser units shall be supplied with all dual pressure protective device, safety or relief valves, hot gas bypass or cylinder unloading mechanisms, pressure gauges and thermometers.

c. The units shall be arranged to automatically unload in relation to the conditions within the space thereby selecting automatically the appropriate stage of operation to maintain the temperature in all areas within the limits mentioned earlier in the specification.

d. Arrangements shall be made to ensure that the compressor starts up under reduced load conditions and that either machine can be used

in lead/ lag operation.

4.10.15 **Starter**

a. The starters to be supplied for all items shall be complete with built-in isolators, push buttons and all necessary auxiliary contact for manual start/ stop operations. Thermal overload protection in all phases, over-current protection devices and under voltage releases shall be provided. Anti-reversal and anti-single phasing device of electronic type shall be installed for each of the three phase motors installed in the system. Three phase motors rated below 3 HP shall be direct-on-line and above 3 HP shall be auto-transformer.

b. Starters shall be mounted on a suitable 14G sheet metal cubicle complete with all safety precautions and suitable identification labelling.

4. 10.16 **Ventilation Fans**

a. The ventilation fans shall be capable of handling the air quantity necessary for the specified system performance against the resistance of the system. They shall be designed for maximum reliability and performance with minimum power consumption and low noise level.

b. The fans shall be tested in accordance with BS 848 and shall comprise motor, impeller, mounting arms, starter and etc. which incorporate neoprene anti-vibration mounts at the arm extremes.

c. The fans manufactured from plastic or other similar approved materials designed for commercial or domestic uses and capable of continuous operation.

4 .11 Installation Guideline

a. The outdoor unit must be installed with installation clearance to allow enough room around the unit for air intake/discharge and possible service and maintenance.

b. In preparation of piping, the copper tubes employed for split unit type air conditioning shall be properly flared at each end and connected with flare nuts. These pipes shall be insulated with proper insulation material of minimum thickness of 12.5 mm.

c. All electrical work included in this document shall be carried out in compliance with the current edition of IEE Regulation For Electrical Installation and the current edition of the regulations for the Electrical Equipment of Building issued by Institution of Electrical Engineers and the Electricity Supply Act 1990 including the requirements of the Energy Commission.

4.12 Noise and Vibration Control

Upon completion of installation, precise measurement of the noise levels in the various areas shall be made. Noise levels measured at any position not

less than 1.2 m from any floor, wall, grill, register or diffuser shall be within the limits specified.'

The assumed background noise levels (N.C) for the various areas are as tabulated below:-

Area	N.C. Level Range
Lab./ Waiting Area / Corridor	35 - 40
Computer Room	30 - 35
Lecture Theatre	30 - 35
Library	25 - 30
Meeting Room	25 - 30
Toilets / Bathrooms	40 - 50
Officer's Room	30 - 35
Tutorial Room	30 - 35
Conference Rooms	30 - 35
Typing Rooms	55 - 60
General Office Room/Multipurpose Hall	35 - 45
Engineering Workshop	60 - 70
Kitchens	50 - 60
Outside AHU Room	45 - 50

The sound pressure level in all octave bands measured with all air conditioning plant running **must not exceed the background noise criteria by 3 dB** or if exceeded the higher level must at least be acceptable to the user without complain.

4.13 Sizing and Selection

The Contractor is required to apply the following basis for AHU/FCU selection:

Equipment SHC = Design SHL
But Equipment LHC > Design LHL
i.e. Equipment TC > Design THL
because TC = SHC+LHC whereas THL = SHL+THL

where
TC = Total Capacity
SHC = Sensible Heat Capacity
LHC = Latent Heat Capacity

and
THL = Total Heat Load
SHL = Sensible Heat Load
LHL = Latent Heat Load

4.14 Special Civil Requirements

In order for air-cond system to perform satisfactory, avoid wastage of energy and meet the requirement especially on control over humidity and

fungus growth, the Contractor must fulfil or provide the following civil works requirements:

1. All ceiling over air-cond space must be of vapour proof material, eg. Superflex or equivalent and painted, gypsum is not accepted.

2. All walls separating air-cond and non airconditioned space must apply wall sealer (vapour seal) on the external side before painting.

3. In addition, the walls must be fully partitioned ie.right up to the floor-slab with plaster, wall sealer and paint. (NB: irrespective whether ducted return or free air return through ceiling)

4. All ground floors below air-cond space must be of vapour-proof material, eg. nitto floor, homogeneous tiles with waterproof cement. Terrazzo or any other water permeable material is not accepted.

5. In addition, the Contractor must use best ground water proofing material and must be extra careful and ensure a good and proper ground water proofing works being provided. If not this surely is going to bring massive and messy problems later should the ground water seep through the floor.

6. For areas served with 24 hour air-cond, the Contractor is required to apply vapour sealer followed by one (1) inch P.U spray on the floor slab above it and also the same on the floor slab below it.

7. In addition, all walls separating 24hr. air cond space and non air conditioned space must be of double-wall or cavity-wall type with one layer of vapour seal and one (1) inch P.U insulation in between. The vapour seal shall be applied on the external wall.

4.15 Other Important Requirements

4.15.1 Air-cond supply air duct through non air-cond ceilings must be provided with 7.0mm thick PE foam (having a thermal conductivity of approximately 0.034W/mK at 0ºC mean temperature) insulation. (eg. like in areas with ducted return)

4.15.2 The Contractor shall supply and provide all necessary testing instruments generally include the following:

-Sling psychrometer
-Air velocity meter
-Ammeter, Voltmeter, p.f meter, megger
-Tachometer
-Infrared thermometer, hygrometer, sound level meter c/w octave band filter

These instruments shall be handed over to the P.D. for permanent use after testing and commissioning.

4.15.3 The requirements mentioned in this section is not exhaustive but only form a basis for the contractor to design the air conditioning system.

The requirements mentioned in this air-conditioning pre-bid is not exhaustive but only form a basis for the Contractor to propose on air conditioning to be provided. The Contractor is required to offer in all aspect a comprehensive and functional air-conditioning system for this project.

The contractor is required to provide air conditioning for component or equipment in Power Room, UPS Room and Battery Room that are very sensitive to heat, high humidity and dust; with mechanical ventilation a standby.

4.16 Design Submission Requirement

The design submission shall have the following minimum details:-

1. Computer-based generated heat load calculation for maximum load for all spaces and zones. (if applicable)
2. Computer-based generated heat load calculation for minimum partial load condition for critical area to be determined by JKR.
3. Psychometric chart for item (1) and (2). (if applicable)
4. Airflow rate and static pressure calculation for all AHU and FCUS.
5. Airflow rate and static pressure calculation for all kitchen exhaust, toilet exhaust, smoke spill and pressurisation systems.
6. Typical noise level calculations for all different areas.
7. Duct sizing and pipe sizing
8. Pump sizing for capacity and head
9. Computer-based Pipe loop analysis (if applicable)
10. Energy Efficient features incorporated in the system and calculation to verify energy saving.

All assumption and reference used shall be clearly stated and substantiated with extracts of relevant standard used.

5.0 FIRE PROTECTION SYSTEMS

5.1 General

5.1.1 The building shall be provided with means of detecting & extinguishing fire and with fire alarms together with illuminated exit signs.

5.1.2 The design, installation, testing and commissioning of the systems shall comply with the requirements of Chief Inspector of Fire Services, the latest edition of Uniform Building Bylaws, Malaysian & the relevant British Standards, FOC Rules & NFPA.

5.1.3 Apart from complying with clause 5.1.2, automatic fire extinguishing system shall be provided for rooms which housed expensive and / or important items.

No.	Type of System	Standard
a	Fire Hydrants	BS 750:1977 and BS CP 402.101;1952
b	Hydraulic Hose Reels	BS 5306 Part 1:1976
c	Portable Extinguishers	BS CP 402 Part 3:1964
d	Dry/Wet Rising Mains	BS 3980:1966 BS 5306 Part 1:1976 BS 750:1964
e	Foam Inlets	BS 3980:1966
f	Automatic Sprinklers	FOC Rules 29th Edition : 1973
g	Fire Alarm Systems	FOC Rules : 1973 BS CP 1019:1972 BS 3116 Part 1:1970 BS 3116 Part 4:1974 BS 5446 Part 1:1977
h	Fire Dampers	AS 1682:1974
i	Fire Lifts	BS 2655: Part 1:Apendix E
j	Smoke Control	AS 1668: Part 1: 1974
h	Jabatan Bomba dan Penyelamat	Local Requirement
i	Jabatan Pelanggan	Special Requirement.(if any)

5.2 Scope of Works

The works to be carried out under this installation shall include but not limited to the following:-

- Portable Fire Extinguishers.

- First Aid Hose Reel
- Automatic Fire Alarm System comprising of Central/Master fire Alarm Panel, Sub-fire Alarm Panel and Central Monitoring System (CMS) linked to Jabatan Bomba dan Penyelamat.
- Dry Riser/ Down Comer/ Wet Riser System
- Clean Agent Fire Extinguishing System (with very low Ozone Depletion Potential and Global Warming Potential Indexes) for occupied/non-occupied equipment rooms such as Computer Room, File Rooms and TNB sub-station and alike.
- Sprinkler System where applicable.
- Fire communication system, inclusive of firemen intercom and fire Emergency Public Address System
- Emergency Exit Signs
- Wiring & Controls between various sensors & central fire alarm panel
- Any other fire fighting appliances & automatic fire protection system as required by the CIFS
- Fire Hydrants
- Electrical works
- Pipe works
- Painting & Sign Writing
- Testing & commissioning of the system

Servicing & maintaining the above works & equipment for a period of as specified in the contract from the date of its handing over.

5.3 System & Equipment Description

5.3.1 General

All items of equipment shall be to the approval of the Chief Inspector of Fire Service.

Piping for hose reel, hydrant ring main, shall be galvanised iron pipe class 'C' to BS 1386 heavy grade or equivalent.

Piping for automatic sprinklers shall be heavy grade galvanised steel heavy gauge class "C" pipes to BS 1387:1985 and JIS G3452 for bigger size.

All fire pumps, drives, controllers or accessories must be specifically approved for fire pump services. Except for jockey pump, all pumps shall be

end suction vertical split centrifugal type. All pumps shall be protected from running dry in both automatic and manual modes.

Electric motor must be rated for continuous duty and of TEFC, A.C. induction motor. Outdoor wiring shall be armoured cable. All underground cable shall be armoured cable laid on a 50 mm thick compact sand bed and buried at least 910mm below the ground.

Diesel engines shall have an engine brake horsepower rating of at least 25% greater than the maximum brake horsepower required to drive the fire pumps at rated rpm.
Sprinkler pumps shall be to FOC's approval.

Operation of all fire pumps shall be fully automatic with manual operation incorporated.

Fire pumps for hose reel system shall consist of one duty and one standby pump set. For sprinkler and hydrant systems, fire pumps shall consist of one duty, one standby and jockey pump set. The pump shall be end suction vertical split centrifugal pump. Where diesel pump set is used as the standby pump, the battery for starting the engine shall be Nickel Cadmium type and the capacity shall be able to perform six starts consecutively.

Duty pump shall be driven by an electric motor. Standby pump shall be either connected to an electric motor which is connected to standby generator supply or the pump shall be driven by a diesel engine.

All gate valves and nozzles shall be copper alloy construction.

Pipe sizes 3" diameter or more can have direct-welded joints except at Pump house or any place that requires dismantling for repairs or replacement. For the latter, dismantling flanged-joints is required.

Welded joint shall not be allowed for G.I. pipe. "Victaulic" joint is allowable but the clip, the bolt and nut shall be treated to withstand corrosion and painted.

All pipe fittings shall be factory casted. Fabricated pipe fittings / pipe joints / tees shall not be used. All pipe fittings which include elbows, tees, etc. must be galvanised or sent for galvanisation before installations.

Any gap due to puncturing of services at compartmentalised walls and floors shall be properly sealed with fire rated compound in accordance to Jabatan Bomba Dan Penyelamat.

Separate water storage tanks or compartments must be provided for fire fighting uses. Practice of having common water storage tank having difference heights of outlets for fire fighting and domestic uses is not permitted.

Electric motor must be rated for continuous duty and of TEFC, A.C. induction motor. Outdoor wiring shall be armoured cable. All underground cable shall be armoured cable laid on a 50 mm thick compact sand bed and buried at least 910mm below the ground.
The Contractor must submit all his drawings and designs to CIFS for

comments and acceptance. A set of drawings and designs endorsed by CIFS must be attached with the offer and submitted to P.D before constructions.

The Contractor shall submit the certified true copy of CIFS Approval for all materials and equipments to P.D.

5.3.2 Fire Extinguishers.

Portable fire extinguishers effective to the class of fire anticipated and hazard of occupancy shall be provided within the building.

The types of fire extinguishers installed shall be easily operated on and shall preferably have the same method of operation.

5.3.4 First Aid Hose Reel System.

The hose reels shall be sited in prominent position on exit routes. They shall be sited in such a way that the nozzle at the free end of the hose can be taken to every room and within 6 meters of every part of the room.

The hose reel shall be recessed in and/or enclosed inside a lock-up cabinet with front-glass panel. A key to open the cabinet shall be hung up inside a break glass box attached to the cabinet. The key shall be of common-user type, i.e. the same key can be used to open out any hose reel cabinet. But however, in times of fire emergency and key missing, the cabinet shall be able to be opened by breaking up the front-glass panel and open from within.

One hose reel pump house may be designed to serve few buildings. However the pump head shall be able to serve the furthest hose reel and the nearest unit and the pump will not go hunting, i.e. intermittent start and stop of pump due to inadequate pressure drop between the pump and the nearest hose reel unit. Flowrate for each hose reel shall be 30 Igpm.

5 .3.5 Fire Alarm System

The fire alarm system shall be triggered off by both manual as well as automatic call points.

The central fire alarm panel/console shall be located one in the Bilik Kawalan Keselamatan (Security Control Room)

A master switch to actuate all alarm bells and flashing lights shall be provided. The panel shall be linked to the nearest Fire Brigade Station.

Fire alarm system shall be zoned with the affected zone having evacuation signal, while the other zones shall have alert signal.

The Fire Alarm System shall be Self Addressing Fully Analogue Addressable type.

5 .3.6 Dry Riser/Wet Riser

Dry or wet risers shall be provided in accordance with the building height. The position of the landing valves shall be approved by the CIFS.

The risers system shall consist of riser, landing valves, canvas hose, hose cradle, breeching inlets, etc.
Landing valves, hose couplings, nozzles shall be of copper alloy construction.

The system shall be free from water hammering with one or more landing valves in operation.

5 .3.7 Clean Agent Total Flooding System (Unmanned and Manned spaces)

TNB-substation, generator house, switch rooms, Computer Room / Server Room and Bilik Kebal which are 100 sq.ft and above in floor area including area under the raised floor and any other areas as required by the CIFS shall be additionally protected by Clean Agent Total Flooding System

The system shall use Clean Agent as the extinguishing media. The system offered shall be in accordance with the National Fire Protection Code 2001, 72. The agent used shall be of non toxic, very low ODP shall have Bomba approval for use in manned area

The system shall at least have the following basic components:-

i) The storage components consist of the agent cylinder, cylinder support (racks) and discharge nozzles. Cylinder pressure shall not exceed 30 Bar.

ii) The control panel to monitor the detection and accessories.

iii) The detection, alarm devices and accessories to give the audible and visual signals

The controls used for operation can either be manual and automatic. The systems shall be provided with manual overrides to prevent unnecessary activation of the fire suppression systems.

The Contractor must incorporate and install cut-outs for fans in time of fire detection for all TNB main, Intake Room, Switch Room, Gen House, etc.

For control panels placed in the outdoor exposed to Sun and Rains, awning must be provided. The manual key switch box being placed below panel and at the lowest spot, must be free from water collection and stagnation.

(NB: Water collection & stagnation inside manual key switch has caused many self-discharge of gas that is not triggered by fire detection).

5.3.8 Automatic Sprinkler System

The building shall be sprinklered throughout except where the omission of sprinklers is to the approval of the CIFS or when the area is protected by other automatic fire extinguishing system.

The Sprinklered building shall be zoned & each zone shall have flow switch & isolating valve. Test pipes c/w shall be installed 2 feet away from the flow switch in the downstream side.

For ceiling spaces 30 inches wide or more, double layered sprinkler system shall be provided.

5.3.9 Hydrants

Outdoors pillar hydrants shall be installed for use by fire brigades.

The water supply for the hydrant shall be taken direct from the water mains if the supply can satisfy the pressure / flow characteristics of the hydrant system. Otherwise the system is to be connected to duplicate fire pump sets. In this case a ring main piping system is preferred.

A jockey pump shall also be provided.

5.3.10 Fire Communication System.

The fire communication system shall consist of a Fireman intercom and fire emergency public address system and centralised monitoring system (CMS).

The fire communication system shall be a separate loosed-circuit and fully supervised two-way telephone system.

Communication points should be located within a protected staircase, fire lift lobbies, and other areas as required by the CIFS. Command Control Centre shall be located at the Central Fire Alarm Panel.

The Fire & Emergency Public Address System shall enable authorised personnel at the command control centre to communicate with the other occupants in the buildings in the event of fire or other emergencies.

5.3.11 Fire Extinguishing System.

Fire protection system shall be provided in the generator house, switch rooms and any other areas as required by the CIFS and in the TNB substation shall follow the current TNB Regulation / Requirements.

Detection shall be of the dual zone design.

All pipes shall be galvanised seamless steel pipe suitable for the system pressure.

For control panels placed in the outdoor exposed to Sun and Rains, awning must be provided. The manual key switch box being placed below panel and at the lowest spot must be free from water collection and stagnation.
(NB: Water collection & stagnation inside manual key switch has caused many self-discharge of gas that is not triggered by fire detection).

The contractor must incorporate and install cut-outs for fans in times of fire detection for all TNB main, Intake Room, Switch Room, Gen House, etc.

5.3.12 Emergency Exit (KELUAR) Signs.

LED type "KELUAR" signs shall be placed at exits and access to such exit.

All exit signs shall be connected to emergency supply. The signs shall also be equipped with NiCd batteries complete with charger, capable of providing power when the main supply fails.

5.3.13 Icon and Signage

All fire protection compartments, box, shaft doors, etc must be provided with proper icon and signage.

5.3.14 Power Supply

Power supply line to each Fire Alarm Panel shall not be affected by the tripping of any distribution board due to fault in other circuit. Essential power supply lines shall be provided for fire protection equipment and controls.

As mentioned earlier, the requirements mentioned in this fire protection pre-bid is not exhaustive but only form a basis for the Contractor to propose on fire protection system to be provided. The contractor is also required to make reference to JKR Cawangan Kejuruteraan Mekanikal's Specification in addition to General Requirements as stated in the scope of work for putting up a complete Fire Protection System functional and comprehensive in every respect.

6.0 KITCHEN EQUIPMENT INSTALLATION.

6.1 General

6.1.1 The installation of complete Kitchen Equipment shall cater mainly for local type of cooking. However, Western cooking shall also be served as an addition.

6.1.2 Cooking shall include normal meals and special meals for functions. Meals served include breakfast, lunch and dinner of local cooking designed to menu served.

6.2 Scope of Work.

6.2.1 The Kitchen Equipment shall include but shall not be limited to the followings:-

6.2.2 To design, supply, deliver, install, test and commission to successful operating conditions the complete Kitchen Equipment and Kitchen Exhaust Hood System.

6.2.3 Wet Chemical Fire Suppression System shall be installed to the Kitchen Hood

6.2.4 Installation of gas piping and storage cylinders complete with all necessary fittings.

6.2.5 Installation of hot and cold water taps, sinks, working tables and other appliances.

6.2.6 Guarantee, comprehensive servicing and maintenance for a period of two (2) years after the date of Certificate of Practical Completion issued.

6.3 Kitchen Hood.

6.3.1 Noise Level

Excessive noise levels are by far the most common and also the most critical problems in most Kitchen Areas. As such, the Contractor is required to provided or installed Venthood Exhaust and Exhaust Ventilation System to the following requirements :-

1. Exhaust Fan sets shall be of the low rpm, low noise, centrifugal type, design, statically and dynamically balanced, 3 phase type and must be of reputable make. Maximum noise level shall not exceed 55 NC if measured 1m away from the hood.

2. Venthood duct shall be straight and not bent.

3. Flexible connections between fan and duct, duct and vent, duct and roof if possible.

4. Air duct sizing shall go for very low friction loss and shall be insulated to reduce noise level.

5. All venthood and exhaust duct hangers/mountings must incorporate vibration isolators.

6.3.2 Kitchen hood shall be made of polished Stainless Steel Grade 304 with thickness of 16 s.w.g or better.

6.3.3 Wet Chemical Fire Suppression System shall be installed to the Kitchen Hood and the controller shall be interfaced with Main Fire Alarm Panel.

6.4 Some Civil Requirements

1. Cooking islands in Kitchen Areas shall be surrounded by open drains with stainless steel grating.

2. Grease Arrestors/Trap shall be provided for Kitchen Waste Discharge.

3. Ground beams on Kitchen Areas shall be casted below the open drains inside Kitchen Areas so as not to block the free flowing of Kitchen Waste Discharge.

7.0 L.P.G. INSTALLATION

7.1 General

7.1.1 The installation shall cater for gas fired equipment in kitchen and workshop.

7.1.2 The installation can be of central supply, decentralised supply or individual supply or any combination of the above.

7.1.3 The gas supply shall preferably be from manifold system with standard size gas cylinders.

7.1.4 Fully charged gas cylinders shall be provided.

7.1.5 The design, installation, testing and commissioning of the LPG system shall comply with the requirements of the Suruhanjaya Tenaga and the Jabatan Keselamatan dan Kesihatan Pekerja.

7.2 The LPG System

7.2.1 The installation shall consist of a cylindrical manifold of two banks of gas cylinders reach of 50 kg capacity with automatic or manual changeover.

One bank shall be on duty while another bank on standby. The Contractor shall supply and install pressure sensing on each bank manifold and gas status with gas low alarm indicator.

7.2.2 The cylinders are attached to the manifold by means of flexible connections. The main gas supplied line shall be installed with emergency shut off valve complete with the proprietary manual pull station.

7.2.3 The gas is piped into the places of application through either a single or double stage reduction regulator. Final pressure shall be 280mm w.g. and intermediate pressure for 2 stage reduction shall be 0.7 kg/sq.cm. Second stage of reduction regulator shall be installed as near to the zone of usage as possible / in each laboratory. All gas vent or relief for regulator shall be vented to atmosphere.

7.2.4 Sufficient numbers of isolation valves shall be provided to allow maintenance in every laboratory or zone without affecting gas supply to other area.

7.2.5 Gas room in accordance with Suruhanjaya Tenaga shall be provided for gas cylinders and shall be properly ventilated and lighted. All electrical fittings inside the gas room shall be of explosion proof type.

7.2.6 Materials of pipes shall be seamless carbon steel pipe to standard API 5L, Grade B, Schedule 40 (for pipes above 25 mm dia.) and Schedule 80 (for pipes 25 mm dia and below) and copper pipe to EN 1057 (Copper piping will only be allowed for the final connection to the gas taps or equipment after the isolation valve). The jointing compound must be of a type which is resistant to L.P Gas and remains plastic, and it shall be applied to the male thread only. Hemp and similar material must not be used in pipe joints. In under-ground, or in inaccessible places, all joints shall be screwed welded or brazed. Pipe work that is to buried in a solid floor shall be factory wrapped or sheathed in PVC pipes to avoid corrosion.

8.0 INTERNAL COLD WATER AND SANITARY PLUMBING SYSTEM

8.1 Objective

The objective of the Needs Statement is to provide the basis for Contractor to propose, design, construct and complete the internal water supply system and internal sanitary system in order to provide reliable and sufficient internal water supply and internal sanitary system to the proposed project. The internal water supply system and internal sanitary system shall be designed and implemented in harmony with other utilities and surroundings to meet client's needs in terms of functionality ease of operation & maintenance and durability*. The need statement of external water supply and external sewerage& waste water system shall be referred to* ***Cawangan Kerja Bangunan Am, Ibupejabat JKR Malaysia.***

8.2 Internal Water Supply System

8.2.1 General

The information in relation to the project such as location, number of buildings, building height, the basic functions of the buildings and the related room data etc, shall be obtained from the architecture needs statement or other documents in the Pre-Bid Document.

8.2.2 Water Demand

The total water demand for the project shall be estimated based on the basic function of the proposed project. The contractor shall design, construct, complete and commission the water supply systems to cater for the total demand.

The criteria for demand estimate and total water demand shall be based on the Design Criteria and Standard For Water Supply System published by JKR Malaysia or The Malaysia Water Association or State Water Authority.

8.2.3 Source of Water Supply

Usually, the State Water Authority (SWA) or the State Jabatan Bekalan Air (JBA) shall provide the source of water supply. In the case where the SWA or JBA cannot supply the water required, then the Contractor shall propose alternative supply subject to the approval of the SWA or JBA and Jabatan Kerja Raya

8.2.4 Scope of Work

8.2.4.1 General

Generally the scope of work for internal water supply system shall include but not limited to the following items:

a) Distribution pipes from tapping points to roof top storage tanks of the proposed buildings with or without pumping system depending on the available pressure at the tapping point.

b) Suction tank and booster pump house complete with M&E system and automatic control system (In the case where pumping system is required).

c) Instruments and meters.

d) Internal plumbing system for all the proposed buildings.

e) Testing and commissioning.

f) All ancillary works necessary for the completion of the project.

Any item which is not specifically stated in the scope of works but is necessary for the completion of the project shall deem to be included and provided for in terms of design and pricing.

8.2.4.2 General Requirement, Specification, Design Criteria and Standards.

The levels, lengths, dimensions and figures mentioned in this Needs Statement are merely indicative and approximate. The contractor shall carry out investigation for confirmation for the purpose of detail design and pricing.

The design and the implementation of the proposed project shall consider the overall cost i.e. initial capital and long-term operation and maintenance cost.

All design shall be generally based on the Design Criteria And Standards For Water Supply System published by JKR Malaysia or The Malaysia Water Association or State Water Authority (SWA). However, the contractor shall at all time comply with the requirements of other local authorities. All construction works shall be carried out in accordance to the relevant specifications currently used by JKR.

All workmanship, materials, components, equipment and instruments shall be chosen taking the environment and media contact into consideration and for long-life time. It shall be of high quality and resistance to corrosion.

Supporting literature and specifications from the manufacturers should be obtained to substantiate this. It shall comply with the relevant Malaysia Standards or Codes Of Practice current on the date submission of proposal or in the absent of the relevant Malaysian Standards, with other Standards or Codes Of Practice proposed by the Contractor providing that these Standards or Codes of Practice are equivalent or superior to the relevant British Standards or Codes.

8.2.4.3 Seeking of Approvals

The Contractor shall be required to seek the approval of the various authorities concerned for the works, such as power supply, consent of landowners and other relevant authorities, etc. The Contractor shall pay all fees, charges or contributions to the relevant authorities if required

8.2.4.4 Professionals Engaged by The Contractor

The Contractor shall engage his own Professional Engineers, Licensed Surveyors, etc whom are registered with the relevant professional bodies to carry out engineering works such as design, supervise, field works, etc which require such qualifications.

8.2.4.5 Distribution Pipes

The contractor shall propose the distribution pipes for the proposed project. Distribution pipes for general building blocks such as hostel block / administration / lecture block etc shall be separated from the distribution pipe for cafeteria / canteen block. Each separate distribution pipe system shall have its own tapping point and water meter.

In the case where available pressure at the tapping point is not adequate, pumping system shall be required for the distribution of water to all the building blocks of the project. The system shall consist of suction tank, pump house, M & E equipment and pumping mains to the roof top storage tanks.

All pipes 100mm and above shall be Mild Steel with cement lining. Air valves c/w isolating valve, scour valves and gate valves must be adequately and strategically provided.

All pipes shall be anchored or restrained by thrust blocks when necessary.

8.2.4.6 Suction Tank

Suction tank for buildings shall be of HDPE, POLYTANK or Pressed Steel FRP subjected to the approval of the Project Director. The tank shall be non-toxic, water tight, properly supported and suitably protected against corrosion and provided with dust and insect proof cover, external and internal ladder. Internal ties and stays where applicable shall be stainless steel. The maximum capacity required for the suction tank shall be one third of the daily demand.

8.2.4.7 Pumping Station and M & E Works

Contractor shall design and construct a pumping station complete with pump sets and instrumentation. The pumping system is to deliver water from suction tank to the roof top storage tanks. The system shall have two (2) sets of pumps, one duty and one standby. Efficiency for pumps must be higher than 80%. The prime mover shall be sized 10% larger than the maximum power

required at the duty point. The pumping system ON/OFF shall be automatically control.

8.2.4.8 Instruments and Meters

The contractor shall propose, supply, install, calibrate and commission all instruments and meters that are necessary to the highest standard of operation reliability and safety. The instrumentation panel shall be installed within the pump house.

The minimum instruments called for in this need statement are as follow:

The contractor shall provide flow meters at suitable location in order to register water consumption. Separated meters shall be installed for fire-fighting system, cafeteria/canteen, Dewan Makan, quarters and other general building blocks.

Suction tank shall be installed with in-situ level indication.

8.2.5 Internal Plumbing

8.2.5.1 General

Internal plumbing shall mean cold water plumbing only ("water", "plumbing system" mentioned hereinafter shall mean cold water and cold water plumbing system respectively).

The criteria and standards shall comply with the requirements of relevant State Water Authority, Local Authority, Fire Department, as well as those stipulated in the relevant Malaysian and British Standards.

The contractor's design shall at least meet the criteria and standards stipulated in "Design and Criteria for Water Supply System" published by JKR Malaysia or The Malaysia Water Association, and the Garis Panduan Reka Bentuk Bilik Air (GRPBBA) for JKR building projects.

Information pertaining to water pressure, availability and quality of public water supply is obtainable from the SWA or JBA.

Any capital contribution levied by the SWA or JBA to be paid by the Client.

The contractor shall design and install the required plumbing systems to all buildings and other locations within the proposed site where water is needed.

8.2.5.2 Plumbing System

The contractor shall design and install the internal plumbing system in accordance to the requirements mentioned hereinafter in order to deliver water to every plumbing outlets as well as Mechanical and Electrical installations with satisfactory head and flow.

The contractor shall propose, design and install the external plumbing systems to sprinklers, garden taps, standpipes, etc for landscaping, gardening and other purposes. These fittings shall be adequate and suitably located within the proposed site with satisfactory head and flow.

8.2.5.3 Individual Building Water Storage Tank

The Contractor shall design and install individual storage tanks to every building in accordance to the Design And Standards Of Water Supply System mentioned herein before and subject to the approval of the SWA or JBA.

Separate storage tanks such as the expansion and make-up water tanks for air-conditioning system, calorifiers, water heaters, etc shall be provided as per M & E needs statement.

Separate water storage tanks for the fire protection system shall be provided as per M & E needs statement and be placed close to the M&E plant rooms.

Separate storage tank for Flush-Valve System shall be provided and non-return valve shall be installed at the inlet pipe of the tank.

Top Water Level/Bottom Water Level (TWL/BTL) of all tanks shall be clearly mentioned on drawings

Overflow and warning pipes shall be provided for all tanks. The level for the warning pipe shall be 50mm above TWL, and level for the overflow pipe shall be 50mm above the warning pipe level.

The discharge point of such pipes shall be at location where it is easily noticeable at times of outflow during ball-valves failure.

Convenient and safe access to the storage tanks shall be provided. Lighting shall be provided at such access as well as at the storage tanks areas.

All storage tanks shall have clearance minimum 1 meter all round as well as from bottom and top of tanks.

8.2.5.4 Fittings

The type, material, quality, finishes and colour of all fittings or plumbing outlets shall comply to the requirements and subject to approval of the Project Director.

8.2.5.5 Materials

All materials used in all plumbing system shall be approved by the SWA or JBA and complying with relevant standards.

Pipes shall be Stainless Steel or Acrylonitrile Butadiene Styrene (ABS) subjected to the approval of the Project Director.

Stainless steel shall comply with ASTM A312, Schedule 40S.
ABS shall comply with BS5391 and BS5392. (15mm-20mm Class E; 25mm-150mm Class D)

Individual storage tank for buildings shall be of HDPE, POLYTANK or FRP subjected to the approval of the Project Director. The tank shall be non-toxic, water tight, properly supported and suitably protected against corrosion and provided with dust and insect proof cover, external and internal ladder. Internal ties and stays where applicable shall be stainless steel.

8.2.5.6 Valve

Piping Plan :

Prior to actual installation of the Flush Valve, it is fundamental that a proper piping plan that will ensure :

Adequate water head pressure
Adequate water supply volume
Adequate water supply velocity

will be available at each valve head to ensure that each and every valve to be installed will function in accordance with its capabilities.

In the case where it is necessary, variable speed pumping system shall be designed and provided to cater for the adequate water head pressure, volume and velocity for toilet flushing system to function.

Pressure Reducing Valves of approved type shall be installed where necessary in order to restrict the pressure sustained by the fittings to 30 meters.

Stop valves of approved types and complying with BS 1010 shall be provided as below:

- Immediately upstream from meters.
- Inlet and outlet of storage tanks / feed cisterns.
- At every pipe branch.
- Additional stop valves shall be provided to isolate pipes having more than 5 fittings.
- Valves shall be the same size as the pipes.
- Such valves shall be located at convenient places such as corridor

for easy operation. The position of such valves shall be at a height of 2 meters from the floor level.

Non-Return valves shall be installed when necessary to avoid back siphonage resulting contamination. Fittings such as garden taps, water closet taps etc shall be considered for such installation.

Ball valves shall be installed for all tanks where applicable (gravity system) and shall be of heavy duty type.

All distribution pipes in the plumbing system shall be tapped from storage tanks except kitchen taps and for culinary purposes shall be tapped directly from water mains. However, subject to the approval of the authority, the distribution pipes connected from the storage tanks to the various fittings may be branched out to kitchen taps. In such case, the distribution pipes to various fittings shall be separated from the kitchen taps by means of non-return valves or other means as to avoid contamination by back siphonage.

Minimum diameter for pipes shall be 15mm except for flush valve system where minimum diameter shall be 25mm.

All pipes shall be concealed in walls, ceilings, boxed up or laid within the common trenches, service ducts, etc provided. Pipes that are unable to be concealed shall be painted.

Where pipes are required to be laid through structural beams or slabs, mild steel pipe sleeves shall be provided for such puncturing.

All pipes shall be properly secured in place with brackets.

8.2.5.7 Ancillary Work

The scope of works shall cover all other ancillary work necessary for the completion of the project.

8.2.5.8 Testing and Commissioning

All piping system, metering system, instrumentation system and equipment after installation shall be tested and commissioned. The contractor shall carry out tests on all individual sections of each system and the system as a whole to prove that the system and equipment have been properly installed,

adjusted and calibrated to produce the required performance as offered. The testing and commissioning shall be carried out by qualified and competent personnel and shall be witnessed by the representative of the Project Director.

Should the whole or part of the installation or equipment fail to produce the required performance as offered, the contractor shall be required to carry out necessary modification or replacement of the same at his own cost.

All energy, water etc. consumed during the testing and commissioning shall be paid for by the contractor. A complete record of the tests and results of such tests shall be submitted in two sets to the Project Director.

8.2.6 Operation and Maintenance

8.2.6.1 General

At the time of handing over of the project, the contractor shall supply two sets of manual of the operation and maintenance of all facilities including pump-sets, instrumentation control, metering system and itemized list of equipment and spare parts which the manufacturers consider as essential to be kept in ready stock for operation and maintenance.

8.2.6.2 Defect and Liability Period

The defect liability period shall be as mentioned in the Pre-bid document. The contractor shall be responsible for the maintenance of the completed works through out the said period. The contractor shall repair or replace all defects, carry out breakdown, scheduled and preventive maintenance works during the said period.

8.2.6.3 Electricity Supply for Pumping Station Installation and Instrumentation

Normally, electricity supply is to be provided by Tenaga National Berhad (TNB). The contractor shall be responsible for estimating power requirements for the pumping system for his work. The contractor shall comply fully with the requirement of TNB, such as construction of substation if necessary. Sufficient power points must be provided for all installations. In the case where power supply is not available, the contractor shall provide alternative proposal.

8.2.6.4 Submission of Proposal, Calculations, Drawings and Cost for Approval

The contractor shall submit his proposal together (endorsed by P.E.) with all design calculations and drawings and itemized cost detail for approval by

the Project Director. Nevertheless, such approval does not in whatsoever relieve the responsibility of the contractor.

8.3 Internal Sanitary Plumbing System

8.3.1 General

The design, construction, installation, testing, commissioning of the Internal Sanitary Plumbing system shall comply with the relevant Malaysian Standards, the requirements of Kementerian Kesihatan, Kementerian Alam Sekitar, the Uniform Building By-Laws and Rules and Regulations of Local Authorities.

The works to be carried out shall include but not limited to the following:-

a) Internal Sanitary Plumbing including installation of all the pipework connecting to water closet, urinals, basins, baths, cisterns, sinks, floor trap, gully trap, manhole, etc.

b) Testing and commissioning of the system.
c) Servicing and maintaining the above works and equipment for a period stated in the conditions of contract.
d) Submission to relevant local authority for approval.

e) And all other associated works

8.3.2 Sanitary Plumbing and Vent System

The contractor shall furnish and install a system of sanitary plumbing and vent piping from all water consuming fixtures, equipment and drains and floor traps.

The contractor shall carry all vent piping through roof, and provides testing gates at each floor for stacks and provisional stacks.

All pipe works shall be as specified under the piping materials section of this specification. Branches of soil and waste stacks shall have regular falls towards the stacks.

The junction for branches to soil and waste stacks shall have 50mm and 25mm throat radius bends respectively.

Inspection openings and clearouts shall be provided to the requirement of the authority having jurisdiction. They shall be positioned to ensure easy rodding of the entire soil and waste system.

Soil and waste discharge shall extend to external sewer line and including connection to the public sewer line.

8.3.3 Sanitary Drainage System

The contractor shall furnish and install a sanitary drainage system up to and including connection to the manholes. Provide all piping, fittings and all other associated equipment necessary to complete the work.

8.3.4 Piping Installation

The word “piping” shall mean all pipes, fittings, nipples, valves, and all accessories connected there to.

Unless otherwises stated, the contractor shall run all horizontal sanitary plumbing piping at uniform grade and as indicated in the following schedule:-

INTERNAL (WITHIN BUILDING)	
PIPE SIZE (mm)	GRADIENT
32	1:20

INTERNAL (WITHIN BUILDING)	
PIPE SIZE (mm)	GRADIENT
40	1:20
50	1:20
65	1:30
80	1:30
100	1:40
125	1:60
150	1:60
EXTERNAL (WITHIN BUILDING)	
PIPE SIZE (mm)	GRADIENT
100	1 : 60
150	1 : 80
230	1 : 200

All vent pipes shall have a minimum gradient of 1:40 unless stated otherwise.

8.3.5 Piping Material

All waste pipe including stacks pipes and vent pipes for internal sanitary plumbing shall be UPVC to BS 4514 and BS 5255 for above ground and BS4660 for underground.

8.3.6 Hangers and Brackets

The contractor shall furnish and install sufficient hangers, supports, beam clamps, clips, inserts and mounting devices to support all piping installed under this contract without sagging, without interferences with complete drainage and so located and arranged as to permit free expansion and contraction.

The contractor shall install all hangers straight and true and in perfect alignment. No hangers can be located near couplings, fittings or bends in piping without making provision for expansion.

For risers, stacks and other vertical piping, “U” bolts shall be used for each floor.

8.3.7 Joints

Joints shall be made in piping as follows:

TYPE OF PIPES	TYPE OF JOINTS
• Cast Iron Piping • Soil pipes, vents	Joints shall be lead caulked
• UPVC Piping • Soil, wastepipes, vent	Joints shall be non-heat-application method All as per Manufacturers instructions.

8.3.8 Jointing of UPVC Tubing to Fitting

All joint shall be made using manufacturers' standard fittings Class AE suitable for drain and waste piping and designed to allow jointing by the non-heat-application method. Jointing of piping shall be by slipping the pipes and the overlapping shall be at least one and one half times the outside diameter of the pipe, all in accordance with the manufacturers' instructions for one or two step heat-application method. On large diameter pipes the tapered core method with flanges and bolt bolting may be used.

8.3.9 Pumps

The submersible pumps shall be of closed coupled centrifugal vertical and split to permit removal of the assemble without disturbing of pump casing, suction and discharge piping, coupling alignment. The shaft shall be of stainless steel and supported by radial thrust ball bearing capable of balancing the hydraulic thrust load. Impeller shall be single suction, closed type cast in one piece and locked to motor shaft with key and screw.

8.3.9.1 As-Built Drawing

All As - built drawings are to duly prepared, update and maintained throughout the contract period. All such drawings duly dated where applicable and duly certified by Registered Professional Engineer shall be submitted to the Government's Representative not later than three months after the completion of the construction works and at the time of handing over of the buildings.

8.3.9.2 Compliance To Rules and Regulations

All works shall be in accordance with good engineering practice and shall comply with the By-Laws and latest Rules and Regulations of all Approving Authorities. A copy of all correspondences with approving authorities shall be extended to the Government's Representative.

Prior to the commencement of the construction works and handing over at the end of the contract period, approval from all Relevant Authorities must be obtained.

All designs and drawings shall be prepared by Registered Professional Engineers. Detail working drawings, workshop drawings and amendments etc. shall be submitted and agreed by the Government Representative prior to construction.

The functional adequacy and professional liabilities of the design shall be sole responsibilities of the contractor.

9.0 ELECTRIC LIFTS INSTALLATIONS

9.1 General

9.1.1 The vertical transportation shall be by a suitable lifts system adequately designed to serve the various needs of the building.

9.1.2 It shall handle all the visitor traffic during visiting hours as well as the staff movement within the building. It shall also handle equipment.

9.1.3 These lifts shall be classified as passengers and / or goods lift. They shall comply to the most recent edition of the Factories and Machinery (electric passengers and goods lifts) Regulations 1970 published under Factories and Machinery Act 1967 by the Machinery Department in West Malaysia.

9.1.4 They shall also meet the minimum requirements of the British Standard Specification for Electric Lifts BS2655, Parts 1, 2 &3.

9.1.5 Where requirements stated further in this specification or in BS 2655 are inconsistent or in conflict with the Factories and Machinery (Electric Passengers and Goods Lifts) Regulations, the requirements stated in the Factories and Machinery (Electric Passengers and Goods Lifts) Regulations shall prevail.

9.2 Details of Equipment

9.2.1 The lift offered shall be of a reputable make with an agency which is long established in this country in terms of supply, installation, servicing and maintenance facilities.

9.2.2 They shall have control system of AC-VVVF thyristor / inverter- converter speed control to achieve optimum performance with stepless acceleration/deceleration and good levelling accuracy in either direction. Gearless drives shall be used for speeds exceeding 4 mps.

9.2.3 They shall also be connected for emergency power operation to the extent based on functional as well as economic considerations. Notwithstanding this all lifts shall be connected to emergency power supply. The Contractor shall indicate which lifts shall have emergency power operation.

9.2.4 Optional with attendant control shall be incorporated in each lift.

9.2.5 Each lift car shall be complete with an approved automatic load weighing Device arranged to prevent overload and to automatically by pass landing calls when the car is full.

9.2.6 Each lift shall be preferably being of the passenger lift with a speed of not less than 1.6 m/s.

9.2.7 The lift shall be complete with 150mm wide stainless hand/crash rail at a suitable height all around the car. (Where necessary)

9.2.8 Schedule of finishes for entrance column and front return panel, car door, landing door and kick plate shall be in stainless steel (unless/otherwise specified and required by the Architect).

9.2.9 Each lift shall also have photocell device in lift car doors together with retractable safety edge mechanism.

9.2.10 Each lift shall also have automatic changeover and suitable inverters to operate the alarm bell, ventilation fan and one of the two lightings in the car from the battery power supply when the normal electric power fails.

9.2.11 The contractor shall also supply and install a complete lift intercom system to enable communication between the master unit in the reception room and each lift car and the machine room.

9.2.12 The Contractor shall also supply and install one central supervisory board. The board shall include the intercom master unit in the reception room mentioned above and car position indications for all lifts supplied. The central supervisory board shall be in the reception room with the main fire fighting alarm console.

9.2.13 They shall incorporate fireman's service to the extent required by the fire department.

9.2.14 Lifts shall be arranged in single car collective operation and/or in group in automatic group supervisory control operation. The number of lifts to be included under group supervisory control operation shall be based according to the selection criteria of the Contractor taking to the consideration the number of lifts provided, types, contract load, contract speed, travel of lift, number of the floors and entrance served, lift car dimensions, etc. The Contractor must give details as to the controls selected for the lift operation. The contractor shall proposed the latest lift control and call system such as **destination call control system for traffic management** to enable better utilization of lift and contributes to energy saving.

9.2.15 Synthesized voice shall be incorporated for each lift.

9.2.16 All passengers lifts shall also cater for handicapped uses.

9.2.17 Lift Traffic analysis is to be provided.

9.3 Other Important Requirement on Lift

1. The Contractor must make double sure with his lift manufacturer that the equipment working voltage range is at -least 415V +5-10% or 374V to 435V and not something like 380V to 415V as happened to certain lift equipment imported from Europe.
   (NB: The lift equipment of 380V to 415V develops problems like control tripping or computer card burn-out).

2. AVR is an important feature to protect lift control and power system

and must be provided.

3. The Contractor shall supply and install Elevator Monitoring System which shall be placed at Bilik Kawalan Keselamatan (Security)

4. The Contractor shall supply and install Architraves of the wide band type covering the whole depth of the entrance wall opening.

5. If needs arises The Contractor shall also supply and install air-conditioning system only for all Lift Control Panels with provision for natural or mechanical ventilation should the air-conditioning system breakdowns. The air-condition compartment with control panel inside shall be vapour-sealed and insulated the same as AHU Rooms.

9.4 Important Civil and Electrical Requirements

1. The Contractor shall design and construct well insulated lift motor Room, but must also ensure that the windows or ventilation openings so designed is effective against rain water splashing-in during heavy rains or thunder storms.

2. Hatch openings and I beams shall be provided as usual to permit future replacement of equipment from Lift Motor Room to the higher floor served by lift.

3. All openings provided above Lift Motor Room shall be provided with curbing.

4. Sloping curb or floor gradually sloping-up must be provided at all lift entrance to prevent water from flowing into the lift pit and damaging the car door control.

5. All bricked-up portions lift shafts (in fact, all services shaft as well) must be plastered to reduce problem of dust collection and other hazards.

6. Lift pit-shall be provided with cat ladder. Plug point and lighting.

10.0 CENTRALISED COMPRESSED AIR SYSTEM

10.1 Scope of works

10.1.1 The works covered under this contract shall include but not limited to the followings:-

10.1.2 To design, supply, deliver, install, test and commission to successful operating conditions the complete compressed air system**.**

10.1.3 Sufficient outlets of compressed air shall be provided throughout the training centre and other places that require the uses of this system.

10.2 Technical Specifications for Compressed Air

10.2.1 Packaged Air Compressor

The compressor assembly shall be of the heavy-duty, air-cooled, lubricated, single-stage, single-acting, positive displacement rotary screw type, vee-belt driven by a squirrel cage motor, TEFC, 2950 rpm, Class F insulation with Class B temperature rise, and IP 54 protection electric motor suitable for 415V/3ph/50hz electric supply.

Whilst in operation, the compressor-motor assembly shall not emit noise at a level of more than 70 dB(A).

The unit assembly shall comprise of the following integral component and/or equipment:-

a) efficient air/oil separator with oil carryover of less than 5 ppm.

b) efficient aftercooler with discharged air temperature not exceeding 15°C above ambient conditions c/w automatic drain.

c) effective oil lubrication c/w spin-on/off oil filter.

d) 3°C pressure dew point refrigerated air dryer c/w pre-separato and coalescing filter with efficiency down to 5 micron and 0.01 submicron, respectively. Both filtrations shall incorporate automatic drain.

In addition, an integral pressure differential indicator shall be provided at the coalescing filter.

(e) automatic vee-belt tensioner.

(f) automatic regulation system with delay stop mode.

g) automatic sequence controller for `DUTY/STANDBY' mode.

h) Air tank certified by Jabatan Keselamatan dan Kesihatan Pekerjaan

and shall be incorporated with electric type automatic drain, safety relief valve, 100 mm dia. pressure gauge and inlet isolating valve.

A service outlet incorporating isolating valve, regulator, coupling, blow gun, hose and necessary jubilee clips shall be installed onto the air receiver for the purpose of in-house usages.

A separator, oil removal filter, pressure regulator and pressure gauge shall be incorporated at the outlet of the air receiver.

10.2.2 Pipes and Fittings

10.2.2.1 General

The welded steel tube/pipe and fittings shall be manufactured from steel which shows not more than 0.060% of sulphur and not more than 0.060% of phosphorus to BS l387:l967 Class Heavy (Class C), finished in hot dipped galvanized process.

Pipe preparation shall include pipe ends to be cut clean and square with the pipe axis, using clean cutter and deburred, re-rounded and cleaned of cuttings.

10.2.2.2 Isolation Valve

All isolating ball valves shall be manufactured of brass alloy materials, capable of withdrawal without cutting the pipework and be of the reinforced PTFE stainless steel ball with vinyl coated handle.

It shall be of the exhaust type to isolate and exhaust downstream equipment requiring maintenance and/or service and suitable for specified working pressure and temperature.

Standard port threads shall be to ISO ll79 interchangeable with BSP Parallel to BS 2779. At the air control sets, the unit shall be an integral part of the Olympian plug-in compressed-air distribution set.

10.2.2.3 Air Control Sets

The air control set shall be incorporated with an Olympian plug-in integral filter-regulator complete with 50mm diameter pressure gauge.

The filter section shall have a 25 micrometer filter element, a manual drain that can operate under flow and no-flow condition and a 0.2 litre orientable metal bowl with condensates sight glass suitable for specified working pressure and temperature.
The regulator section shall be of the relieving type fitted of syphon tube design for extreme sensitivity, superior flow and regulation characteristics with snap action lock plastic knob to prevent accidental alteration of pressure setting. Gauge shall conform to BS 1780: Pt. 2 Industrial Class 2. These units shall be an integral part of the complete air control sets.

The Olympian plug-in porting block shall constitute as part of the air control sets in order to facilitate the use of clean, oil-free and non-lubricated compressed air for instrumentation air, cleaning and spraying purposes and be fitted with a set of quick release coupling.

The lubricator shall be an integral part of the air control sets and shall be of the Olympian plug-in micro-fog type incorporating automatic built-in flow sensor to accommodate, without adjustment, a wide range of air flow from below 5 m^3, cross-fire jet venturi, non-return valve in syphon tube ensuring immediate lubricating when used intermittently, fine drip-rate adjustment with snap-action lock, and 0.2 litre orientable metal bowl with oil level sight glass. It shall be capable of specified working pressure and temperature range.

Port threads shall be to ISO 1179 interchangeable with BSP parallel to BS 2779 and fitted two (2) set of quick release couplings

All quick release couplings shall be of the one-way shut-off type with automatic shut-off valve incorporated in the socket of chrome-plate steel suitable for specified working pressure.

10.2.2.4 Pipe Runs

The pipes shall install to the applicable routes indicated in a neat manner without any springing or forcing. Wherever practicable, a clearance of at least 25mm shall be maintained between other services. Where pipework crosses the other services and a clearance of 25mm cannot be maintained, it shall be electrically bonded, wrap insulated or equivalent. Termination point shall be made at high level.

10.2.2.5 Pipework Supports

The pipework supports shall be provided at intervals as specified below:

Metric Sizes Outside Dia. Mm	Max. intervals for vertical runs Metres	Max.intervals for horizontal runs Metres
12	1.2	1.0
15	1.8	1.2
22	2.4	1.8
28	2.4	1.8
35	3.0	2.4
42	3.0	2.4
54	3.0	2.7
76	3.6	3.0

This contractor shall ensure that all pipework does not come into contact with any treated timber contained in the building structure.

10.2.2.6 Pipework concealed in Walls/Floors

Pipework concealed in walls/floors shall have their routes clearly marked on `as fitted' drawings, where specified.

Where the route differs from the contract drawings, the contractor shall brought to the attention of the P.D. prior to installation.

Any joint to be buried in a wall shall be satisfactorily tested and approved before being concealed. Joints in wall shall be kept to a minimum.

10.2.2.7 Pipe Passing Through Walls

Pipes passing through fire compartment walls shall be provided with cooper sleeves. Fire stopping shall be provided within the sleeve. All pipes shall be provided with cover plates fitted over the sleeve where exposed to view and shall not have any joint occurring within sleeve.

10.2.2.8 Underground Piping

All underground piping shall be laid on a thick compact sand bed and buried at least 910mm below the ground. Buried pipes shall be factory wrapped with bituminous compound and shall be properly supported by suitable brackets and enclosed in semi-glazed pipe of one size larger than the pipe.

10.2.2.9 Separations

The contractor shall ensure that pipelines are physically separated from metal sheaths and armor of electric cables and from metal conduits, ducts, trunking
and have earth continuity conductors associated with any cables.

10.2.2.10 Dropper Pipes

Dropper pipes running along walls and columns to the air control sets, shall be covered with 2 inches x 1 inch, 22 swg mild steel trunking.

The trunking shall be spray painted to the colour to be decided by P.D.

10.3 Compressor Room Ventilation

10.3.1 Based on the heat dissipation rate of the aftercooler and compressors offered, suitable ductworks to exhaust out hot air from both the equipment to the outside of the plantroom, shall be designed and later, construct by this contractor.

10.3.2 The ductworks shall be acoustically and thermally insulated.

10.3.3 The ducts shall be dimensioned such that the total pressure drops does not exceed 3mm water column.

10.3.4 An intake opening for the ventilation air shall be provided such that the air flow speed through it is about 3 m/sec. (10 ft./sec.). The opening shall be located at high level.

10.3.5 A fresh air grille shall be mounted at this opening. The grille shall be fabricated from best quality galvanized steel sheets. Grille of size 500mm and below shall be of 1mm thick, and size above 500mm shall be 1.25mm thick. The air grille shall be of high quality finish and shall be to the approval of P.D.

10.4 Control Panel

10.4.1 Each control panel shall be supplied c/w auto-transformer starters with built-in isolators, start/stop push buttons, run/trip/low oil level indication light, thermal overload and single phase protection, a voltmeter, hourmeter, auto duty-standby selector switch, ammeter and phase indicator lights. The control panel shall be mounted on the wall at a location as shown in the tender drawing.

10.5 Electrical Power Requirements

10.5.1 Power Factor Requirement

10.5.1.1 The monthly average power factor of all the equipment supplied shall be not less than 0.85.

10.5.1.2 The above condition is to be achieved by power factor improvement equipment or devices. However, if the power factor correction is done other than at the load, than the cabling, electrical switching protection devices between the load

and the point of correction shall be rated according to the worst power factor condition that they may be subjected to .

10.5.1.3 Power factor improvement equipment used shall conform to IEC 70/70A standards and shall be suitable for continuous operation at a nominal voltage of 415V and up to 440V, 50Hz, 3 phase.

10.5.1.4 Capacitors used shall be dry type with self-healing protection and discharge devices. Loss shall not exceed 0.5/Kvar.

10.5.1.5 When automatic power factor correction bank is used, the regulator with the required number of steps should also incorporate no-volt protection relay, anti-hunting relay and a manual & automatic control switch. The regulator should be set to respond to Kvar need of the system with no hunting.

10.5.1.6 The regulator shall have LED display to show the number of steps switched

on at any one time and settings for the sensitivity value and the desired power factor.

10.5.1.7 Current transformer of suitable ratio shall be rated at 15VA and minimum accuracy of Class 1.

10.5.1.8 A K.W.hr. meter & KVar.hp. meter shall be incorporated in switchboards with a connected total rated equipment load of 50 kw and above.

10.5.1.9 This contractor shall be liable to pay any surcharge, or part thereof, levied by the TNB as a consequence of low power factor of the installed equipment

10.5.2 Control Panel, Electrical Switchboard and Wiring

10.5.2.1 Manual push buttons type of switches and selector lever including wiring in conduit to isolator shall be incorporated to operate the various equipment installed.

10.5.2.2 Contractor shall supply and install metal cubicle switchboard which shall house all circuit breakers, starters, contactors, relays, selector switches and indicating instruments for the equipment, inclusive of ammeters and voltmeters.

10.5.2.3 The metal cubicle switchboard shall be fabricated from pressed steel sheets of not less than No. 18 B.S.W. gauge in thickness, and shall be of rigid structural construction with all joints nearly welded and finished flush, and all bare edges turned over or lipped.

10.5.2.4 The door of the metal cubicle switchboard shall be fabricated from pressed steel sheets of not less than 18 B.S.W. gauge in thickness, and shall be rigidly reinforced on the inside with all edges finished round. The door shall be fitted with a chromium plated locking handle of such a construction that the door cannot be opened unless the isolator switch or handle is first turned to the OFF Position thereby cutting off the electric power supply to the electrical mechanisms inside the metal cubicle switchboard.

10.5.2.5 Felt or rubber insert shall be incorporated in the frame of the metal cubicle switchboard to ensure dust-proof locking arrangement. The door of the metal cubicle switchboard shall be fitted on the inside with shelves for storing spare cartridge fuses and contacts and electrical circuit diagrams. Spare fuses of each sizes used shall be supplied on handing over the system.

10.5.2.6 All contactors, starters, relays and contactors shall be fitted on insulated panels. All incoming and outgoing circuits and wiring shall be brought to the contactors, starters, relays and controllers via insulated terminal strips mounted within the metal cubicle and all wiring between terminal strips and electrical equipment inside the control panel shall be neatly run and taped in accordance with the requirements of the Tenaga Nasional Berhad.

10.5.2.7 All wiring shall be carried out either with P.V.C. cables in galvanized conduits or M.I.C. cables and shall be run strictly in accordance with the requirements

of the Tenaga Nasional Berhad.

10.6 Air Hose

10.6.1 The air hose shall be of a special quality, burst-proof, weather and oil resistant, light and flexible type, having a smooth inside surface to provide low flow resistance. The hose shall have a minimum bursting pressure of not less than the required application of the requirement pressure at site. All termination point shall be terminated at high level.

10.6.2 The hose shall be kept in reel and ready to be used by method of pulling to the desired point or location.

10.7 Specification For Testing And Commissioning

Before handing over, the whole system shall be tested to the satisfaction of the P.D. The testing procedure shall comply with the latest requirement of relevant authorities.

10.7.1 All manifolds, compressors, air dryers, etc. should pass the appropriate tests at the maker's works, and certificate indicating performance and sound pressure level should be available on request by the P.D.

11.0 DUST/FUME/SMOKE HOOD EXTRACTION SYSTEM

11.1 Scope of works

11.1.1 The works covered under this contract shall include but not limited to the followings:-

11.1.2 To design, supply, deliver, install, test and commission to successful operating conditions the complete Dust/Fume/Smoke Hood Extraction Systems located at workshops. Such system shall consist but shall not be limited to the followings:-

a) Centrifugal Fan
b) Ducting
c) Dust/Fume/Smoke Extractor Hood c/w filtration system

11.2 Centrifugal Fan

The fan shall be of the centrifugal, direct driven type. The design of the fan housing shall be of heavy gauge galvanised steel sheet mounted upon a rigid support structure which afford minimal resistance to airflow and noise generation. Maximum noise level shall not exceed 65dbA if measured 1m away from the hood.

The Fans shall be constructed with the motor out of the air system. The fan shall be suitable to be used for extracting exhaust gases, volatile fumes and small dust.

The shroud shall have a rolled bead and internal structure members for added strength.

The fan impeller shall be of the galvanised sheet steel, centrifugal type with a well designed inlet ventilate for maximum performance. Impeller shall be dynamically and statically balanced to reduce vibration, noise generation, an even airflow, higher capacity and lower noise level.

Motor and centrifugal impeller shall be mounted on vibration isolators. Motors shall be isolated from the exhaust airstreams; air cooling for motor shall be taken into motor compartment from a location free from contaminations. Motor shall be readily accessible for maintenance.

11.3 Ductwork

All ductwork and fittings shall be constructed in accordance with practice recommended in the current editions of the ASHRAE Guide and Data Book published by American Society of Heating, Refrigeration and Air-Conditioning engineers. The degree of zinc coating on sheet steel shall be in accordance with clause of BS 2989-1965. The ductwork shall be provided with suitable bracings as listed below for additional stiffness to prevent sagging, drumming or vibration. Duct size transformation pieces shall be gradual and shall generally follow a slope of 1 in 7.

Flexible connections shall be provided where the ductwork joins the arm extractor. Such connection shall consist of flame-proof double skin. The flexible connection shall be such that it is possible to renew the hose without having to dismantle the ductwork.

11.4 Bends and Offsets

On all bends and offsets, the centre line radius shall not be less than one and one-half times the width of duct unless otherwise shown where right-angled bends are used.

All branches shall be taken off at not more than 45° angle from the axis of the main duct and fitted with folded metal splitter dampers fixed in position with a rod and clamp.

11.5 Duct Supports

All ductwork shall supported rigidly at centres to prevent sagging and vibration on purpose made hangers, support and cantilever brackets.

Each length of duct shall be supported separately at centre not greater than 2 m. Duct supports shall consist of galvanised steel angle iron bearers of similar size to that used for bracing that section of ductwork with galvanised steel rods not less than 4 mm dia. or flat iron brackets of similar size to that used for bracing that section of ductwork as hangers. Additional supports shall be provided where necessary for sound insulation.

11.6 Fume Extractor Arm

It must be a flexible type of extraction arm and the ventilation needs is with fume extraction at-source. This method is that it can capture the air pollutions where they are produced to prevent them from spreading all over the premises and reaching the operators breathing zone.

- The arm must be type of combination of inner and outer arm tubing.
- The unit must have an external easy to adjust elbow joint, together width the spring assisted joint support in double ball bearing.
- The hood can angle 110° in any direction, has a safety mesh and handle for manoeuvring with have just one hand. It also must have a built-in damper.
- Large handle which can be reached from any position. All manoeuvring is done with just one hand.
- Flame-proof double skin flexible hose of PVC with internal steel spiral.
- Universal joint with hood collar and shutt-off damper.

- Maximum reach and working radius of 2.0 meter.

- Hose diameter/tubing diameter shall be 150-160 mm complete with ball bearing mounted and with 3 friction link.

- Recommended air flow hood 800 – 1000 m^3/hr.

- The arm must be complete will mountings bracket hose, hood with damper, necessary support and etc.

11.6.1 Fume Extractor Hood

It must be a canopy hood type of extraction and the ventilation needs is with fume extraction at-source. This method is that it can capture the air pollutions where they are produced to prevent them from spreading all over the premises and reaching the operators breathing zone. The hood itself shall be made of stainless steel plate with 1.6mm thickness. It is also important to provide a filtration system to the exhausted air before it discharged to the atmosphere. This has to cater both odour and dust from exhausting to the atmosphere.

11.7 Painting

The Tenderer shall include the cost of painting of all equipment included in this tender. The colour of the paint shall be approved by the Authorised Agencies or P.D and shall consist of 1 primer coat and 2 top coats of finishing oil paint. Before any painting is carried out, the contractor shall ensure that the surface is clean, free from grease and rust. If necessary, de-greasing and de-rusting procedures shall be carried out.

12.0 OVERHEAD TRAVELLING CRANES AND OTHER LIFTING EQUIPMENT

12.1 General

12.1.1 The complex shall be equipped with electric overhead crane and other lifting equipment adequately designed to serve the varied needs of all different building.

12.1.2 The Contractor shall design, supply all materials, equipment, plants and labours and perform all installation, testing and commissioning works required for the complete and satisfactory completion of the whole installation, repair and replace all defective and faulty materials, equipment, plants and works and perform all breakdown, scheduled and preventive maintenance works during the Maintenance Period as specified in the Contract.

12.1.3 The whole installation shall be fully complying to the requirements of the relevant authorities as described per clause 3.0 (General Condition of Contract). The Contractor shall liaise with all parties concern and provide details for civil and electrical power requirement. All costs, fees required for the above and for obtaining the necessary approval and certificates from the relevant authorities shall be deemed to be included by the Contractor.

12.1.4 Equipment and system designed, supplied and installed shall be reliable, high quality, suitable for tropical conditions. All materials and works, except those clearly specified and stated not necessary, shall deem to be included in the project and shall be supplied/performed by the Contractor.

12.1.5 The Contractor shall ensure that all equipment supplied and installed are acceptable to the various authorities having jurisdiction over the installation and to fill in all notices and requests required to obtain approval from them and to pay all the related necessary fees.

12.2 Scope of works

12.2.1 The Contractor shall liaise with client and OEM to determine the right safe working load of the various OTC and lifting equipment.

12.2.2 The works included in this installation shall be complete crane system including electrical switchboard, hoisting unit, track wheels , end carriage, ,end carriage wheel, girder, control pendant, overload device , limit switches, accessories and necessary work.

12.2.3 The end carriage shall be welded box design. It shall be designed to cater the weight of the crane and load is equally distributed between the carriage wheels. The end carriage shall be equipped with buffer at the four ends. The end carriage wheel shall be fabricated from spheroidal graphite cast iron (GGG 70).

12.2.4 All crane components ,equipment and electrical installation such as end carriages, hoist motor, overload devices, limit switches, crab/trolley, hook, pendant control, cable gland, contactor control shall be design for 'explosion proof' to ensure that the installation is not capable of igniting surrounding atmosphere. Devices which may spark in operation shall be installed in a 'flameproof' enclosed panel box with a junction box for safety.

12.3 Design Considerations

12.3.1 The crane structures shall be designed and manufactured to BS2573 and BS 466 and the whole part shall be designed to comply with but not limited to IEC, DIN, FEM and ISO.

12.3.2 The crane shall be designed to withstand the effect of any combination of and not limited to the following load :-

a) Dead loads
b) Live Loads (including hook load multiplied by the Impact Factor appropriate to the class of crane)
c) Inertia forces
d) Erection forces and effects
e) Wind load and out of service wind load.
f) Forces due to collision buffers with resilient buffers.

12.3.3 The crane unit and hoist shall be designed to minimize noise level. The overall noise level shall not exceed 85dBA at 1 meter distance.

12.4 Testing Equipment

12.4.1 For purpose of testing the crane, this Contract is to include the supply on loan of the testing equipment such as weights (1.25 SWL), teodolite as specified for the Site Tests. The Contractor is to describe in his tender the apparatus he proposes to be used.

12.5 Reliability, Maintainability and Durability of Design and Equipment

12.5.1 The Contractor shall be required to demonstrate to the satisfaction of the P.D that the design of lifting cranes, hoists and equipment consists of elements that have a proven and demonstrable successful track record in delivering the standards and performance required under the terms of the contract and specifications. All associated works shall be completed to perfect the system.

12.5.2 After the satisfactory completion of the system, each crane shall lift and sustain a test load of 125 percent of the safe working load when located at the center of the span. A number of test loads shall be applied for the purpose of producing a main beam load/deflection curve over a range of 50 to 125 percent loading. During the overload test each motion in turn shall be maneuvered in both directions and the crane shall sustain the load under full control. The specified speeds need not be attained but the crane shall show itself capable of smooth moving with the overload without difficulty. Each brake shall be separately tested under this test load.

12.5.3 The cost of carrying out all the tests including the cost of electricity, test weights, and others shall be borned by the Contractor and this cost shall be included in the Contract price.

12.5.4 The integration and total system design for the facility shall represent the best use of proven technology and shall be capable of meeting or exceeding the specifications.

12.5.5 The system designed and installed shall be smooth in operation and have no discernable vibration. The Contractor shall take all necessary steps to ensure that the equipment supplied meets the above requirements and shall be deemed to have included in his offer price for such sound absorbing and anti-vibration materials or devices as are necessary to ensure a satisfactory degree of silence and absence of vibration to the satisfaction of the P.D.

12.5.6 All equipment designed, supplied and installed shall be capable of continuous operation. The installation shall be operated from the supply mains and also connected to the essential power supply for emergency operation as necessary.

12.5.7 The Contractor shall be responsible for the submission, complying and obtaining the approval of all relevant authorities. The price quoted by the Contractor shall be deemed to include the entire requirement above.

12.5.8 During maintenance and guarantee period, the Contractor shall at his own expense, remedy and supply/replace all defective parts or items, inclusive of all consumable items so that the complete mechanical system is maintained in a first class running order. This maintenance shall include regular and systematic checking, cleaning and necessary adjustments to the equipment.

13.0 BUILDING SUPERVISORY SYSTEM (BSS)

13.1 General

13.1.1 A Building Supervisory System shall be installed to enable monitoring and also remote control where necessary for all mechanical services in the Hospital areas.

13.1.2. Plant monitoring and equipment control shall be made through a Supervisory Workstation installed in the Engineering Department. An additional Workstation shall also be installed at the Control Room.

13.2 Scope of Works

The works covered under this contract shall include the following:-

13.2.1. Supply and installation of a Building Supervisory System complete with the following:-

Supervisory computers c/w CPU of the latest model and speed, original software inc. anti-virus software, hard disk with latest maximum memory and RAM, CD ROM Drive, 17" SVGA graphic colour monitors, standard keyboard and mouse, alarm / report printers, stand alone controller unit, direct digital controllers, flowmeter, switches, transducers, sensors, high level interface with main fire alarm panel and chiller microcomputer control panel, relays and cabling installation, etc.

13.2.2 Essential power supply for all system Power Points requirements (computers, printers, direct digital controllers, master/slave etc). Uninterruptible Power Supply (UPS) for computers and printers shall be provided for at least 30 minutes.

13.2.3. To provide a system of at least 72 hours of memory protection for the database and real time clock during both normal & essential power failure.

13.3 Details of Equipment

1. On the hardware side, the Contractor shall offer equipment of models and types of the latest improved version and reputable make that are already established and proven in the local market.

2. The system shall be able to perform plant monitoring, equipment control, database management, system performance analysis and management reports etc.

3. The system shall provide standard program or functions inclusive of but not limited to the followings:-

    a. Time of Day Scheduling
    b. Holiday Scheduling
    c. Maintenance Scheduling
    d. Temperature Compensated Duty Cycling
    e. Electrical Demand Limiting
    f. Start and Stop Time Optimisation
    g. Temperature Override
    h. Outside Air Enthalpy Optimisation
    i. Power failure/Auto Restart
    j. User Define Programming
    k. Real time graphics
    l. Historical graphics for last 24 hours

4. The system shall monitor sensor inputs as follows:-

    a. Dry contacts for status and alarm
    b. Supervised Class B contacts
    c. Pulse Dry Contacts for metering
    d. 0 - 10 VDC
    e. 0 - 1000 ohms
    f. 4 - 20 mA

5. The Controller shall be able operate in an environment of 30 to 122 F and a 0 to 90% RH, non condensing.

6. Operator access to the system shall be divided into a minimum of 3 basic levels for operation, programming and configuration of the system.

7. The system shall also meet requirements inclusive of but not limited to the followings:-

    a. It shall be configured as a distributed processing network of panels not dependant on a host computer for any operation.

    b. It shall be modular and easily expanded by the user in both capacity and functionality.

    c. The system shall have a user programmable delay between successive starts to limit demand peaks.

    d. Alarm events shall be stored in 2 Workstations concurrently so that the failure of either one does not result in the loss of any data.

    e. The network shall be fault tolerant, and any stand-alone Controller detecting an error in its operation shall disconnect itself from the network to allow the remaining controllers to

continue normal operations.

f. Terminal communications - the system shall have the capability of auto dialling communications over the dial-up telephone network.

g. The Controllers shall obtain self diagnostics that continuously monitor the proper operation of the unit.

h. Alarm handling shall have a change-of-state priority assignment for 4 levels of criticality, i.e.

Maintenance Alarms low priority,
Equipment safety alarms high priority,
Security points emergency priority,
Life safety alarms fire priority etc.

The system shall list all alarms in the building in a single summary and shall have provision to store up all alarm events or maintain a History Record of the alarms from the day the system is put into operation.

13.4 Schedule of Control Points

The schedule of control points shall be inclusive of but not limited to the followings :- (Legend: DI: Digital Input, DO: Digital Output, AI: Analog Input, AO: Analog Output). (If applicable)

13.4.1 General Compressed Air System

a. Air Compressor Set

Status	DI
Trip alarm	DI
KW	AI (Main Supply to Switchboard)
Amp	AI (Main Supply to Switchboard)
Program	(Alarms, Totalise & Maintenance Schedule)

b. Air Receiver Tank

Pressure	AI
Program	(Pressure Alarm)

13.4.2 L.P.G. System

a. Manifold

Pressure Low Alarm	DI (Individual Bank)

Program	(Alarm)

13.4.3 Cold Water System

a. Booster Pump

Status	DI
Trip Alarm	DI
Flowrate	AI
Pressure	AI (Before check value)
KW	AI
Amp	AI (Main Supply to Switchboard)
Program	(Alarms, Totalise & Maintenance Schedule)

b. Suction Water Storage Tank

High Alarm	DI
Low Alarm	DI
Program	(Alarm)

c. Main Elevated Water Storage Tank

High Alarm	DI
Low Alarm	DI
Program	(Alarm)

13.4.4 Fire Protection System

a. Hose Reel Pump

Status	DI
Trip Alarm	DI
Pressure	AI (Before check valve)
Program	(Alarms, Totalise & Maintenance Schedule)

b. Wet Riser/Sprinkler/Hydrant/Jockey Pumps

Status	DI
Trip Alarm	DI
Pressure	AI (before check valve)
Program	(Alarms, Totalise & Maintenance Schedule)

c. Water Storage Tank for Fire Protection System

High Alarm	DI

Low Alarm	DI
Program	(Alarms)

d. CO2 Panel

Fault	DI
Alarm	DI
Discharge	DI
Program	(Alarm, Totalise & Maintenance Schedule).

e. Central Fire Alarm Panel

Auxiliary Contact for Status & Alarm
Program (Alarm)
High Level Interface with Addressable Fire Alarm Panel

13.4.5 Submersible Sump Pump

Status	DI
Trip Alarm	DI
Sump Pit	High Alarm DI (Individual Sump Pit)
Program	(Alarms, Totalise & Maintenance Schedule)

13.4.6 Lift

a. Lift

Status	DI
Trip Alarm	DI
Temperature	AI (Every Lift Motor Room)
Program	(Alarms, Totalise & Maintenance Schedule)

Elevator Monitoring System:
Auxiliary contact for floor indication.

13.4.7 Air Conditioning & Ventilation System

a. Main Switchboard at Chiller Plant Room

KW	AI (Main Supply)
Power Factor	AI (Main Supply)
Amp	AI (Main Supply)
Earth Fault Trip/ Overcurrent	DI (Main Supply)
Status	DI (Main Supply)
KW	AI (Individual Chillers)
Amp	AI (Individual Chillers)

KW	AI (Ind. Cooling Tower Fan)
Amp	AI (Ind. Cooling Tower Fan)
KW	AI (Individual Condenser Water Pump)
Amp	AI (Individual Condenser Water Pump)
Kw	AI (Individual Chilled Water Pump)
Amp	AI (Individual Chilled Water Pump)
Program	(Totalise)

b. Chiller

Status	DI
Trip Alarms	DI
Start/stop	DO
Temperature	AI (Condenser Water In)
Temperature	AI (Condenser Water Out)
Temperature	AI (Chilled Water In)
Temperature	AI (Chilled Water Out)
Program	(Alarms, Totalise, Time Scheduling, Start Stop Time, Temperature Override, Demand Limiting, Maintenance Scheduling, UDP)

Chiller own Control Panel:
Auxiliary contact for status & alarms.
High Level Interface with Chiller Microprocessor Panel

c. Cooling Towers

Status	DI
Trip Alarms	DI
Start/Stop	DO
Make Up Tank High Alarm	DI
Make Up Tank Low Alarm	DI
Program	(Same as chiller)

d. Condenser Water Pump

Status	DI
Trip Alarm	DI
Pressure	AI (Suction)
Pressure	AI (Delivery)
Flowrate	AI
Start/Stop	DO
Program	(Same as chiller)

e. Chilled Water Pump

Status	DI
Trip Alarm	DI
Pressure	AI
Flowrate	AI
Start/Stop	AI
Program	(same as chiller)

f. Chilled Water By-Pass System

Differential Pressure	AI
2Way Bypass valve Actuator	AO

g. Chilled Water Expansion Tank

High Alarm	DI
Low Alarm	DI
Program	(Alarms)

h. Air Handling Unit (AHU)

Start/Stop	DO
Status	DI
Filter Alarm	DI (Primary)
Filter Alarm	DI (Secondary)
Filter Alarm	DI (HEPA)
Trip Alarm	DI
Temperature	AI (Return Air)
Temperature	AI (off-coil)
Temperature	AI (chilled water in)
Temperature	AI (chilled water out)
Temperature	AI (Hot Water for Reheat only-Supply)
Temperature	AI (Hot Water for Reheat only-Return)
Relative Humidity	AI (Return Air)
Flowrate	AI (Supply Air)
Static Pressure	AI (Supply Air)
Actuator	AO (2 Way Valve Modulating for Chilled Water)
Actuator	AO (2 Way Valve Modulating only for Reheat)
Actuator	AO (Supply Air Volume Damper)
Actuator	AO (Fresh Air Damper)
Variable Speed Control	AO (Only for VAV design)
KW	AI (Main Supply to S/B)
Amp	AI (Main Supply to S/B)
Power Factor	AI

	Program	(Alarms, Totalise, Time Scheduling, Duty Cycle, Start/Stop time, UDP Temperature Override, Demand Limitings, Maintenance Scheduling).

j. <u>VAV Box Controller (for VAV only)</u>

Start/Stop	DO
Zone Temperature	AI
Air Flowrate	AI
VAV Damper Position	AO
Manual Override Control	DO
Remote Temperature Setting	AI

k. <u>Air Quality Monitoring</u>

CO2 level Monitoring	AI
Program:	(Alarm)

l. <u>Outside Air</u>

OA Temperature Monitor	AI
OA Relative Humidity Monitor	AI

m. <u>Ventilation Fans</u>

Start/Stop	DO
Status	DI
Trip Alarm	DI (3 phase fan only)
Program:	(Alarm)

n. <u>Smoke Spill Fan</u>

Status	AI
Status	AI (Main Power Supply)

o. <u>Pressurisation Fan</u>

Status	DI
Status	DI (Main Power Supply)

p. <u>Fan Coil. Unit (FCU)</u>

Start/Stop	DO
Status	DI
Filter Alarm	DI (Primary)
Filter alarm	DI (Secondary)
Trip Alarm	DI
Temperature	AI (Room Temperature)

Relative Humidity	AI (Room RH)
Temperature	AI (Chilled Water in)
Temperature	AI (Chilled Water out)
Actuator	AO (2 Way Valve Modulating for Chilled Water)
Amp	AI (Main Supply to S/B)
Program:	(same as AHU)

13.4.8 UPS System

AC Status	DI
Battery Status	DI
Trip Alarm	DI (Charger)
Temperature	AI (UPS Room)
Own Control Panel:	
Auxiliary Contact for Status & Alarms.	
Program	(Alarms, Totalise, Maintenance Schedule)

13.4.9 Generator Set

a. Battery

AC Status	DI
DC Status	DI (Battery)
Trip Alarm	DI (charger)

b. Generator Set.

Status	DI
Change over status	DI

c. Generator House

Temperature	AI

d. Frequency

Frequency	AI

e. Own Control Panel

Auxiliary Contact for Status & A1 arms, Load Current, etc.

f. Fuel Oil Tank

High Alarm	DI
Low Alarm	DI

13.4.10 Main Intake/Switch Rooms

Temperature	AI (Room Tem)
KW	AI
Amp	AI (lines)
Volts	AI (RY, YB,BR)
PF	AI
ACB Status	DI (For TNB Supply)
ACB Status	DI (For Gen Set Supply)
Own Control Panel:	
Auxiliary Contact for Status & Alarms.	
Program	(Alarms, Totalise, Maintenance Schedule)

13.4.11 Sewerage Treatment Plant

a. Main Power Supply

KW	AI
Amp	AI

b. Main Sewer Pump

Status	DI
Trip Alarm	DI

c. Rotating Screen

Status	DI
Trip Alarm	DI

d. Aerator

Status	DI
Trip Alarm	DI

e. RBC (Rotating Biological Contactor)

Status	DI
Trip	DI

f. Sludge Pumps

Status	DI
Trip	DI
Program	(Alarms, Totalise, Maintenance Schedule)

g. Water Level

High Alarm	DI
Low Alarm	DI

13.4.12 Cold and Hot Room

Status	DI
Temperature	DI
Relative Humidity	AI
Trip Alarm	DI
Program	(Alarms, Totalise, Maintenance Schedule)

14.0 ENERGY EFFICIENCY REQUIREMENTS

14.1 General

The contractor shall adopt the design parameter to ensure that the complete building be energy efficient to operate and maintain. Some energy efficient design criteria are ready mentioned in the various section of the design brief. This section shall serve to reinforce the concept and requirement for an energy efficient building to be constructed for this project. The contractor shall refer to MS 1525: 2001 – Code of Practice Energy Efficiency and Use of Renewable Energy for Non – Residential Buildings for design guidance

The contractor is required to employ "Specialist Energy Consultants" to study and submit energy features and systems both Passive and Active design philosophy shall be incorporated in the propose design submission. The submission shall include calculations, material, system, comparative study and criteria use in selecting a specific energy efficient design for this project.

14.2 Building Envelope Design

The Overall Thermal Transfer Value (OTTV) shall not exceed 45 w/m^2. For roofs with skylights the maximum permissible Roof Thermal Transfer Value (RTTV) is 25 w/m^2. The formulae to calculate these values are found in the MS 1525:2001 as stated above.

14.3 Air-Conditioning and Mechanical Ventilation(ACMV) Design

a. System and Equipment Sizing

Air conditioning systems and equipment shall be sized to provide no more than the space and system loads calculated, consistent with available equipment capacity.Redundacy in capacity of equipment, if incorporate into the sizing of the duty equipment, shall include efficiency devices such as variable speed drive, multi-compressor etc. So as not to diminish the equipment/system efficiency when operating at varying load.

Multiple units of the same equipment type, such as multiple chillers, with combined capacities exceeding the design may be specified to operate concurrently only if controls are provided which sequence or otherwise optimally control the operation of each unit based on load. Individual air cooled or water cooled direct expansion unit greater than 35 kWr shall consist of either multi compressor or single compressor with minimum 3-step capacity (cylinder) unloader (0-50-100% capacity) or variable unloaders.

b. Separate Air Distribution System

Zones which are expected to operate non-simultaneously for more than 750 hours per year shall be served by separate air distribution

systems. Separate air distributions systems should be also be considered for areas of the building having substantially different cooling characteristics and usage, such as perimeter zones in contrast to interior zones and public galleries in contrast to conference halls or meeting rooms.

c. Temperature Control

Each system shall be provided with at least one thermostat for the regulation of temperature. Each thermostat shall be capable of being set by adjustment or selection of sensors over a minimum range of between 18°C to 26°C.

d. Humidity Control

In a system requiring moisture removal to maintain specific selected relative humidity in spaces or zones, no new energy shall be used to produce a space relative humidity below 70% for comfort cooling purpose.

e. Zoning for Temperature Control

At least one thermostat for regulation of space temperature shall be provided for each separate system and each separate zone.

As a minimum, each floor of the building shall be considered as a separate zone. On a multi-storey building where the perimeter system offsets only the transmission gains of the exterior wall, an entire side of uniform exposure may be zoned separately.

VAV box zones shall be arranged to cover homogenous areas,i.e. similar to the zoning for the daylight effect on spatial design.

f. Control Setback and Shutoff

Each system shall be equipped with a readily accessible means of shutting off or reducing the energy used during periods of non-use or alternate uses of building spaces or zone serve by the system The following are examples that meet these requirements:-

- Manually adjustable automatic timing devices
- manual devices for use by operating personnel
- Automatic control system
- Occupancy sensors

g. Mechanical Ventilation

Each mechanical ventilation system (supply and/or exhaust) shall be equipped with a readily accessible switch or other means for shut off

or volume reduction when ventilation is not required.Example of such devices would include timer switch control, thermostat control, duty cycle programming and CO^2 sensor control.

h. System Testing and Commissioning

Air system balancing shall be accomplished in a manner to minimize throttling losses and then the pump impeller shall be timed or pump speed shall be adjusted to meet design flow conditions.

ACMV control systems shall be tested to assure that control element are calibrated, adjusted and in proper working condition.

15.0 OTHER MECHANICAL REQUIREMENTS

15.1 In addition to mechanical equipment, systems or requirements already mentioned or stated in the earlier sections, the Contractor is also required to supply and install other mechanical equipment or system to fulfil requirements necessary for an overall complete mechanical system that are functional and comprehensive in every respect.

15.2 In general, these requirements are mentioned or highlighted inside this Need Statement Requirements. But however, some of their requirements may not be explicitly or specifically stated but they are essential or fundamental equipment or systems that the Contractor has to provide them in order for the concern departments or related mechanical services to function properly and efficiently.

15.3 The Contractor is contractually bound to ensure that all these equipment or systems supplied and installed, shall comply to regulations and bylaws of the authorities having jurisdictions, the relevant B.S. Standards and also other relevant authorities general guidelines or requirements.

The write up of the systems is not exhaustive but shall only form a basis for the Contractor to propose on the installation to be provided. The Contractor is also required to make reference to current design needs before putting up a complete installation of the system and making it functional in every aspect.

- END-