
TECHNICAL SPECIFICATIONS

ARCHITECTURAL

RIYAN PVT LTD

TECHNICAL SPECIFICATIONS

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1. PRELIMINARIES

1.1 Standard and Codes

- 1.1.1 The Contractor shall, perform the Works in compliance with all regulations, standard specifications or statutes of the Government of Maldives unless otherwise conform to this specification.
- 1.1.2 The current British Standard Specifications and Codes of Practice shall apply to and form part of these specifications unless otherwise specified in respect of all materials and works to which they have application.

1.2 Drawings and Specifications

- 1.2.1 Drawings and Specifications are intended to complement each other, so that if anything is shown on the Drawings, but not mentioned in the specifications or vice versa, it is to be furnished and built as though specifically set forth in all three. If any discrepancies, errors, ambiguities or omissions occur in the Drawings or Specifications, the same shall be referred to the Consultant before proceeding with the Works, and the Consultant decision on such discrepancies, errors, ambiguities or omissions shall be final.
- 1.2.2 In addition to the Drawings and Specifications attached hereto, the Consultant will during the progress of the Works furnish additional Drawings, Specifications, and instructions as may be necessary, in the opinion of the Consultant for the purpose of the proper and adequate execution and maintenance of the Works, and the Contractor shall make his work conform. Such drawings and instructions shall be deemed to be part of the Contract Documents.

1.3 Transportation to the Site

- 1.3.1 The Contractor shall provide all necessary transport, handling and storage of all materials, components and the like to their points of installation on site including transport to and from storage. The Contractor shall provide all necessary transport of labour to and from the site.

1.4 Schedule and Execution Plan

1.4.1 The Contractor shall prepare and submit to the Consultant for approval the construction schedule and an execution plan of temporary facilities, stockyards, etc., before the start of the Works.

1.5 Repairing and Correction

1.5.1 Any breakage(s) or defect(s) of existing buildings, road utilities, or part(s) of them caused by the Works including transportation for the works shall be repaired or corrected by the Contractor with his responsibility.

1.6 Workmanship and Materials

1.6.1 All workmanship shall be of the best standard. All goods and materials to be incorporated in the Works must be new, unused, of the most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the contract.

1.6.2 The Contractor shall submit for the approval of the Consultant a list of names and addresses of the manufacturers and trade marks or names of all the various types of materials and goods he propose to use in the Works. The list shall include reference to the specifications clause or article to which the materials and goods apply.

1.6.3 Materials shall be obtained from approved sources and used in accordance with the manufacturer's printed instructions. In the absence of a specification all materials shall comply with a relevant standard. The consultant shall order the removal of any materials, which he has not approved.

1.6.4 No orders for materials and goods shall be placed until approval has been obtained for the materials and goods from the consultant.

1.6.5 The Contractor shall note that it is his responsibility to include in his price for the cost of the materials and products as specified and no adjustment will be allowed should the consultant reject the alternatives.

1.7 Obvious Work

1.7.1 Where an item of work is obviously required for the type of work being undertaken then it shall be deemed to have been included even though the item is not specifically mentioned or shown in the Drawings or Specifications.

1.8 Protection

1.8.1 The Contractor shall have the Works and adjoining properties protected from inclement weather. Any loss or damage caused by weather, carelessness or lack of skill of workers, accident or otherwise shall be of such property that is affected. The Contractor shall provide all necessary dustsheets, barriers and guardrails and clear away at completion.

1.8.2 The work shall be suspended for such time as may be directed and/or approve by the Consultant if the specified quality of work is difficult to maintain during inclement weather.

1.9 Scaffolding

- 1.9.1 The Contractor shall provide, erect, maintain, dismantle and clear away at completion proper and adequate including that required for subcontractor and suppliers. Putlog holes shall be made good to match the adjacent surface as the scaffolding is dismantled.
- 1.9.2 The Contractor shall be responsible for all safety precautions in connection with the scaffolding including the provision of all bracing, scaffold boards, toe boards and the like and for entire sufficiency for the work.

1.10 Construction Machinery, Plants and Equipment's

- 1.10.1 All necessary construction machines shall be provided and maintained by the Contractor and shall be approved by the Consultant.
- 1.10.2 If cranes or any other type of plant which places any load on the structure are proposed, all details of such plant shall be submitted to the Consultant for approval before the work is actually commenced. If approved by the Consultant and contractually acceptable, permission may be given for the structure to be strengthened, in order to carry out loads, and the Contractor shall be responsible for any resulting additional costs.
- 1.10.3 The Contractor shall be responsible for making good to the satisfaction of the Consultant any damage to the permanent structure that may be caused by his plant and equipment.

1.11 Samples

- 1.11.1 The Contractor shall furnish for the approval with reasonable promptness, all samples as directed by the consultant. The Consultant shall check and approve such materials with reasonable promptness only for conformance with the design concept of the Works and for compliance with the information given in the Contract Document. The Work shall be in accordance with the approved samples
- 1.11.2 All samples shall be delivered to the Consultant's office with all charges in connection therewith paid by the Contractor and deemed to be included in the Contract Price.
- 1.11.3 Duplicate final approved samples, in addition to any required for the Contractor's use, shall be furnished to the Consultant, one for office use and one for the site.
- 1.11.4 Samples shall be furnished so as not to delay fabrication, allowing the consultant reasonable time for consideration of the sample submitted.
- 1.11.5 Each sample shall be properly labelled with the name and quality of the material, manufacturer's name, name of project, the contractor's name and date of submission, and the specification clause to which the sample refers.

1.12 Ordering Materials

- 1.12.1 The Bills of Quantities shall not be used as a basis for ordering materials and the Contractor is entirely responsible for assessing the quantities of materials to be ordered.

1.12.2 Upon receipt of the Consultant's order to commence the Works, the Contractor shall immediately place orders for all required materials and will be held responsible for any delays occurring due to late placing of such orders.

1.12.3 The Contractor shall pay all expenses, taxes and dues etc. incurred on the procurement of materials from abroad

1.13 Water and Electricity for the Works

1.15.1 The Contractor shall make all necessary arrangements and provide all water for the proper execution of the Works, together with all transport, temporary plumbing, storage and distribution, pay all charges and alter, adept and maintain temporary work as necessary and remove and make good at completion.

1.15.2 The Contractor shall make all necessary arrangements and provide all artificial lighting and power (maintain a generator if necessary) for the proper execution and security of the Works and its protection, with all meters, temporary wiring and fittings, pay all charges and alter adapt and maintain the temporary work as necessary and remove and make good at completion.

1.14 Site Offices for Contractor

1.14.1 The Contractor shall provide maintain and clear away on completion of the Contract all necessary site offices, canteens, messing and welfare facilities, temporary buildings, toilets and the like for all site staff employed by the Contractor and required by subcontractors and suppliers.

1.14.2 The offices shall be open at all normal working hours to receive instructions, notices and other communications.

1.14.3 The Contractor shall obtain the approval of the Consultant of the proposed site layout, type and drainage arrangement of all the buildings prior to erection of same. All buildings shall be supplied and maintained in good condition and of neat appearance, all maintenance to same as instructed by the Consultant shall be carried out at the Contractor's expense.

1.14.4 Under no circumstances shall overnight accommodation be permitted on Site except for the site watchman in carrying out his duties.

1.15 Contractor's Site Area

1.15.1 Throughout the period of the Contract the Contractor shall maintain the area of his operation within the limits of the Site in a clean, tidy and safe condition by arranging materials and the like in an orderly manner. All rubbish, debris, waste materials and the like shall be systematically cleared from the Site as it accumulates.

1.15.2 The Contractor shall take all steps necessary as directed by the Consultant to minimize or eliminate dust, noise or any other nuisance, which may occur. Plant emitting dust, smoke, excessive noise or other nuisance shall not be permitted.

1.16 Progress Meetings

- 1.16.1 During the course of the Works, progress meetings shall be held at fortnightly intervals for the purpose of co-ordinating the Contractor's works and to ensure that full compliance is maintained.
- 1.16.2 Minutes of such meetings should be recorded; copies will be distributed to all persons concerned and full effect shall be given to all instructions contained therein.
- 1.16.3 Prior to such meetings the Contractor shall give to the Consultant's Representative details in writing of that portion of the Works he proposes to construct during the coming two weeks with details of the plant and method he proposes to employ. These proposals shall be discussed at the meeting and no work based on such proposals shall proceed without the approval of the Consultant's Representative.
- 1.16.4 The Contractor shall submit all reports as instructed by the Consultant in connection with progress meetings and the day to day management of the Works.

1.17 Progress Photographs

- 1.17.1 The Contractor shall supply once a month, at the time of submitting his Interim Certificates, twelve photographs from 36 exposures showing the progress of the Works. The Consultant shall direct the times and position from which the photographs are to be taken.
- 1.17.2 The photographs shall be submitted in three copies un mounted of a size not less than 15 x 10 centimetres with the description of the viewpoint stamped in ink on the back. The negative shall have the date on it and remain the property of the Consultant and no prints from these negatives may be supplied to others unless previously authorized in writing by the Consultant.

1.18 Setting Out

- 1.18.1 The Contractor shall be responsible for accurately setting out the Works to the specified positions, dimension, levels and Building Lines and also checking the site surveys for dimensional and level accuracy and reporting any discrepancies before building work commences.
- 1.18.2 The Contractor shall provide the Consultant with all facilities, equipment and labour to enable him to check the setting out and levels of the Works at all times. The checking of any setting out point, line or level by the Consultant shall not in any way relieve the Contractor of his responsibility
- 1.18.3 All setting out points, benchmarks, site rails, pegs and other survey points shall be clearly marked and protected from damage or disturbance during the execution of the Works

1.19 Billboards

- 1.19.1 The Contractor shall provide and maintain two billboards for the Site each consisting of a plastic board panel of size not more than 2.4m x1.2m (2.88m²) supported 2.5m above the ground with steel angle framing or similar material and fixed in concrete foundations.
- 1.19.2 Each board shall have the following written in both Dhivehi and English (letter height not to exceed 100mm) by a skilled sign writer:

The name of Project

The name of Employer

The name and address of Consultant

The name and address of Contractor

1.19.3 A scaled layout shall be prepared and submitted for the Consultant's approval before fabrication.

1.19.4 No advertising material other than the above will be permitted.

1.19.5 The location and layout of Sub-Contractors or Manufacturer's billboards, if allowed, must be submitted for the Consultant's approval.

1.20 Loading in Excess of Design Load

1.20.1 No loading in excess of the design loading shall be placed on any portion of the structure without the written permission of the Consultant

1.20.2 If such permission is granted, all beams or other members of the structure which are subjected to loading other than the designed loading shall be strengthened and supported to the satisfaction of the Consultant, and the Contractor shall be responsible for any resulting additional costs

1.20.3 The Contractor shall be responsible for making good to the satisfaction of the Consultant any damage to the permanent structure that may be caused by such excess loading.

1.21 Building Permit

1.21.1 The Contractor shall allow for obtaining the building permit and for paying all fees in connection therewith.

1.22 Permanent Drainage, Electricity and Water connection

1.22.1 The Contractor shall allow for arranging and obtaining the permanent drainage, water and electricity connections to the proposed development and he shall be responsible for making all payments in connection therewith.

1.23 Handing Over

1.23.1 Prior to handing over the proposed development the Contractor shall gain the approvals and respective Completion Certificates from all the local government authorities and the like that the work has been completed in accordance with their requirements. Any payment in connection therewith shall be paid by the Contractor.

2. SITE WORKS

2.1 Demolition

2.1.1 Demolition includes the complete demolition including grubbing up of foundations and the proper termination of all services as required by the Drawings including the removal and disposal of all demolished materials. The demolition work shall be executed in a systematic manner.

2.1.2 Demolition operations and the removal of debris shall be carried out to ensure minimum interference with roads, streets, footpaths and other adjacent occupied or used facilities.

- 2.1.3 Damage caused to adjacent facilities by demolition operations shall be repaired by the Contractor at his own expense. The Contractor shall arrange and pay for the disconnecting, removing and capping of utility services, notify the affected utility agency in advance and obtain written approval before commencing work.
- 2.1.4 Before commencement of work, submit a method statement to the Consultant as to the proposed method and sequence of demolition of the building and a safety plan which shall cover the risk assessment and safety measures for such method statement. The Consultant reserves the right to prohibit any method of execution of the Works which he regards as unsafe.
- 2.1.5 Drawing information, particularly for unconventional layouts and special structures, will be made available to the Contractor if possible. The Contractor shall state in his method statement if it is based on such drawings. In the absence of drawings, the Consultant may require a detailed structural survey to be carried out and endorsed by a Registered Structural Engineer (or equivalent) to define the existing structure and the appropriate method and sequence of demolition.
- 2.1.6 No work on site shall be allowed to commence until the proposed method statement has been accepted and all precautionary measures, hoardings, covered walkways, and other requirements are in place.

2.2 Site Clearance

The Site shall be cleared of all vegetation, rock, boulders, etc. and surface soil shall be removed as directed by the Consultant. The trees which are to be retained shall be protected from damage

Spreading, levelling and consolidating on site where required, shall be made with suitable surplus excavated material obtained from the Site. Other soils used for filling shall be approved by the Consultant

The Contractor shall dispose all unsuitable and surplus excavated material

The Contractor shall tidy up and leave the Site in a clean and sanitary condition at all times during the execution of the Works.

2.2 Excavation

- 2.2.1 Excavation shall be performed to the required depth as shown in the Drawings.
- 2.2.2 A survey of the existing site shall be made and the results of same submitted to the Consultant before commencement of the work
- 2.2.3 Excavation area shall be protected from any water flowing in. Sides of excavations shall be shored or inclined to retain excavation unless otherwise specified
- 2.2.4 Excavation near adjoining structures shall be executed with care so as not to damage those structures.
- 2.2.5 The Contractor shall take all necessary precautions during the excavation for the Works particularly those excavation which are adjoining existing buildings and shall protect such buildings from the damage or collapse by means of temporary or permanent shoring, strutting, sheet piling or

underpinning or excavation in short lengths and/or other methods as he deems fit and also he shall properly support all foundations, trenches, walls, floors, etc. affecting the safety of the adjoining existing buildings.

- 2.2.6 The Contractor shall alter, adopt and maintain all such works described above for the whole period of the Contract and shall finally clear away and make good all damages done.
- 2.2.7 The construction and efficiency of the shoring, underpinning, strutting and the like for the purpose for which it is erected shall be the responsibility of the Contractor, should any subsidence or any other damage occur due to the inefficiency of the shoring, underpinning, strutting and the like or any other support provided, the damage shall be made good by the Contractor at his own expense and responsibility.
- 2.2.8 The shoring, strutting, piling and the like, shall be executed in such a manner as to cause as little inconvenience as possible to adjoining owners or the public and the Contractor shall be responsible for negotiating with the adjoining owners the means to safeguard their property and for the use of any portion of their land for the purpose of executing the excavations and no claims submitted on this ground will be entertained.
- 2.2.9 The Contractor shall be held solely responsible for the safety of the adjoining existing buildings, the sufficiency of all temporary or permanent shoring, underpinning, piling, and the like.
- 2.2.10 The Contractor shall keep the Consultant informed as to manner in which he intends to proceed with the execution of the excavations and obtain his approval. Such approval if given shall not absolve the Contractor of his responsibility.
- 2.2.11 Excavation shall extend a sufficient distance from walls, footings, etc. to allow space for placing and removing shoring and formwork, for performing all work in the excavations and for the inspection of same.
- 2.2.12 Excavated material shall be deposited within specified areas as directed unless otherwise specified.
- 2.2.13 The Contractor is deemed to have inspected the site and to leave ascertained for himself as to the nature of the soil, etc. and also the areas where to collect and stack the materials for which necessary site clearance shall have to be made at his own cost.
- 2.2.14 Stacking or excavated materials shall be done at places approved by the Consultant and he shall have recorded the original ground levels of such places jointly with the Contractor before commencement of stacking operation.
- 2.2.15 Extra excavation and allied lead/lift required specifically for providing working space to workmen or shuttering to walls of basement etc. shall be measured for payment, no extra claim being allowed for such work incidental to development and executions of allied jobs. Only authorized excavation approved by the Consultant shall be paid for
- 2.2.16 Sufficient clear working space shall be left all around excavated area. The disposal of waste/unserviceable materials may be in filling and/or in embankment according to nature of place of disposal. The appropriate specifications for filling and/or embankment shall apply
- 2.2.17 All foundation trenches shall be excavated to the full widths and depths shown on the drawings or to such greater or smaller depths as may be found necessary in the opinion of the Consultant and so instructed by his representative.

- 2.2.18 Should any excavation be taken down below the specified levels, the Contractor shall fill in such excavation at his own cost with cement concrete specified for foundations, well rammed in position until it is brought up to the level.
- 2.2.19 The Contractor shall notify to the Consultant when the excavation is completed and no concrete or masonry shall be laid until the Consultant has inspected of the soil for each individual footing.
- 2.2.20 All foundation pits shall be refilled to the original surface of the ground with approved materials, which shall be well consolidated as instructed by the Consultant.
- 2.2.21 The Contractor shall erect temporary barricades around the excavations and if necessary make provisions of red lamps.
- 2.2.22 The Contractor shall remove/maintain/restore all service lines like telephone, water supply, electricity etc. without any extra charges.

2.3 De-watering

- 2.3.1 Where the excavation level is below the natural water table and it is necessary to pump continuously from the excavation or to install a specialist type of dewatering equipment around the perimeter of the site or excavation, the Contractor will be responsible for ensuring the safety and stability of all adjoining structures and services or utilities above or below ground level.
- 2.3.2 It will also be the responsibility of the Contractor that the equipment installed shall ensure that the excavation and subsequent construction is carried out in dry conditions.
- 2.3.3 Continuous or permanent de-watering of the excavation or Site may not be undertaken without the written approval of the Consultant and the methods to be employed shall also comply with Codes of Practice and Local Authority requirements.
- 2.3.4 The water pumped from the excavations or well points shall be pumped to disposal points or sumps approved by the Consultant and the Local Ward Office and if so required be passed through settling tanks before disposal.
- 2.3.5 Unless prior approval has been obtained no water must be disposed of in the Municipality's sewer systems.

2.4 Backfill

- 2.4.1 All earth used for filling shall unless otherwise stated, be selected hard dry material from the excavation. The maximum dry density of the fill material shall be not less than 1600 kg/m³.
- 2.4.2 The backfill of excavations shall be placed in horizontal layers not exceeding 300mm in thickness. Each layer shall be compacted by hand or other mechanical means to the required density before the next layer is added.
- 2.4.3 Care shall be taken when filling or back-filling to avoid any wedging action or eccentric action upon or against the structure of the work.
- 2.4.4 Before placing of fill, the surface of the sub-grade shall be compacted at optimum water content to the same percentage of maximum dry density required of subsequent lay.
- 2.4.5 The Consultant will inspect all compacting devices that the Contractor proposes and shall have the right to reject any device which he feels is unsuitable for the job.

- 2.4.6 Heavy equipment for spreading and compacting fill and backfill shall not be operated closer to walls than a distance to the difference in height between the top of the footings and the layer being compacted.
- 2.4.7 When back-filling behind retaining walls, basement walls and the like the said structures shall be kept propped during the complete operation. The hydraulic compaction of fill shall not be permitted and the back filling shall be carried out in layers not exceeding 150mm thick.
- 2.4.8 Each layer shall be compacted to 90% of the modified compaction. No back filling shall be carried out until the wall concrete has achieved its full works cube strength and care shall be exercised so as not to damage the external tanking membrane and its protection.

3. CONCRETE WORKS

3.1 General

- 3.1.1 Materials used in the Works shall be new, of the qualities and kinds specified herein and equal to approved samples. Delivery shall be made sufficiently in advance to enable further samples to be

taken and tested if required. No materials shall be used until approved and materials not approved shall be immediately removed from the Works.

- 3.1.2 Materials shall be transported, handled and stored on the site or elsewhere in such a manner to prevent damage, deterioration or contamination.

3.2 Cement

- 3.2.1 Cement shall be Ordinary Portland cement of an approved brand.

- 3.2.2 Cement shall conform to BS 12.

Cement shall be of recent manufacturer and used within 6 months of manufactured date.

The Contractor shall with each fresh consignment of cement delivered to the site furnish the Consultant with a copy of the Manufacturer's statement of compliance with the above Standard Specifications together with the date of manufacture, certified by an independent agency in the country of origin and its date of delivery to Site.

Check tests will be required by the Consultant. These tests shall be carried out at the Contractor's expense.

Any cement failing to meet the required standards will be rejected and replaced at the Contractor's expense.

Any cement not conforming to BS 12 shall not be used unless otherwise approved by the Consultant.

3.3 Aggregate

- 3.3.1 Fine aggregate shall be river sand conforming to BS 882.

- 3.3.2 Coarse aggregate shall be crushed stone excluding limestone or derivatives of limestone conforming to BS 812.

- 3.3.3 Aggregate shall not contain injurious amount of rubbish, dirt, organic impurities and other foreign matters.

- 3.3.4 Strength of aggregate shall be more than that of hardened concrete paste.

- 3.3.5 Shape of coarse aggregate shall not be flat or slender.

- 3.3.6 Aggregate to be used in concrete shall possess the qualities indicated in the following tables.

Quality of Aggregates

| Aggregate type | Open dry specific gravity | Percentage of water absorption (%) | Percentage of solid volume for the evaluation of particle shape (%) | Clay lump (%) | Loss in washing test (%) | Organic impurity (%) | Water soluble chloride (%) |
|------------------|---------------------------|------------------------------------|---|---------------|--------------------------|----------------------|----------------------------|
| Coarse aggregate | <= 2.5 | <= 3.0 | => 55 | <= 0.25 | <= 1.5 | 0 | <= 0.25 |
| Fine aggregate | >=2.5 | <= 3.5 | - | <= 1.0 | <= 3.0 | 0 | <= 0.01 |

* Colour of test solution not to be darker than standard solution

Grading requirements for aggregates

| Nominal size | Amount Passing Each Sieve (% Mass) | | | | | |
|------------------|------------------------------------|--------|--------|--------|-------|--------|
| | 37.5mm | 20.0mm | 14.0mm | 10.0mm | 5.0mm | 2.36mm |
| Graded 40-5mm | 90-100 | 35-70 | * | 10-40 | 0-5 | * |
| Graded 20-5mm | 100 | 90-100 | * | 30-60 | 0-10 | * |
| Graded 14-5mm | 100 | 100 | 90-100 | 50-85 | 0-10 | * |
| Single-size 40mm | 85-100 | 0-25 | * | 0-5 | * | * |
| Single-size 20mm | 100 | 85-100 | * | 0-25 | 0-5 | * |
| Single-size 14mm | 100 | 100 | 85-100 | 0-50 | 0-10 | * |
| Single-size 10mm | 100 | 100 | 100 | 85-100 | 0-25 | 0-5 |

*British gradation limits for coarse aggregate (BS 882) *Not*

specifically specified in BS 882.

3.7 Manufactured sand and blast furnace slag to be use in concrete shall not be used unless otherwise specified or approved by the Consultant.

3.3.8 In case of using fine aggregate of 0.01% or more water soluble chloride content, the necessary measures for corrosion inhibiting of reinforcement shall be instructed by the Consultant.

3.3.9 Sources of aggregate shall be to the approval of the Consultant and samples of aggregate from the proposed source shall be submitted to the Consultant at least 28 days before its intended use.

3.4 Water

3.4.1 Water shall not contain injurious amount of impurities that may adversely affect concrete and reinforcement.

3.4.2 Ground water shall not be used for concrete works.

3.4.3 Water shall be obtained from a public supply where possible, and shall be taken from any other sources only if approved by the Consultant.

3.4.4 Only water of approved quality shall be used for washing out formwork, curing concrete and similar surfaces.

3.5 Handling and Storage of Material

3.5.1 Cement

3.5.1.1 Cement shall be stored in a manner to prevent weathering.

3.5.1.2 Bagged cement shall be piled no more than 10 bags so as to permit easy inspection

3.5.2 Cement caked even to the slightest extent shall not be used. Such cement and rejected cement shall be immediately separated from other bags of cement so that they shall not be mistaken for others.

3.5.3 Aggregate

3.5.3.1 Aggregate shall be stored in a manner effectively separating coarse and fine aggregate according to type and shall be prevented from inclusion of dirt, rubbish and other undesirable foreign matters.

3.5.3.2 Coarse aggregate shall be unloaded and piled in a manner not to cause segregation of small and large particles. Aggregate to be stored in piles shall be in mounds of moderate height and at a location where good drainage is provided.

3.6 Mix Proportion and Strength

3.6.1 Mix ratio for reinforced concrete shall be in the proportion 1:2:3 (cement: fine aggregate: coarse aggregate) by dry volume.

3.6.2 Mix ratio for lean concrete shall be in the proportion 1:2:6 (cement: fine aggregate: coarse aggregate) by dry volume.

3.6.3 Water-cement ratio for concrete shall be 0.4% to 0.45%

3.6.4 The specified design strength of reinforced concrete shall be 25 N/mm²

3.6.5 The required slump of concrete shall be 100 mm.

3.6.6 Design mix proportion shall be to obtain required workability, consistency and durability.

3.7 Production of Concrete

3.7.1 Field-mixed Concrete Plant

3.7.1.1 The Contractor shall select the necessary facilities for storage, batching, mixing and transporting of each of the materials and submit them for approval of the Consultant prior to start work.

3.7.2 Measuring

3.7.2.1 All materials shall be measure by volume for each batch and water may be measured volumetrically.

3.7.2.2 Cement shall be measured by number of bags unless automatic cement weight measure is in use.

3.7.3 Mixing Control

3.7.3.1 Concrete mixture shall be constantly controlled to obtain required workability and mixed strength. Mixing time for each batch shall be not more than 3 minutes.

3.7.4 Quality Control

3.7.4.1 The Contractor shall conduct tests for quality control toward insuring that concrete of the required quality is constantly produced.

3.7.4.2 The Contractor shall have all quality control tests report ready for submission as required by the Consultant.

3.7.5 Quality Inspection of Concrete at the Point of Placement

3.7.5.1 The Contractor shall conduct tests on concrete at the point of placement. When test results meet the tolerances given below, the concrete shall be qualified to have passed the tests.

The tolerance between actual slump and required slump of the concrete shall be 2.0%mm

3.7.5.2 For the estimation of compressive strength of concrete in compressive strength tests, when the average value of compressive strength of concrete obtained in a test is not less than the specified design strength, it shall be qualified to have passed the test. In case of failure to the above requirements, the Contractor shall take necessary measures such as to perform appropriate test as instructed by the Consultant.

3.8 Transporting and Placing

3.8.1 General

3.8.1.1 The Contractor shall establish manner and schedule for transporting and placing of concrete and obtain approval of the Consultant.

3.8.1.2 Concrete shall be transported in a manner to minimize segregation, spill, age and other changes in quality thereof.

- 3.8.1.3 Concrete shall be placed and consolidated in a manner to insure uniformity and optimum density.
- 3.8.1.4 In case of rain or other conditions that may affect the quality of concrete during concreting, the Contractor shall take necessary measures as instructed by the Consultant.
- 3.8.2 Time Limit
 - 3.8.2.1 The time limit from start of mixing to completion of placing of a batch as a rule shall be 30 minutes.
- 3.8.3 Preparation prior to Placing.
 - 3.8.3.1 The place where concrete is to be deposited shall be cleaned and sheathing shall be sprinkled with water. Subsequently, water accumulated in the form shall be removed.
- 3.8.4 Construction Joint
 - 3.8.4.1 Joint surfaces shall be cleaned, made free of laitance and other foreign matters, and wetted prior to concreting. Joint surface shall be roughened if directed by the Consultant.
 - 3.8.4.2 The locations of shapes of construction joints shall be consulted and approved by the Consultant.
- 3.8.5 Concrete Placing
 - 3.8.5.1 Concrete placing shall be proceeded to keep the surface of placed concrete as horizontal as possible.
 - 3.8.5.2 Concrete shall be continuously poured to compact around reinforcing bars and corners of formwork.
 - 3.8.5.3 The maximum time interval between placements of continuous concreting shall not exceed 0.5 hours. However, when special measures are taken this time limit may be changed according to instruction or approval of the Consultant.
- 3.8.6 Consolidation
 - 3.8.6.1 Vibrating of concrete and tapping of formwork shall be performed to wall, column and other places difficult for concrete to proceed. Proper number of workers for placing and compacting concrete shall be arranged.
 - 3.8.6.2 Vibrator shall be operated for concrete called for water tightness, difficult portion for concrete to proceed and other cases directed by the Consultant.

However, vibrator shall not be touched reinforcing bars and shall not be operated more than 30 seconds at same spot.
 - 3.8.6.3 Concrete shall be placed 300 - 600 mm thickness at once in case vibrator is performing. In case flexible-insert-vibrator is called for, concrete shall not be placed thicker than the length of the insert or vibrator at one pouring.
- 3.8.7 Placing Speed

3.8.7.1 Concrete shall be placed at the speed suited for the workability of the concrete and condition of the place of placement, which insures proper consolidation of concrete.

3.9 Concrete Curing

3.9.1 Curing Method

3.9.1.1 After concrete has been placed, the concrete surface shall be kept moist by sprayed with water or by other appropriate methods, and shall be protected from direct sunlight and rapid drying. The top surface of slabs shall be kept flooded with water at all times after concreting for the duration of curing period. This curing period shall be for not less than 14 days.

3.9.1.2 As a rule, no foot traffic or loads shall be permitted on concrete for at least 24 hours after placement.

3.10 Test

3.10.1 General

3.10.1.1 The contractor shall be required to conduct all tests according to BS method and procedure.

3.10.1.2 Test, as a rule, shall be conducted at the locations directed or at the testing institutions approved by the Consultant.

3.10.1.3 The Consultant shall conduct test, as a rule.

3.10.1.4 In case of failure in test, measure shall be taken as instructed by the Consultant.

3.10.1.5 The Contractor shall keep test records during the work and for 2 years after completion of the contracted work.

3.10.2 Material

3.10.2.1 Cement Test

(1) Setting test.

(2) Soundness test.

(3) Compressive strength test.

Note: Item (1) shall be conducted once in every manufacturer.
Item (2) & (3) shall be conducted once in every 2,000 bags.

3.10.2.2 Aggregate test:

(1) Grading and fineness modules.

3.11 Concrete

3.11.1 Fresh concrete

Slump, air content, shall be conducted daily, and more often at request of the Consultant.

3.11.2 Compressive strength test of concrete

Test for estimation on strength of concrete in structure:

- 3.11.2.1 In order to assume estimated strength of concrete in structure, compressive strength test shall be conducted for prepared test pieces on the 7th day and 28th day and those test pieces shall be made for sampling at placing of concreting.
- 3.11.2.2 Strength test shall be conducted for each of the following conditions: each days pour, each class of concrete, each change of supplies or source and each 100 cubic meter of concrete or fraction thereof. The number of test pieces to be used in a test shall be not less than 3 for each test of the 7th day and the 28th day unless otherwise instructed by the Consultant.
- 3.11.2.3 Test pieces shall be made in accordance with British Standards, and sampling shall be taken as near as possible at the point of placement.
- 3.11.2.4 Test pieces shall be stored without being disturbed and shall be covered during the first 24 hours, and carefully transported specimens to the testing laboratory. Test pieces shall be cured in water after de-moulding. The temperature of test pieces shall be kept as close as possible to the temperature of the concrete in structure until the time of testing.
- 3.11.2.5 The test results shall be expressed in the average value by calculating the average compressive strength of all test pieces. The average value must be equal to or greater than the specified strength.

3.12 Defective Concrete and Finishes

- 3.12.1 Honeycombed surfaces shall be made good or on the instruction of the Consultant be cut out by the Contractor and make good at his own expense.
- 3.12.2 Concealed concrete faces shall left as from the formwork except honeycombed surfaces shall be made good. Faces of concrete to be rendered shall be roughened by approved means to form a key. Faces of concrete that are to have finished other than those specified shall be prepared in an approved manner as instructed by the Consultant

4. CONCRETE FORMWORK

4.1 Structure and Material

4.1.1 Structure

- 4.1.1.1 Formwork shall be performed to obtain accurate concrete in accordance with the designated drawings.
- 4.1.1.2 Formwork shall be firmed and secured to bear the force of concreting and tightened to avoid cement paste seeping.

4.1.2 Materials

- 4.1.2.1 Sheathing for formwork shall be waterproof plywood of not less than 12 mm thick. Joint of sheathing shall be butt joint and firmly assembled. In case of using wood board for sheathing, boards shall be 15 mm thick and applied planer. Joint shall be tongued and grooved unless otherwise approved by the Consultant.
- 4.1.2.2 Form liners shall be sound and suitable materials to accurately and safely cast the in-situ concrete structure as shown on the Drawings.
- 4.1.2.3 Timber form boards for sheathing where used for fair-faced concrete shall be of such new materials as not to cause any defects to the surface of the concrete. Special care shall be taken in fabrication, storage and protection of these boards.
- 4.1.3 Other Material
 - 4.1.3.1 Fastening hardware to be used shall be those with allowable tensile strength guaranteed by manufacturer through strength tests.
 - 4.1.3.2 Form oil shall not have injurious effects on quality of concrete nor to bonding of surface finishing materials and shall be subject to approval of the Consultant.

4.2 Performance

4.2.1 Design of formwork

- 4.2.1.1 Formwork shall be designed to withstand construction loads during concreting, lateral pressure of fresh concrete, shock and vibrators due to concrete placing.
- 4.2.1.2 Formwork shall be free of injurious leakage of water, easy to remove, and shall not damage concrete at removal.
- 4.2.1.3 Supports shall be provided with the adequate horizontal and diagonal bracing and/or stays to prevent collapsing, heaving and twisting of formwork due to horizontal loads working during concrete placing.

4.2.2 Tolerance

The dimensional tolerances in location and cross section of concrete member used for designing and construction of formwork shall conform to the following table.

Standard Values of Dimensional tolerances

| Item | Tolerance (mm) |
|---|----------------|
| Tolerance in distance from datum line of each floor to respective members | + 10 |
| Tolerance in cross section of columns, beams and walls | - 5 , + 10 |
| Tolerance in thickness of floor and roof slabs | 0, +10 |

4.2.3 Fabrication and Erection

- 4.2.3.1 Erection of formwork, and transportation and storage of materials thereof shall be started only after previously placed concrete has reached an age which acceptance of these loads will not have any adverse effect on the concrete.
- 4.2.3.2 Sheathing shall be fabricated and installed accurately to match the locations, shapes and dimensions of members called for in the Drawings.
- 4.2.3.3 Sheathing shall be installed tightly so as not to permit cement paste or mortar to escape from joints.
- 4.2.3.4 Pipes, boxes and other embedded hardware shall be properly secured to sheathing or others so that they will not move during concrete placing.
- 4.2.3.5 Supports shall be erected plumb. Supports at any two vertically consecutive floors shall be erected as near as possible to identical locations on a common plane.
- 4.2.3.6 Shoring shall be erected paying special attention to safety.
- 4.2.3.7 If sheathing is reused, the surface in contact with the concrete shall be thoroughly cleaned off and sufficiently repaired before reuse. In case of using for fair-faced concrete, the same sheathings shall be used twice after approval of the Consultant.
- 4.2.4 Inspection
- 4.2.4.1 Formwork shall be inspected by the Consultant prior to placing of concrete.
- 4.2.5 Striking of forms
- 4.2.5.1 The minimum period for keeping the forms in position and for watering after laying the concrete shall be as stated below, except otherwise specified in drawings. Forms shall be removed in such a manner as to ensure the complete safety of the structure, so that there is no shock or vibration as would damage the reinforced concrete.
- 4.2.5.2 The responsibility for the safety of the concrete shall rest entirely with the Contractor and the Contractor shall be held liable for any damage done and shall have to make good the same at his own expenses.
- 4.2.5.3 The Contractor shall inform the Consultant when he intends to remove shuttering and shall obtain his consent, but the consent of the Consultant shall not relieve the Contractor of his responsibility.
- 4.2.5.4 The minimum time for formwork to remain in place shall be as per the following table.

| | |
|--|----------|
| Vertical sides of beams, slabs and columns | 24 hours |
| Soffits of slab | 10 days |
| Soffits of beams | 21 days |
| Cantilevers | 28 days |

4.2.6 Relocation of Support

4.2.6.1 Supports under concrete shall be not relocated

4.2.7 Removal of formwork

4.2.7.1 Formwork shall be removed gently, after its removal has been approved by the Consultant.

4.2.7.2 Inspection by the Consultant shall be obtained immediately after the removal of sheathing and defects shall be immediately remedied according to instruction of the Consultant.

4.2.7.3 After shoring has been removed, members shall be carefully observed for cracking and deflection, when found, they shall be reported immediately to the Consultant.

5. STEEL REINFORCEMENT

5.1 Material

- 5.1.1 Reinforcing steel shall be of the dimensions given in the Drawings.
- 5.1.2 Reinforcing bars shall comply with the requirement of B.S.4449. and welded wire fabric, square bar fabric and expanded metal shall comply with appropriate part of B.S.4483.
- 5.1.3 Dia 6mm reinforcing steel shall be round mild steel bars, and 12mm, 16mm, 20mm and 25mm shall be deformed high strength bars.
- 5.1.4 Any other non-specified reinforcing steel shall be used only with the approval of the Consultant.
- 5.1.5 All reinforcing steel and binding wire shall be stored under cover and shall be at least 250mm above the ground.

5.2 Cleaning

- 5.2.1 Reinforcing bars shall be cleaned before use so that it is free from rust, oil, dirt or other coatings that reduce bond.

5.3 Bending and Laps

- 5.3.1 The reinforcement shall be bent cold in an approved bar bending machine.
- 5.3.2 Preferably bars of full length shall be used. Lapping of bars where necessary shall conform to BS1487 'Bending Dimensions of Bars of Concrete reinforcement.'

5.4 Reinforcement Cover

- 5.4.1 Concrete cover for reinforcement shall be as follows:

| | | |
|--|-------|----|
| FOR ANY STEEL IN UNDER GROUND CONCRETE | 50 | MM |
| CLEAR COVER IN SLABS | 25-30 | MM |
| CLEAR COVER IN BEAMS SOFFIT | 30-35 | MM |
| CEAR COVER IN SIDES OF BEAMS | 30 | MM |
| CLEAR COVER IN COLUMNS | 40 | MM |

5.5 Placing

- 5.5.1 Reinforcement intended for contact when passing each other shall be securely tied together with binding wire.
 - 5.5.2 Binders and stirrups shall tightly embrace the longitudinal reinforcement to which they shall be security bound or spot welded.
 - 5.5.3 Binding wire shall be turned in from the formwork and shall not project beyond reinforcing bars.
- All reinforcement shall be inspected by the Consultant and approved before concrete is placed in the forms.

6. WATER PROOFING

6.1 Description of work

- 6.1.1 Extent of water proofing work is shown on drawings.
- 6.1.2 Install slurry type waterproofing to top surfaces of balcony slabs and external surfaces of underground concrete work.
- 6.1.3 Install crystalline type water proofing to underground water tanks and roof slabs in strict accordance with the approved manufacture's printed instructions.

6.2 Materials

- 6.2.1 Crystalline Type: Material used shall be a cementitious coating containing catalytic chemicals which migrate in to the concrete using moisture present in the concrete as the migrating medium, and which cause the moisture and the un-hydrated cement in the concrete to react causing the growth of non-soluble crystals of dendritic fibers in the void and capillary tracks of the concrete that allow passage of water, thereby rendering the concrete itself water proof.
- 6.2.2 Acceptable products: Xypex concentrate, modified, ultra plug and quick set as manufactured Xypex chemicals (Canada) Limited (or equivalent).

6.3 Storage of materials

- 6.3.1 General: All materials shall be stored in original undamaged containers with manufacturers seals and labels intact. Material shall be stored off the ground in a dry enclosed area.

6.4 Surface preparation

- 6.4.1 General: All surfaces shall be examined for form tie holes and defects such as honeycombing, rock pockets, cracks, etc. These areas shall be repaired in accordance with these specifications and the manufacturers printed instructions.
- 6.4.2 Concrete finish: concrete surfaces shall have an open capillary system to provide tooth and suction shall be clean; free from scale, excess form oil, laitance, curing compounds and other foreign matter.
- 6.4.3 Smooth surfaces or surfaces covered with excess form oil or other contaminants shall be washed lightly sandblasted, water blasted, or acid -etched with muriatic acid, as required to provide a clean absorbent surfaces.
- 6.4.4 Horizontal surfaces shall not be troweled or power - troweled, and shall be left with a rough float finish or a broom finish. Vertical surfaces may have a sacked finish. Comply with manufacturers specifications for requirements pertaining to minimum 'age' of concrete deck surface scheduled to receive water proofing.
- 6.4.5 Surface moisture: Water proofing shall be applied to 'green' concrete as soon as possible after forms have been stripped or to older pours which have been thoroughly moistened with clean water prior to application. Free water shall be removed prior to application.

Mixing of crystalline water proofing compound: comply with manufactures specification for 2-coat installation.

6.5 Application

- 6.5.1 General: Apply all materials under the direction of the manufacturer's representative.
- 6.5.2 Constructions joints and surface defects: Comply with waterproofing material manufacturer's printed directions in the preparation, and treatment of construction joints and surface defects.
- 6.5.3 Surface application: After all repair, patching and sealing strip placement has been prepared in accordance with manufacturer's recommendations and approved by manufacturer's representative, treat concrete surface with first coat slurry mix of crystalline waterproofing compound.
- 6.5.4 Brushing: Use a short bristle or broom to work the slurry well into the concrete, filing all hairline cracks and surface pores.
- 6.5.5 Second coat: Apply second coat while first coat is still 'green' but after it has reached an initial set, all as recommended by the water proofing material manufacturer.

6.6 Curing

- 6.6.1 General: Curing shall begin as soon as the waterproofing materials have set up sufficiently so as not to be damaged by a fine spray. Treated surface shall be sprayed three times a day for a three-day period. Allow material to set 12 days before filling the structure with liquid
- 6.6.2 Protect treated surfaces from damage due to wind, sun, rain and temperatures below 35 degrees F. For a period of 48 hours after application, arrange protections to permit proper curing conditions for waterproofing material.
- 6.6.3 Clean up: Remove all surplus materials from the premises and leave all areas broom-clean. In the case of temporary protections remove all such items carefully to avoid damage to treated surfaces. Assemble all such materials and remove from premises followed by broom cleaning as noted.

7. EMBEDDED DAMPPROOF MEMBRANE

7.1 General

- 7.1.1 This section deals with laying of flexible sheet as damp proof membranes or has chemical or vapour barriers embedded in the fabric of the building. It does not deal with the weatherproof roof sheeting, or with vapour barriers.

7.2 Products

- 7.2.1 Polythene sheets for under slab DPM: gauge 500, manufacturer and reference to approval.
- 7.2.2 Adhesive tape: A type recommended by the sheet manufacturer.

7.3 Workmanship

- 7.3.1 Manufacturers Recommendations: to be strictly followed for all products and materials. Apply sheets to clean, dry surfaces with all joints sealed to give a completely water proof continuous membrane.
- 7.3.2 Polythene Sheet Under-Slab Dpm: lay a level bed of fine sand, not less than 13mm thick or as specified to receive membrane.
- 7.3.3 Polythene Sheet Dpm: ensure that sheets are clean and dry. Lay single layer loose on base, lap edges 150mm and seal with mastic or adhesive tape.
- 7.3.4 Pipe Etc: where pipe etc. pass through sheeting make junction completely watertight by forming collars fully bonded / sealed to both pipes and sheeting.
- 7.3.5 Project: finished sheeting adequately and prevent puncturing during following work sheet to be covered by permanent over laying construction as soon as possible.

8. STRUCTURAL STEEL

8.1 Scope

- 8.1.1 This section shall apply to the work involved with structural steels. All incidental items of structural steel shall be stated in the particular specification.

8.2 Materials

8.2.1 Steel

- 8.2.1.1 Shape of steel shall be precise and straight and free of injurious scratches and rust.
- 8.2.1.2 All steel sections shall be galvanized sections of strength class 43 A.
- 8.2.1.3 Dimensions of steel section and tolerance of dimension shall conform to standard dimension of steel regulated in ASTM or BS standard.

8.2.2 Bolt

- 8.2.2.1 Shape of bolt, nut, and washer shall be in accordance with requirement of BS 4190 & BS 3692.
- 8.2.2.2 Quality of bolt shall be SC 43 A.

8.2.3 Welding Rod

- 8.2.3.1 Arc welding rod shall conform to materials to be welded, and position.

8.3 Fabrication

- 8.3.1 Main fabrication shall be done in workshop unless otherwise specified or approved by the Consultant.
- 8.3.2 Full scale drawing of each section shall be drawn prior to fabrication and checked by the Consultant.
- 8.3.3 Section of each material shall be cut perpendicular to axis unless otherwise specified in the drawing.
- 8.3.4 Saw and angle cutter shall be used for cutting, and cut section shall be free of any noticeable defect.
- 8.3.5 Deformation caused by cutting shall be corrected.
- 8.3.6 Normal temperature or hot drawn process shall do bending process. Steel shall be red heat in hot drawn process.
- 8.3.7 Those directed in the drawing shall be chiselled finish and completely attached. Materials shall be checked for bend, distortion, warp, etc. before fabrication.

8.4 Bolt

8.4.1 Bolt Hole

8.4.1.1 Spacing of boltholes shall be as directed in the following table.

| Diameter of Bolt | Standard Pitch | Minimum Pitch | End Distance | Edge Distance |
|-------------------------|-----------------------|----------------------|---------------------|----------------------|
| 12 | 50 | 30 | 30 | 25 |
| 16 | 50 | 40 | 40 | 30 |

- 8.4.1.2 Minimum pitch and end distance for lightweight steel shape shall be more than 3 times and 2.5 times a Bolt diameter respectively.
- 8.4.1.3 Diameter of hole shall not be over 0.5 mm larger than bolt diameter. However, for anchor bolt 5mm clearance shall be allowed between bolt diameter and diameter of hole unless otherwise specified.
- 8.4.1.4 Bolthole shall either be drilled open or reamed after sub punching. Punching can only be permitted for a material thickness less than 13 mm.
- 8.4.1.5 Rolled edge around a hole shall be removed.
- 8.4.1.6 Position of a bolthole shall be precise so that the center of all holes aligns.
- 8.4.2 Protection against loosening of Nuts
 - 8.4.2.1 Nuts shall be protected against loosening by concrete covering, double nuts or other proper means.
- 8.5 Welding**
 - 8.5.1 Welding
 - 8.5.1.1 Welder shall have an authorized qualification in Maldives and approved by the Consultant.
 - 8.5.1.2 Other tests shall be conducted to confirm welder's skill in accordance with type of work.
 - 8.5.1.3 Tack welding shall be carried out by the welder approved by the Consultant.
 - 8.5.2 Welding Machine
 - 8.5.2.1 Arc welding machine shall be alternate or direct current type, which provides sufficient and adequate current.
 - 8.5.3 Preparation
 - 8.5.3.1 Welding shall be done as much downward as possible using a jig such as Rotary frame.
 - 8.5.3.2 Welding rod shall be always kept in a dry area and if necessary, dried by drying equipment.
 - 8.5.3.3 Welding surface shall be free of water, scale or others injurious to welding work. Slag appeared on the created surface in the middle of welding shall be cleaned before starting again.
 - 8.5.4 Fabrication
 - 8.5.4.1 Welding edge shall be smoothed by automatic gas cutting or other proper finishes.
 - 8.5.8 Finishes
 - 8.5.8.1 Surface of welds shall be as smooth as possible and size and length of welds shall not be less than designed dimensions.
 - 8.5.8.2 Reinforcement of weld shall not exceed $0.1s + 1 \text{ mm}$ (s: Designated size) in fillet welds.
 - 8.5.8.3 Welded parts shall be free of undercut, overlap, crack, blow hole, lack of welds, and lack of weld settlement, rolled up slag or other defects.

8.5.8.4 Crater at the end of bead shall be carefully heaped up and slag, sputter, etc. shall be completely removed after welds.

8.5.9 Safety

8.5.9.1 Safe scaffoldings shall be provided for the field welds work.

8.5.9.2 Welding facilities shall be such that there shall be no electric leakage of electric shock. There also shall be sufficient protection for fire.

8.5.9.3 Electric shock protection device shall be used and also care shall be taken not to get suffocated or intoxicated by gas when welding in small area.

8.5.10 Inspection

8.5.10.1 Welding parts shall be inspected before, during and after welding in accordance with work schedule.

8.6 Erection and Field Painting

8.7.1 Erection

8.7.1.1 Erection procedure shall be prepared by the contractor and be approved by the Consultant prior to the erection.

8.7.1.2 Material shall be stored on flat surface in order not to get distortion, twist or other defects. Correction shall be made to those distortions or twisted before erection.

8.7.1.3 Horizontal reinforcement and bracing shall be placed and bolts are temporary tightened as trusses are put up.

8.7.1.4 Connection of materials by bolts, etc. shall be made after distortion on plumb is thoroughly corrected.

8.7.1.5 Temporary bracing or other reinforcement shall be placed to resist wind pressure or other loads erection.

8.7.1.6 When heavy objects are placed on a horizontal element in the course of erection, they shall be reinforced with prior approval of the Consultant.

8.7.1.7 Care shall be taken on all facilities so that there is no accident.

8.7.2 Field Painting

All steel work shall delivered to site unprimed shall be cleaned of impurities, scrapped and wire brushed to remove rust and painted with one coat of priming paint applied by brush.

Steelwork delivered to Site primed shall be cleaned of impurities and damage to the priming paint and made good with priming paint.

Galvanized steelwork to be painted shall be cleaned of impurities. Where rusting has occurred the rust shall be removed by wire brushing and made good with an approved rust inhibitor. The surfaces shall be coated with a mordant solution, washed with clean water and painted with two coats of priming paint applied by brush.

Steelwork, which is to be concealed shall be prepared and primed as above and shall be painted with two priming coats and one finishing coat of paint applied by brush.

8.8 Anchor Bolt

8.8.1 The other methods for movable burying shall be as directed by the Consultant.

9. MASONRY

9.1 Materials

9.1.1 Material used for masonry and plastering work shall conform to Section 3 - CONCRETE WORKS.

9.1.2 Masonry work shall be done with cement bricks or blocks of approved quality unless specified otherwise.

9.1.3 The blocks shall be free from excessive amounts of salt or other impurities and shall be inspected and approved by the Consultant.

9.2 General

9.2.1 Execution Drawing

9.2.1.1 Work shall be complied with this specification unless otherwise stated on particular Specification or Drawings. Any work not specified shall be discussed and directed by the Consultant. Execution drawing of block or brick alignment (inclusive of indication for hanging bolt, wood plug and conduit pipe), detail reinforcement, window opening, and other requirement shall be prepared and submitted for the Consultant.

9.2.2 Stake-Board

9.2.2.1 Stake-board shall be provided at each 5m in length and shall be inspected by the Consultant for the accuracy, firmness and secureness. However, suitable ruler, plumb bob and leveller shall be provided for minor performance of cement block and bricks.

9.2.3 Transportation and storing

9.2.3.1 Care shall be taken for damage during transportation of materials and any defect of natural finished concrete blocks or bricks shall be rejected.

9.2.3.2 Different size of material shall be stored separately and projected from dirt and other impurities.

9.2.4 Curing

9.2.4.1 Any shock or load shall not be applied until concrete mortar or other fills hardened. Corner, projection and top of cement block or brick work shall be protected from rain, dryness, cold, damage and stain by covering.

9.2.4.2 Void between blocks or bricks shall not be intruded by rainwater.

9.3 Blockwork

9.3.1 Material

9.3.1.1 Blocks shall be of standard quality low permeability blocks with no defects and sample shall be submitted for approval of the Consultant.

Blocks shall be **Solid cement blocks 150 mm thick for external walls and hollow cement blocks 100 mm thick for internal walls**. The average compression strength should be not less than 2.8N/mm^2 and shall comply with physical requirements of ISO 6073: 1981

9.3.2 Horizontal reinforcement for concrete block wall;

9.3.2.1 Horizontal reinforcement shall be provided at end of wall adjoining to concrete column. Reinforcing bar shall be anchored into end block and column.

9.3.2.2 Horizontal reinforcing bar for block wall shall be 6 dia. @ 1000 mm.

9.3.3 Placing Blocks & Bricks

9.3.3.1 Cement blocks shall be saturated with water and joint shall be cleaned.

9.3.3.2 Bonding mortar shall be used immediately after mix, and mixed mortar left for more than one hour shall be rejected.

9.3.3.3 Vertical and horizontal joint of blocks shall be filled completely and suitable with mortar on line shall not be moved or rearranged. Joint and surface of block of exposed finished block wall shall be cleaned immediately after joint is filled.

9.3.3.4 In case concrete block wall is attached to structural concrete, block wall shall be placed before concreting structure.

9.3.3.5 Mortar for joint shall be touched with steel trowel before hardened and exposed joint shall be finished with uniform width and planned without roughness or cavity.

9.3.3.6 Height for placing block per day shall be maximum 1.2 m unless otherwise specified.

9.3.3.7 Blocks shall be placed with cavity side under.

9.3.4 Joints

9.3.4.1 The thickness of joints shall not exceed 10 mm and the joints shall be rated (13 mm dup.) when the mortar is still floor, so as to provide for proper bond for the plaster. Any mortar which falls on the floor from this joints or removed due to raking of joints shall not be reused.

9.3.5 Lintel

9.3.5.1 Lintel shall be reinforced concrete as approved or directed by the Consultant.

9.3.5.2 Main reinforcing bar shall be anchored more than 40D (40 x diameter of the bar) at both end.

9.3.5.3 In case lintel is prefabricated, shop drawing shall be submitted for approval of the Consultant.

9.3.6 Frame of Opening

9.3.6.1 In case frame is temporarily installed before placing of blocks, frame shall be firmly placed and joiner shall be bonded with mortar as placing each block at side and top of frame.

9.3.6.2 In case frame is installed after placing of blocks, joiner shall be bonded with additional mortar at space or every two blocks or more.

9.3.6.3 Back of frame shall be filled and compacted with mortar by providing shuttering board.

9.3.6.4 Wood plug and anchor bolt shall be covered with mortar or concrete.

9.3.7 Piping

9.3.7.1 Principally, piping shall not be placed in block wall unless piping block is in use.

9.3.7.2 In case electric conduit pipe is placed in cavity of concrete blocks, care shall be taken not to obstruct reinforcing bar, and cavity shall be completely filled.

9.3.7.3 In case chipping and piping on face of blocks is unavoidable, performance shall confirm to instruction of the Consultant.

9.3.7.4 Joiner and supporter for exposed piping shall be buried at joint which back is filled or otherwise approved by the Consultant.

10. PLASTERING

10.1 General

10.1.1 All masonry walls shall have smooth finished cement plaster on both sides with a surface setting coat of neat cement applied within an hour of the completion of rendering.

10.1.2 Cement rendering to floor shall be same as above.

10.2 Materials and Storage

10.2.1 Plaster materials which are affected by moisture such as plaster and cement shall be stored properly.

10.2.2 Materials used for plastering shall conform to those of Section 3 - Concrete Works. Grading of sand, however, shall be as in table below

| Grading of sand | Mortar plastering | Plastering |
|--|-----------------------------------|--------------------------------|
| 5mm sifting thorough 100% 0.15mm sifting less than 10% | for first coat for finish coat | for first coat and dubbing out |
| 2.5mm sifting through 100% 0.15mm sifting less than 10% | for finish coat | for second coat |

10.2.3 White cement or filler or similar shall confirm to the requirements of Portland cement, BS.12.

10.2.4 The use of mixtures shall be approved by the Consultant's representative. The amount of admixture shall be such that it affects mortar strength very little.

10.3 Mixing ratio

10.3.1 Mixing volume ratio of mortar shall be as in table below:

| Base | area of application | first coat cement:sand | Dabbing out cement:sand | Finish coat cement:sand |
|----------------|---------------------|------------------------|-------------------------|-------------------------|
| Masonry blocks | Floor | - | - | 1:4 |
| | Interior wall | 1:4 | 1:4 | 1:4 |
| | Exterior wall | 1:4 | 1:4 | 1:4 |

10.4 Thickness of Coating

Standard thickness of coating (mm)

| Base | Area of application | First coat | Dubbing out | Second coat | Finish coat | Total |
|---------------|---------------------|------------|-------------|-------------|-------------|------------|
| Masonry block | Floor | - | - | - | as per dwg | as per dwg |
| | Interior wall | 8 | - | 8 | 4 | 15 |
| | Exterior wall | 8 | - | 8 | 4 | 15 |

Thickness of coating shall be standard thickness of coating unless otherwise indicated on the Drawings.

10.5 Finish

10.5.1 Type of finish and work schedule

| Type | Work Schedule | Notes |
|------------------------|---|--|
| 1.Smooth Trowel finish | 1. Shall be applied flat by metal trowel 2. Shall be finished by pressing with the trowel. | Before applying second coat, corner and edge shall be screed well. |
| 2. Wooden float finish | Shall be applied by wooden float | |

10.6 General Preparation

10.6.1 Remove efflorescence, laitance, dirt and other loose material by thoroughly dry brushing.

10.6.2 Remove all traces of paint, grease, dirt and other materials incompatible with coating by scrubbing with water containing detergent and washing off with plenty applying coatings unless specified otherwise.

10.6.3 In-situ Concrete Surfaces: Scrub with water containing detergents to ensure complete removal of mould oil, surface retarders and other materials in compatible with coating . Rinse with clean water and allow to dry unless specified otherwise.

10.6.4 Organic Growths: Treat with fungicide to manufacturer's recommendations and bush off.

10.6.5 Hacking for Key: roughen specified surfaces thoroughly and evenly by removing the entire surface to a depth of 3mm by scabbling, bush hammering or abrasive blasting, clean surfaces by washing and brushing.

10.6.6 Smooth Concrete Surfaces: where no keying or mix or bonding agent is specified, wet smooth concrete surfaces immediately before plastering.

10.7 External Plastering

10.7.1 Dissimilar Solid Backgrounds for Plastering: where plaster is to be continued without break across joints between dissimilar solid backgrounds which are rigidly bonded together, cover the joints with a 200mm wide mesh strip (back grounds in the same plane) or with the corner mesh (internal angle) fixed at not more than 600mm centers along both edges , unless specified or otherwise.

10.7.2 Dissimilar Solid Backgrounds for Plaster: where plaster is to be continued without break and without change of plane across the face of a 300mm and rigidly bonded to the background.

10.7.2.1 Cover the face of the column /beam/ lintel with building paper extending 25 mm on the adjacent background.

10.7.2.2 Over lay with expanded metal lathing extending 50mm beyond the edges of the paper and securely fixed with masonry nails at not less than 100mm centres along both edges.

Alternatively, an approved paper and mesh lathing may be used.

10.7.3 Dissimilar Solid Backgrounds for Rendering: where rendering is to be continued without break across joints between dissimilar solid backgrounds which are in the same plan and rigidly bounded together, cover joints with a 150mm wide strip of building paper overlaid with

300mm wide metal lathing fixed at not more than 600mm centers along both edges unless specified otherwise.

10.7.4 Service Chases: cover with steel mesh strip fixed at not more than 600mm centers along both edges.

10.7.5 Conduits bedded in under coat to be covered with 90mm wide jute scrim budded in finishing coat mix, pressed flat and trowelled in. Do not lap ends of scrim.

10.8 Internal Plastering

10.8.1 Accuracy of plaster 16mm thick or more: maximum permissible gap between an 1800mm straight edge and any point on the surface to be 3mm.

10.8.2 Dubbing Out: if necessary to correct inaccuracies, dub out in thickness of not more than 10mm in same mix as first coat. Allow each coat to set before the first is applied . Cross scratch surface of each dubbing out coat immediately after set.

10.8.3 Metal Mesh Lathing: Work undercoat well in to interstices to obtain maximum key.

10.8.4 Under Coats: generally to be not less than 8mm with thickness greater than 16mm applied as two equal coats. Rule to an even surface and cross scratch - end coat to provide a key for the next hand applied coat.

10.8.5 Cement Based Under Coats: all to dry out thoroughly but not rapidly, to ensure that drying shrinkage is substantially complete before applying next coat.

10.8.6 Dissimilar Backgrounds: where scrim or lathing or beads are not specified, cut through plaster with a fine blade in a neat, straight line at junctions of :

10.8.6.1 Plastered rigid sheet and plastered solid backgrounds.

10.8.6.2 Dissimilar solid backgrounds.

10.8.7 Smooth Finish: trowel or float to product a tight matt, smooth surface with no hollows abrupt change of level or trowel marks. Do not use water brush and avoid excessive trowelling and over polishing.

10.9 External Rendering

10.9.1 Dubbing Out: if necessary to correct inaccuracies, dub out in thicknesses of not more than 10mm in same mix as first coat. Allow each coat to dry before the next is applied. Cross scratch surface of each dubbing out coat immediately after set.

10.9.2 Under Coats for hand applied finishes:

10.9.2.1 Apply first undercoat or dubbing out coat by throwing from a trowel.

10.9.2.2 Coats to be no less than 8mm thick, with thickness greater than 16mm applied as two equal coats. On weak backgrounds first under coat to be not less than 10mm thick.

10.9.2.3 Brush down each under coat to remove dust and loose particles and wet thoroughly before application of next coat.

10.9.2.4 Cross scratch under coat without penetrating the coat, to provide key for following coat(s).

Drying: Keep each coat damp for the first three days by covering with polythene sheet and/or spraying with water. Thereafter prevent from drying out too rapidly. Work in shade whenever possible.

Allow each coat to dry out thoroughly to ensure that drying shrinkage is substantially complete before applying next coat.

Playing Floated Finish: Finish with wood or other suitably faced float to give an even texture. Do not draw excessive laitance to surfaces.

10.10 Metal Mesh Lathing / Reinforcement For Plastered/Coatings.

10.10.1 Lathing to be provided as reinforcement for plastering in columns, walls or specified in drawings products.

10.10.2 Products:

10.10.2.1 Plain Expanded Metal Lathing: To B.S 1369 with a minimum weight of 1.9 kg/mm². Manufacturer to approval of the Consultant.

10.10.2.2 Wire Ties: Unless other specified, annealed iron, galvanized to B.S 443.

10.10.2.3 Clout Nails: galvanized steel or stainless steel nails to B.S 1202: Part 1, table 3.

- 10.10.2.4 Staples: Galvanized steel wire staples to B.S 1494: Part 2.
- 10.10.3 Workmanship
- 10.10.3.1 Framing: fix securely and accurately to help ensure that coatings on lathing , when finished, are true to line and level , within specified tolerances and free from cracks, rippling, hollows, ridges and sudden changes of levels.
- 10.10.3.2 Runners/Bearers spanning between concrete beams/ribs: fix with 3mm wire ties twisted around 38 mm X 10 gauge screws driven well into fixing blocks or plugs in sides of beams/ribs.
- 10.10.3.3 Wire Ties: twisted ends tightly together, cut off surplus and bend ends of wire away from face of coating.
- 10.10.3.4 Plain Expanded Metal Lathing:
- (a) Stretch lathing and fix securely in accordance with manufacturers recommendations to give a taut, firm base for plaster/ rendering.
- (b) Fix with the long way of the mesh at right angles to supports and with all strands sloping in the same direction.
- (b) Lap side edges not less than 25mm. Lap ends 50mm at supports and 75mm between supports. Laps must not occur within 100mm of angles or bends.

11. CARPENTRY AND JOINERY

11.1 Materials

- 11.1.1 Timber shall be in accordance with the requirements of BS 1186 'Quantity of Timber and Workmanship in Joinery', Part 1, 'Quality of Timber'.
- 11.1.2 Timber and timber products shall be subject to the inspection and approval of the Consultant.
- 11.1.3 Timber shall be seasoned to stable moisture content compatible with the finished use, straight and true and free from wind, warp and distortion and in lengths suitable for the members required.
- 11.1.4 All timber shall be in long lengths and laps, scars or splices shall be over a bearing surface. Where obtainable, finishing timber exposed to view shall be in single lengths.

11.2 Preservation of Timber

- 11.2.1 All timber shall be treated for insect attack and is to be of the correct moisture content and free from surface moisture content and dirt.
- 11.2.2 All rafters, purlins, framing scribe pieces, wall plates, and trusses etc. shall be treated for insect attack with approved timber preservative. No extra payment shall be made for such coating and will be considered inclusive in the rate of the respective item in the BOQ.
- 11.2.3 Treatment shall be carried out after all cutting and shaping is completed.

11.3 Hardware

- 11.3.1 Hardware shall be standard quality and samples shall be submitted to the Consultant for approval.

11.3.2 All hinges shall be stainless steel or brass and shall be approved by the Consultant.

11.3.3 The dimensions and quality of hardware shall meet the requirements and shall not be rested, deformed or defective.

11.4 Dimensions and Finish

11.4.1 All dimensions of timber given are finished dimensions.

11.4.2 All elements and others of structural nature, which are exposed, must be machine planed to a smooth finish.

11.4.3 All unexposed timber shall be machine planed to a rough finish.

11.4.4 All joinery work shall be dressed on all four sides and hand dressed where necessary and sanded to all exposed surfaces. All arises in any way accessible shall be sanded and smoothed off.

11.5 Workmanship

11.5.1 All connections whether nailed, screwed glued, mortised or dove-tailed shall be accurately made and properly executed to provide sound, satisfactory connections for the class of work required.

11.5.2 Timbers containing defects or distortions shall not be used.

11.5.3 All joinery shall be manufactured by skilled tradesman with accurate tolerances and set out and with tools, jigs, machines and equipment appropriate for the work.

11.5.4 Assembly of the joinery units and joinery frames, etc. shall be by means of glued connections appropriate to the work - mortise and tenon, housing and doweling, etc. where practicable including the use of glued blocks wherever required. Nailing, screwing shall only be used with prior approval of the Consultant; corrugated fasteners shall not be used for effecting connections.

12. ALUMINIUM DOORS AND WINDOWS

12.1 Aluminium Doors and Windows

- 12.1.1 All windows and doors are to be constructed by approved specialist suppliers of medium section to the particular requirements noted on the drawings as to weight and profile. All sections shall generally conform to relevant British Standard Specifications.
- 12.1.2 All frames should be made to fit the actual openings with a 3 mm clearance all around. Discrepancies in overall width or height exceeding 3mm will not be allowed and the frames will be rejected in such cases. Any small discrepancies shall have the gaps suitably backed and filled with gun-applied water repellent mastic sealant
- 12.1.3 All sealants used in the assembly of, and in the fixing of cladding and window framing, shall be non-setting to allow thermal movement without detriment to those joint sealants used for peripheral caulking and shall be one part silicone sealant and shall conform to BS 4245. All spliced joints between mullions should be sealed with an approved silicone product, compatible with other sealants and packings used.
- 12.1.4 The auxiliary components in sashes as locks, pivots, sliding gear etc. shall comprise of stainless steel or resisting materials.
- 12.1.5 The tolerances are to be as follows:
- a) Inside width of frame 3mm Maximum
 - b) Inside height of frame 3mm Maximum
 - c) Depth of frame 2mm Maximum
 - d) Opposite side, Inside distance 2mm Maximum
- 12.1.6 The performance - associated requirements are
- 1) Strength (resistance to wind pressure and other forces applied in use)
 - 2) Air tightness or ability to cut out drafts.
 - 3) Water - tightness against rain or dew.
 - 4) Sound arresting effect to (shut off noise from outside as well as inside).
- 12.1.7 All surfaces shall have an anodized protective surface layer of minimum 60 Micron thickness.
- 12.1.8 Glazing shall be done as specified by the Consultant. Glass shall be tinted, or as specified in the drawings. Thickness shall be according to the size of panels as given hereunder.

| | |
|---|-------------------------------------|
| Not exceeding 1 sq. ft. | 4mm |
| Exceeding 1 sq. ft. but not exceeding 2 sq. ft. | 5mm |
| Exceeding 2 sq. ft. but not exceeding 4 sq. ft. | 6mm |
| Exceeding 4 sq. ft. but not exceeding 6 sq. ft. | 8mm |
| Exceeding 6 sq. ft. but not exceeding 12sq. ft. | 10mm |
| Exceeding 12sq. ft. | > 12mm or as approved by consultant |

- 12.1.9 Prior to import and / or purchase of the Aluminium Doors and Windows, the relevant specification of the manufacturer, along with samples has to be submitted to the Consultant for approval. This clause shall not be contravened on any account.
- 12.1.10 The fitting shall be done with utmost care not to spoil the finishes given by the manufactures, and any cleaning done shall be done with cleaners etc. as specified by the Manufactures.
- 11.1.11 The Contractor shall provide all items, articles, materials, operations, mentioned, or scheduled on the drawings, including all the labour materials, including fixing devices, equipment and incidentals necessary as required for their completion.
- 12.1.12 The Contractor shall submit shop drawings and/or samples of each type of doors, windows, railings and other items of metal work to the Consultant for approval. The shop drawings shall show full size sections of doors and windows etc. thickness of metal, details of construction hardware as well as connection of windows, doors and other metal work to adjacent work.
- 12.1.13 Aluminium doors and shutters shall be manufactured by an approved manufacturer and shall be of sections, sizes combination and details shown on the drawings. The frame member shall be one piece, corners shall be electrically welded, ground smooth and true and glazing bars shall be threaded or interlocked as approved by the Consultant.
- 12.1.14 Glazing for doors and windows shall be of specified thickness and of approved quality and shall conform to specification of glazing. Fixing for glazing shall be done with aluminium Snap-On beading as per detail drawing and instructions. Necessary continuous rubber gaskets of approved make shall be provided.
- 12.1.15 Colour for doors and windows shall be approved by the Consultant.

12.2 Aluminium louvers

- 12.2.1 Product data shall be submitted for approval; this shall include specified model and AMCA ratings or equivalent.
- 12.2.2 Contractor shall submit all shop drawings indicating materials, construction, dimensions, accessories, and installation details.
- 12.2.3 Contractor shall submit samples of the product for approval.
- 12.2.5 Louvers shall comply with AAMA specification 2605 "Voluntary Specification for High Performance Organic Coatings on Architectural extrusions and panels", ASTM B244 -68, AAC22A41 or equivalent.
- 12.2.6 Louvers shall be well suited for the design environment (temperature, humidity, and ventilation); i.e., it shall be within manufacturer's recommended design environment limits for optimum results.
- 12.2.7 All louvers shall be installed according to manufacturer's instructions.
- 12.2.8 All units shall be installed plumb, well fitted and securely attached to supporting frames.

12.2.9 Delivery of materials to site in shall be in manufacturers' original, unopened containers and packaging with labels clearly indicating manufacturer, material and location of installation.

12.2.10 Materials shall be stored in a dry area indoors and protected from damage in accordance with manufacturer's specifications.

12.2.11 Materials and finishes shall be protected during handling & installation to prevent damage.

12.3 Top hung windows, ventilators and side hung doors

12.3.1 All windows and doors should be weather stripped. The weather protection should be achieved by a positive compressive action against the section and should not depend on external contact. At every contact between two profiles two weather stripping sections should be provided to complete weather protection.

12.3.2 The bottom section for hinges must be capable of being adjusted vertically if necessary. The gap between section and the floor should be covered with a pair of special splay-tube sections.

12.3.3 The shutter sections for both windows as well as doors shall be hollow section type and shall be overall size 57 x 45 mm and the door sections shall be overall size 81 x 45 mm (including flanges).

12.3.4 The shutters of the windows and doors should be assembled with stainless steel pins and nylon washers. Handles shall be anodised aluminium finished to match the aluminium sections and mounted with self-lubricating nylon washers.

12.3.5 A mortise cylinder rim automatic deadlock of high quality with double pin tumbler shall be used.

12.3.6 Windows shall have anodised aluminium handles, colour as framing and a latching mechanism securing the shutter to the frame both at the top and bottom.

12.3.7 Required fittings;

12.3.7.1 Single action door closer concealed in the head bar of the outer frame and mounted on an adjacent pivot at the threshold and deadlock fitted.

12.3.7.2 The left hand leaf of double doors with flush bolts at head and sill with deadlock fitted to the right hand leaf.

12.3.7.3 Escape doors to have panic bolts assembly with vertical elements concealed in the sill and door closer as in 12.3.7.1.

12.4 Installation

12.4.1 Aluminium work shall be installed adjusted and glazed by experienced workmen all in accordance with the manufacturer's installation instructions and in full conformity with the approved shop drawings, samples and other submitted data. Under no circumstances shall materials be installed on surfaces that contain condensation, dirt, grease or other foreign encountered materials that would hinder or prevent proper installation and functioning for the use intended.

12.4.2 Aluminium work shall be carefully and accurately assembled with proper and approved provision for contraction and expansion and set in correct locations as per approved detailed shop drawings, all level, square, plumb and aligned with other

work. All joints between framing and structural building shall be sealed in order to be watertight and weather-proof and to satisfy all other requirements of the Consultant.

12.4.3 Frames shall be designed and manufactured with a maximum 2.5mm tolerance around the opening in the structure. These joints are to be finished by applying an approved sealant into a polystyrene foam backing strip.

12.4.4 All aluminium works are to be fully protected for the duration of the contract from damage by other trades. The Consultant shall approve the method of protection.

- 12.4.5 If for any reason final finishes become scratched, abraded or damaged during transport, delivery, storage or erection, it shall be the Contractor's responsibility to remove or repair those defective areas or components as directed and to the complete satisfaction of the Consultant.
- 12.4.6 Repair work shall be identical to the manufacturer's applied finish with regard to gloss, finish and visual appearance. Field touch up of painted aluminium is permitted only with the written permission of the Consultant. Where touch up is not an authorised means of repair the damaged materials must be replaced by new.
- 12.4.7 Upon completion of work all protective coverings from all exposed surfaces shall be removed. All surfaces shall be cleaned using soap or detergents as recommended by the aluminium manufacturers to remove sealants, discolouration and any other foreign material. Defection of any type determined by the Consultant shall be repaired at the Contractor's expense.
- 12.4.8 Extreme care shall be taken when cleaning the exterior portion to protect all other adjacent works.

12.5 Sealing joints

- 12.5.1 The Contractor shall ensure that joints are dry and remove all loose material, dust and grease.
- 12.5.2 Joints shall be prepared in accordance with sealant manufacturer's recommendations using recommended solvents and primers where necessary.
- 12.5.3 Adjoining surfaces which would be impossible to clean if smeared with sealant shall be masked.
- 12.5.4 Backing strips shall be inserted in all joints to be pointed with sealant. When using backing strips, the Contractor shall not leave gaps and shall not reduce depth of joint for sealant to less than the minimum recommended by the manufacturer.
- 12.5.5 Cavities shall be filled and jointed with sealant in accordance with the manufacturer's recommendations. Sealant shall be tooled to form a smooth flat bead.
- 12.5.6 Excess sealant shall be removed from adjoining surfaces using cleaning materials recommended by the sealant manufacturer, and shall be left clean.

12.6 Glass installation

- 12.6.1 Workmanship shall generally be in accordance with CP 152 and respective British Standards.
- 12.6.2 The glass is to be delivered to the site with adequate protection to prevent damage and where possible it is to be fixed in position immediately after delivery. When fixed the Contractor is to take all necessary precautions to prevent damage during succeeding building operations and will be entirely responsible for the replacement of any broken or damaged glass at his own cost.
- 12.6.3 The Contractor is to be solely responsible for determining the exact sizes of glass required, including a tolerance of 2mm to each edge and he is recommended to check the necessary dimensions on site.
- 12.6.4 No glazing is to be carried out until rebates have been painted with primer. Glazing beads as applicable are also to be primed before fixing.

- 12.6.5 All mastic is to be neatly struck off to agree exactly with site lines inside and out.
- 12.6.6 Rates are to include for all necessary springs, clips, setting blocks, location blocks and distance pieces and for taking off and later re-fixing loose beads
- 12.6.7 Glass apertures in timber doors are to be bedded in chamois leather glazing strip, black ribbon velvet or P.V.C. glazing strip to the approval of the Consultant.

15. METAL WALL PANELS

13.1 References

13.1.1 General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

A. ASTM International:

1. ASTM D1781 Standard Test Method for Climbing Drum Peel for Adhesives.
2. ASTM D1929 Standard Test Method for Determining Ignition Temperature of Plastics.
3. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
4. ASTM E108 (Modified) Standard Test Methods for Fire Tests of Roof Coverings.
5. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
6. ASTM E283 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
7. ASTM E330 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors By Uniform Static Air Pressure Difference.
8. ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Curtain Wall, and Doors By Uniform Static Air Pressure Difference.

B. American Architectural Manufacturers Association (AAMA):

1. AAMA 2605 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. International Organization for Standardization (ISO):

1. ISO 9001-2000 Quality Management Systems - Requirements.

D. National Fire Protection Association (NFPA)

1. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

13.2 System Description

13.2.1 Performance Requirements: Provide composite metal panels that have been manufactured, fabricated and installed to withstand loads from deflection and thermal movement and to maintain performance criteria stated by manufacturer without defects, damage or failure.

A. Water and Air Leakage: Provide systems that have been tested and certified to conform to the following criteria:

1. Air Leakage, ASTM E283: Not more than 0.06 cfm per ft² of wall area (0.003 (L/s m²) when tested at 1.57 psf (0.075 kPa).

2. Water Penetration: No water infiltration under static pressure when tested in accordance with ASTM E331 at a differential of 10% of inward acting design load, 6.24 psf (0.299 kPa) minimum, after 15 minutes.

a. Water penetration is defined as the appearance of uncontrolled water in the wall.

b. Wall design shall feature provisions to drain to the exterior face of the wall any leakage of water at joints and any condensation that may occur within the construction.

B. Fire Performance: Provide composite fire rated panels that have been evaluated and are in compliance with regulatory code agency requirements specified herein.

13.3 Submittals

13.3.1 General: Submit listed submittals in accordance with Conditions of the Contract.

13.3.2 Product Data: Submit product data, including manufacturer's SPEC-DATA sheet, for specified products.

A. Shop Drawings: Submit shop drawings showing layout, profiles and product components, including anchorage, accessories, finish colors and textures.

1. Include details showing thickness and dimensions of the various system parts, fastening and anchoring methods, locations of joints and gaskets, and location and configuration of joints necessary to accommodate thermal movement.

B. Samples: Submit selection and verification samples for finishes, colors and textures.

1. Selected Samples: Manufacturer's color charts or chips illustrating full range of colors, finishes and patterns available for composite metal panels with factory applied finishes.

2. Verification Samples:

2.1. Structural: 12 inch × 12 inch (305 × 305 mm) sample composite panels in thickness specified from an available stock color, including clips, anchors, supports, fasteners, closures and other panel accessories, for assembly approval. Include panel assembly samples not less than 24 inches × 24 inches (610 × 610 mm) showing 4-way joint.

2.2. Include separate sets of drawdown samples on aluminum substrate, not less than 3 inches × 5 inches (76 × 127 mm), of each color and finish selected for color approval. Larger samples of standard colors are available with production-applied coatings.

C. Quality Assurance Submittals: Submit the following:

1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties, or a third party listing documenting compliance to a comparable code section.

2. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and physical requirements.

3. Manufacturer's Instructions: Manufacturer's installation instructions.

4. Manufacturer's Field Reports: Manufacturer's field reports.

D. Closeout Submittals: Submit the following:

1. Warranty: Warranty documents specified.

13.4 Quality Assurance

13.4.1 Qualifications:

1. Installer Qualifications: Installer experienced in performing work of this section who has specialized in the installation of work similar to that required for this project.

- a. Certificate: When requested, submit certificate indicating qualification.
- 2. Manufacturer Qualifications: Company with a minimum of 5 years of continuous experience manufacturing panel material of the type specified:
 - a. Able to provide specified warranty on finish.
 - b. Able to provide a list of 5 other projects of similar size, including approximate date of installation and name of Architect for each.
 - c. Able to produce the composite material without outsourcing of the coating or laminating process.
 - d. Able to provide a certificate of registration to ISO 9001-2000.

3. Fabricator Qualifications: Company with at least 3 years of experience on similar sized metal panel projects and qualified by panel material manufacturer. Capable of providing field service representation during construction

13.4.2 Mock-Ups: Install at project site a job mock-up using acceptable products and manufacturer approved installation methods. Obtain Owner's and Architect's acceptance of finish color (drawdown samples to be used for color approval of nonstandard coil coated colors), texture and pattern and workmanship standard. Comply with Division 01 Quality Control, Mock-Up Requirements Section.

1. Mock-Up Size: to be proposed by contractor

2. Maintenance: Maintain mock-up during construction for workmanship comparison; remove and legally dispose of mock-up when no longer required.

3. Incorporation: Mock-up may be incorporated into final construction upon Owner's approval.

13.4.3 Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Division 01 Project Management and Coordination, Project Meetings Section.

13.5 Delivery, Storage & Handling

13.5.1 General: Comply with Division 01 Product Requirements Sections.

13.5.2 Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

13.5.3 Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

1. Protection: Protect finish of panels by applying heavy-duty removable plastic film during production.

2. Delivery: Package composite wall panels for protection against transportation damage. Provide markings to identify components consistently with drawings.

3. Handling: Exercise care in unloading, storing and installing panels to prevent bending, warping, twisting and surface damage.

13.5.4 Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperatures recommended by manufacturer.

1. Storage: Store panels in well-ventilated space out of direct sunlight.

a. Protect panels from moisture and condensation with tarpaulins or other suitable weather tight covering installed to provide ventilation.

b. Slope panels to ensure positive drainage of any accumulated water.

c. Do not store panels in any enclosed space where ambient temperature can exceed 120 degrees F (49 degrees C).

2. Damage: Avoid contact with any other materials that might cause staining, denting or other surface damage.

13.6 Project Conditions

- 13.6.1 Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

13.7 Warranty

13.7.1 Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

13.7.2 Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under the Contract Documents.

1. Warranty Period:

- a. Panel Integrity: 10 years commencing on Date of Substantial Completion.
- b. Finish: 10 years commencing on Date of Substantial Completion.

PRODUCTS

13.8 Composite Fire resistive metal panels

13.8.1 Manufacturer: Mitsubishi Plastics Composites America, Inc.

13.9 Product Substitutions

13.9.1 Substitutions: No substitutions permitted.

13.10 Composite Metal Panel Materials

13.10.1 ALPOLIC/fr Composite Fire Resistive Metal Panels:

- 1. Panel Thickness: 4 mm.
- 2. Core: Thermoplastic core material with inorganic fillers that meets performance characteristics specified when fabricated into composite assembly.
- 3. Face Sheets: Aluminum alloy 3105 H14 and as follows:
 - a. Coil coated with a fluoropolymer paint finish that meets or exceeds values expressed in AAMA 2605 where relevant to coil coatings.
 - b. Spray coated with specified finish (quantities less than 7500 ft² (700 m²)).
- 4. Bond Integrity: Tested for resistance to delamination as follows:
 - a. Peel Strength (ASTM D1781): 22.5 in-lb/in (100 N-m/m) minimum.
 - b. No degradation in bond performance after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F (21 degrees C).
 - c. Thermally bonded to the core material in a continuous process under tension.
- 5. Fire Performance:
 - a. Flamespread, ASTM E84: <25.
 - b. Smoke Developed, ASTM E84: <450.
 - c. Surface Flammability, Modified ASTM E108: Pass.
 - d. Ignition Temperature:
 - 1) Flash, ASTM D1929: 716 degrees F (380 degrees C).
 - 2) Ignition: 752 degrees F (400 degrees C).
 - e. Flammability, Exterior, Non-load-bearing wall assemblies and panels, NFPA 285:

Pass.

6. Product Transparency:

- a. Provide a Product Transparency Declaration (PTD) for the Composite metal panels

13.10.2 Production

Tolerances: 1. Width:

+/- 2.0 mm.

2. Length: +/- 4.0 mm.

3. Thickness (4 mm Panel): +/- 0.008 inch (0.2 mm).
4. Thickness (6 mm Panel): +/- 0.012 inch (0.3 mm).
5. Bow: Maximum 0.5% length or width.
6. Squareness: Maximum 0.2 inch (5.1 mm).
7. Edges of sheets shall be square and trimmed with no displacement of aluminum sheets or protrusion of core material.

13.11 Accessories

- 13.11.1 General: Provide fabricator's standard accessories, including fasteners, clips, anchorage devices and attachments for specific applications indicated on contract documents.

13.12 Related Materials

- 13.12.1 General: Refer to other related sections in Related Sections paragraph specified herein for related materials, including coldform metal framing, flashing and trim, joint sealers, aluminum windows, glass and glazing and curtain walls.

13.13 Fabrication

- 13.13.1 General: Shop fabricate to sizes and joint configurations indicated on drawings.
 1. Where final dimensions cannot be established by field measurements, provide allowance for field adjustment as recommended by the fabricator.
 2. Form panel lines, breaks and angles to be sharp and true, with surfaces that are free from warp or buckle.
 3. Fabricate with sharply cut edges and no displacement of aluminum sheet or protrusion of core.

13.14 Finishes

- 13.14.1 Factory Finish: Lumiflon-based fluoropolymer resin coating that meets or exceeds values expressed in AAMA 2605 where relevant to coil coatings.
 1. Color: Prismatic Champagne ME010

13.15 Source Quality

- 13.15.1 Source Quality: Obtain composite panel products from a single manufacturer.

EXECUTION

13.16 Manufacturer's Instructions

- 13.16.1 Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions.

13.17 Examination

13.17.1 Site Verification of Conditions: Verify that conditions of substrates previously installed under other sections are acceptable for product installation.

13.18 Preparation

13.18.1 Surface Preparation: -

13.19 Installation

13.19.1 General:

1. Install panels plumb, level and true in compliance with fabricator's recommendations.
2. Anchor panels securely in place in accordance with fabricator's approved shop drawings.
3. Comply with fabricator's instructions for installation of concealed fasteners and with provisions of Section 07 90 00 for installation of joint sealers.
4. Installation Tolerances: Maximum deviation from horizontal and vertical alignment of installed panels: 0.25 inch in 20 feet (6.4 mm in 6.1 m), noncumulative.

13.19.2 Related Products Installation Requirements: Refer to other sections in Related Sections paragraph herein for installation of related products.

13.20 Field Quality Requirements

13.20.1 Field Quality Control: Comply with panel system fabricator's recommendations and guidelines for field forming of panels.

13.20.2 Fabricator's Field Services: Upon Owner's request, provide fabricator's field service consisting of product use recommendations and periodic site visit for inspection of product installation in accordance with fabricator's instructions.

1. Site Visits: As requested by owner

13.21 Adjusting

13.21.1 Adjusting:

1. Repair panels with minor damage such that repairs are not discernible at a distance of 10 feet (3 m).
2. Remove and replace panels damaged beyond repair.
3. Remove protective film immediately after installation of joint sealers and immediately prior to completion of composite metal panel work.
4. Remove from project site damaged panels, protective film and other debris attributable to work of this section.

13.22 Cleaning

13.22.1 Cleaning: Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.

13.23 Protection

13.23.1 Protection: Protect installed product's finish surfaces from damage during construction.

1. Institute protective measures as required to ensure that installed panels will not be damaged.

14. ROOFING

14.1 Scope

14.1.1 This Section deals with external weather-proof roofing systems.

14.1.2 Section Includes: Fabrication, supply, installation and testing of all roof system

14.2 Roof Cladding

14.2.1 Roof cladding shall be local thatch or equivalent.

14.2.2 Structural support: timber sections as per drawings.

14.2.3 Fastening: No. 12-14x45mm hexagonal head self-drilling and tapping screw seal.

14.2.4 End laps: 200mm and should be sealed with a recommend sealant for pitches below 7 degrees.

14.2.5 Side laps: as per manufacturer's recommendations.

14.3 Products

14.3.1 The roofing shall be local thatch material as approved by Engineer, with colour to approval.

14.4 Workmanship

14.4.1 Accessories: Flashing, trims, filler pieces, spacers, tapes, sealant, etc. where not specified to be the types recommended by the sheet manufacturer.

14.4.2 Fastening: Select types and location of fastenings to meet the following requirements.

14.4.2.1 Wind suction loaded: Calculate in accordance with CP 3: Chapter5: Part2 , making due allowance for any internal pressure.

- Basic wind speed: 45 m/sec.
- Topography factory S1 : 1.0
- Ground roughness, building size and height Factory (S2) : as determined from CP3:Chapter5 : Part 2, Table 3.
- Statistical factor (S3) : 1.0

14.4.3.2 Imposed loads other than wind and maintenance load, 1.5 KN/m² concentrated on a 300mm² which ever produces the greater stress. Maintenance point load: 0.9 KN concentrated on any 125mm².

14.4.3.3 Dead load: allow for self-weight of sheeting.

14.4.3.4 Roof pitch: as indicated on drawings.

14.4.3.5 Distance between not less than 900mm or as indicated on the drawings.

14.5 Fixing

14.5.1 Quality of Work: Handle and store to preserve surface using clean dry gloves. Do not slide sheets over rough surface or each other. Packs of all sheets must be kept dry in transit and stored clear of the ground under cover to prevent water and /or condensation being trapped between adjacent surfaces. If packs become wet, sheets should be separated, wiped with a clean cloth without delay and placed so that air circulation completes the drying process.

14.5.5 Cutting and drilling:

14.5.5.1 Cuts sheets accurately with clean, true lines and no distortion with a power saw with abrasive cutting disc.

14.5.5.2 Cut openings in sheet for out lets, vent pipes , flues etc. to the minimum size necessary . Reinforce edges of openings with structural members.

14.5.5.3 Drill all holes. Position at regular intervals in straight lines. Holes for primary fastenings to be 1.5mm larger than the diameter of fastening unless selfdrilling type is used.

14.5.5.4 Remove burrs, drilling swarf, lubricant, dust and any other foreign matter before finally fixing sheets into position.

14.5.6 Direction of Laying: Lay sheets with exposed joints of side lap away from prevailing wind.

14.5.7 End Laps: to be fully supported.

14.5.8 Sealant:

14.5.8.1 Install to manufactures recommendation.

14.5.8.2 Position in straight, unbroken lines parallel to edges of sheets. Placed into corrugations. Do not allow to sag into position.

14.5.8.3 Ensure continuity and effectiveness of seal, especially at corners of sheets.

14.5.8.4 Do not over compress.

14.6 Fittings and Features

14.6.1 Profile Fillers: use where specified and wherever necessary to close off corrugation cavities from the outside and inside of the building. Position on the line of, or above, fastening and ensuring a tight fit and leaving no gaps. Where sealed laps are specified bed profile fillers in sealant on top and bottom surface, but do not obstruct channels for ventilation or condensation drainage.

14.6.2 Flashing Trims: All fittings for flashing / trim shall be as per manufacturers' recommendation and lapped at joints as follows:

14.6.2.1 Vertical and sloping flashing / trims: end lap to be the same as for adjacent sheeting.

14.6.2.2 Horizontal flashing / trims: end laps to be 150mm and sealed.

14.6.3 Gutter: Ensure that gutters are fully supported at each joint and at intermediate position not more than 900mm apart. Fix with spigot ends up the slope and make all the joints fully watertight. Position sheeting to leave a clear width across the gutter of not less than 230mm.

14.6.4 Insulation:

- 75mm thick Rock Wool insulation blanket with aluminium foil backing on both sides laid between purlins at 1000 centres, including wire mesh. Manufacturer and reference - to approval.

15. FINISHES

15.1 General

15.1.1 Glazed Ceramic Tile shall comply with British Standard specification No. 1281 and shall be approved sizes as shown on Drawings and the product of a reputable manufacturers approved by the Consultant.

15.1.2 Unglazed Ceramic Tile shall comply with the requirements of British Standard No.1286 and shall be of approved sizes as shown on the drawings and the product of a reputable manufacturer.

15.2 Manufacturers

15.2.1 All tiles, ceramic or homogenous, for the project shall be manufactured as mentioned on finishing schedule / details drawings. Required brands of tile shall be use only described locations and tile brands shall not change if only approved by consultant.

15.2.2 Following brands of tiles shall use for described locations as per finishing schedule / details drawings. All the tiles shall be submitted to Consultant for approval prior to use.

- Niro
- Cotto
- Lanka tile
- White horse

15.3 Ceramic and Vitreous Tile Materials

15.3.1 Ceramic and Vitreous clay Wall Tiles:

15.3.1.1 All tiles for wall installation shall be have cushion edge, impervious, polished or semi-polished porcelain and highly glazed surface. Colours shall be as selected by the Consultant and shall include trimmers, corner pieces, bullnose and all other special shapes indicated or required. All this shall be free from flaws, cracks and crazing.

15.3.2 Floor Ceramic and Vitreous Tiles

15.3.2.1 All porcelain floor tiles should exhibit required texture as indicated or required (polished, semi-polished, no skid or heavy duty) and it should be laid with 3mm groove. Floor tiles shall be specially prepared for floor use but shall have all the qualities of ceramic tiles listed above for wall use.

15.4 Flooring

15.4.1 Vinyl flooring:

15.4.1.1 Marbleised, directional vinyl sheet and tile flooring with extra strong polyurethane reinforcement with a subtle blend of light through to dark tones. All vinyl flooring, homogenous or permanently static dissipative pressed, shall be utilised at specified locations as indicated in the drawing. It shall have the required thickness as indicated in the drawing and shall include coving, cover formers, end cap strip on coving top.

15.4.1.2 Following brands of vinyl flooring shall use for described locations as per finishing schedule / details drawings. All types of vinyl flooring shall be submitted to Consultant for approval prior to use.

- Tarkett (United States of America)
- Objectflor Art and Design GmbH covering (Germany)

15.4.2 Carpeting:

15.4.2.1 Both loop and cut pile plain fiber carpets must meet the requirements of EN 1307 and should be 100% permanent colour polypropylene having a 5mm underlay with imported grippers. It shall include aluminium single side edging and must be soil and stain resistant.

15.4.2.2 Following brands of carpets shall use for described locations as per finishing schedule / details drawings. All types of carpets shall be submitted to Consultant for approval prior to use.

- danfloor (United Kingdom)
- Forbo flooring systems (Switzerland)

15.4.3 Cement Flooring:

15.4.3.1 Thin section cement render (2-4 mm thick per coat) shall be used as cement rendering over bricks and/or blocks to achieve a modern rendered finish and shall possess high water resistance. Following brands of cement render shall use for described locations as per finishing schedule / details drawings. All types of cement render shall be submitted to Consultant for approval prior to use.

- SUPA COAT (Australia)
- Hanson Portland-limestone Cement (Germany)

15.4.3.2 Provision of external cement paving of 450mmX450mmX50mm as well as 75mm interlocking paving as indicated in the drawing for external walkways and car port area respectively. Following brands of paving shall use for described locations as per finishing schedule / details drawings and shall be submitted to Consultant for approval prior to use.

- PRIORA MARSHALLS (United Kingdom)

15.5 Wall papers

Provision of acrylic/vinyl coated wall papers on plastered walls with 100mm high timber skirting. The plastered walls must be kept dry before placing wall papers to ensure proper adherence of wall paper to the wall and also aides for future removal. Following brands of wall papers shall use for described locations as per finishing schedule / details drawings and shall be submitted to Consultant for approval prior to use.

- Brewster Home Fashions (United States of America)
- Mirage Wall coverings (United States of America)

15.6 Woven Thatch Mat wall Finish

Wall cladding / finish with 5mm thick woven synthetic thatch mat fixed to 20mm thick exterior plaster finish with 25x25mm timber frame at 600x600mm span.

15.7 Wood veneer Wood veneer shall comply with ISO 9001 (Quality Management) and ISO 14001 (Environment Management) and finish up to ceiling level with 100mm timber skirting. Its natural wood surface shall be protected by a proprietary wearresistant film or coat. Following brands of wood veneers shall use for described locations as per finishing schedule / details drawings and shall be submitted to Consultant for approval prior to use.

- Proligna (Prodin-Prodema – Spain)
- Gunlocke (United States of America)

15.8 Ceiling

15.8.1 Suspended Ceilings:

15.8.1.1 Suspended aluminium ceilings shall be powder coated with a material, preferably epoxy, polyester or epoxy polyester with the approval of consultant.

15.8.1.2 Aluminium concealed clip-in grid ceiling system comprising a “spring T” or ‘A spring” that supports the ceiling tiles. It shall be fixed to and below a primary grid, usually a galvanized channel section as indicated and approved by the Consultant.

15.8.1.3 Provision of plain mineral fibre acoustical suspended ceilings with fibres mixed with wet process with a high quality vinyl emulsion paint surface coating.

15.8.1.4 Following brands of ceiling types shall use for described locations as per finishing schedule / details drawings. All finishing materials shall be submitted to Consultant for approval prior to use.

- Technical Metal Industrial Co.L.C.C (United Arab Emirates)
- Hebei Optimum Construction Materials Co., Ltd (China)

15.8.2 Composite Board:

15.8.2.1 Zinc Aluminium Composite board with multi-layer Ti-Zinc treated surface protected by fluorocarboned resin paint FEVE. Following brands of crash rails shall be used for described locations as per finishing schedule / details drawings and shall be submitted to Consultant for approval prior to use.

- Alucobond (Germany)

15.8.3 Suspended Flat Ceiling:

15.7.3.1 All interior spaces with suspended flat ceiling with 12mm thick plywood panels under 50x50mm hardwood trellis with emulsion paint finish.

15.7.3.2 All toilets or wet rooms with suspended flat ceiling with 12mm thick calcium silicate boards under 50x50mm hardwood trellis with emulsion paint finish.

15.8.4 Exposed rafter ceiling:

15.8.4.1 All exposed rafters are finished with woven bamboo matt pasted under 6mm thick plywood panels with clear matt lacquer finish.

15.9 Corner Guards

15.9.1 Surface mounted guards consisting of a continuous retainer with snap-on Acrovyn 4000 cover. Color matched end caps to be provided for both partial and full height applications and shall be approved by Consultant.

15.9.2 Following brands of corner guards shall be used for described locations as per finishing schedule / details drawings and shall be submitted to Consultant for approval prior to use.

- C/S Acrovyn

15.10 Crash Rails

15.10.1 Crash rails shall be 150mm wide and comprise of fireproof PVC plastic acrylic cover with aluminium alloy inner-support.

15.11 Partition Walls

15.11.1 Provision of Aluminium Composite board partition wall framed with aluminium extrusion, covered by powder coating. The infill panel shall be laminated glass consisting of two layer of normal glass sandwiched with the underlay polyvinyl butyral (PVB) firm. This shall be provided at described locations as per finishing schedule / details drawings with excellent sound & thermal insulation as well as 100% water proof and resistant to stains.

15.11.2 Tempered glass partition walls at described locations as per finishing schedule / details drawings shall be 12mm thick and insulated properly.

15.11.3 All laminated phenolic board partition systems shall be impregnated with melamine resin and decorated on both sides. It must be resistant to damage from impacts or stains, including indelible inks and highly durable.

15.11.4 Following brands of partition walls shall be used for described locations as per finishing schedule / details drawings and shall be submitted to Consultant for approval prior to use.

- Reliance Metal Industries Sdn Bhd (Malaysia)
- MDP Enterprises (India)
- Hufcor (United States of America)
- Ironwood Manufacturing (United States of America)

15.12 Mortar Materials

15.12.1 Standard brand of light gray or white Portland cement as specified in drawings/Finishing schedule/ BOQ, conforming to current British Standard specifications shall be used.

15.12.2 Sand: shall be clean, sharp, river sand, conforming to British Standard Specifications and graded fine to coarse within the following limits: 100% passing 8 sieve, 90% to 100% passing 16 sieve, 60% to 90% passing 30 sieve, 25% to 55% passing 50 sieve and 0% to 15% passing 100 sieve.

15.13 Cement Colour

- 15.15.1 Dry cement colour, chemically inert, non-fading, alkali fast, mineral pigment, as approved shall be used wherever refinished.

15.14 Waterproofing

- 15.14.1 Floors of toilet areas, corridors and planter boxes shall be treated with an appropriate water proofing coating, approved by the Consultant

15.15 Installation Requirements

- 15.15.1 As far as possible, tile lay out work should be in such a way that no tiles less than half size occurs.
- 15.15.2 Align joints in wall tile vertically and horizontally except where other patterns are shown or specified, Align joints in floor tiles at right angles to each other straight with walls to conform to the patterns selected.
- 15.15.3 Verify locations of accessories before installing tiles. Work shall be coordinated with plumbing and other trades before starting of tile work.
- 15.15.4 Installation of ceramic and vitreous tile shall be in accordance with manufacturer's instructions.

15.16 Floor Tile Installation

- 15.16.1 All ceramic and vitreous clay tile floors shall be in Portland cement setting beds. Concrete surfaces shall be cleaned and surface of concrete shall be wetted prior to placing of setting bed mortar. Tiles shall be immersed in water for minimum of 4 hours before laying.
- 15.16.2 Setting Bed Mortar Mix: shall consist of one (1) part Portland cement and two (2) parts dry sand, by volume, to which not more than 1/10 part of hydrated lime may be added.
- 15.16.3 When mixed with water, the mortar mix shall be of such consistency and workability as to produce maximum density. Determine consistency by stroking the mortar surface with a trowel. Where of correct consistency, the trowelled surface readily assumes a smoothed, slickened appearance.
- 15.16.4 Spread setting bed mortar and screed to provide smooth, dense beds with true planes pitched to drains. The thickness of bed shall be such that the floor tile will finish flush with adjacent finished flooring, but bedding shall have average thickness of 38mm.
- 15.16.5 After bed has set sufficiently to be worked over, trowel or brush a thin layer, 3mm in thickness, of neat Portland cement or special tile adhesive (approved by Consultant) paste over the surface of the back of tile.
- 15.16.6 Do not prepare larger setting bed than can be covered with tile before the mortar sets.
- 15.16.7 Press tile firmly into the bed tapping with wood blocks to obtain firm bedding of total tile area and a smooth top surface.
- 15.16.8 All tiles shall be properly aligned with straight joints in even widths. Joints width shall be determined by spacers on ceramic tiles. Tamping shall be completed within one (1) hour after placing tile. Adjust work out of line within this period.
- 15.16.9 Tiles shall be fitted closely around pipes running through walls and floors. Pitch floors to drains.

15.17 Wall Tile Installation

- 15.17.1 Base Plaster 13mm thick applied to masonry wall shall be one-part Portland cement, threeparts of river sand by volume. Where additional thickness build-up is required to conform to indicated lines, apply as separate coat at no cost to employer.
- 15.17.2 Setting bed of tiles shall be done with cement slurry or special tile Adhesive (approved by Consultant). The thickness of slurry bed shall be 3mm thick minimum for setting tiles and walls.
- 15.17.3 Installation of tiles shall be in accordance with standards and applicable requirements previously specified for floor tile.
- 15.17.4 Tiles shall be installed in perfect vertical plumb and as per the pattern and joints if shown on drawings

15.18 Grouting

- 15.18.1 Grouting shall not commence for at least 24 hours after placing of tiles.
- 15.18.2 Grout for floor and wall ceramic and vitreous tiles shall be waterproof, neat white Portland cement with dry cement colour added as directed by the Consultant. If white grout is selected, cement shall be white.
- 15.18.3 Grout mixed to a creamy consistency in accordance with manufacturer's directions shall be used for joint filling. Maximum width of joints shall be 3mm.
- 15.18.4 Force maximum grout into the joints with trowel. Before grout sets, strike or tool joints to base of cushion and fill all skips and gaps. Do not permit setting bed materials to show through grouted joints.
- 15.18.5 Cure grout joints by maintaining damp condition for three (3) days by sponging down, or other methods approved by the Consultant. Allow floors to set 48 hours before permitting ordinary foot traffic.

15.19 Defects in Tiles and Tile Laying

- 15.19.1 The surface of all tiled floors shall be perfectly in level and shall be executed by experienced workers in the field of tile laying.
- 15.19.2 A sample panel of laid tiles of each type shall be approved by the Consultant before commencement of tile laying.
- 15.19.3 Mismatches of colour, chipped or damaged tiles installed by the Contractor shall be rejected and shall have to be replaced by the Contractor at his own cost and risk.
- 15.19.4 Mismatches of colour in tiles installed by the Contractor shall be rejected and shall have to be replaced by the Contractor at his own cost and risk.

15.20 Guarantees

- 15.20.1 Manufacturer shall provide his standard guarantees for work under this section. However, such guarantees shall be in addition to not in lieu of all other liabilities which manufacturers and Contractor may have by other provisions of the Contract Documents.

15.21 Coral Stone Cladding

15.21.1 The surface of the exterior wall plastering should be levelled before applying coral stone cladding.

15.21.2 Corals should be cut and adjusted on site to fit corners and edges.

15.21.03 Coral stone to be installed on to the existing exterior plastering with white plastering for aesthetics.

15.21.04 Coral stone cladding to be done by experienced workers.

16. PAINTING

16.1 Material

16.1.1 All paints shall be approved by the Consultant for colour, quality and type. All painting work shall be carried out in accordance with the paint manufacturer's specifications unless otherwise directed by the Consultant.

16.1.2 All paints and finishes used for the project shall be manufactured by or under license from the following manufacturer; **Nippon Paints (Japan)**

Imperial Chemical Industries (UK) Sigma Paints (Saudi Arabia)

Paints from manufacturers not listed above shall only be used with prior written approval of the Consultant

16.1.3 Paint shall be ready mixed and all paints, varnishes, enamels, lacquer stains, paste fillers and similar materials shall be delivered to the site in the original containers with the seals unbroken and labels intact. Each container shall give the manufacturer's name, type of paint, colour of paint and instructions for reducing. Thinning shall be done only in accordance with the manufacturer's directions.

16.1.4 Use of product by the same manufacturer shall be a general rule in each stage of work in this Specification.

16.1.5 Colour, luster, colour scheme, finish shall be decided by the Consultant after checking sample paint test.

16.1.6 The painting shall be performed by experienced and competent painter.

16.1.7 Where walls are specified to be painted, all columns arises, groove, rough surfaces, reveals, soffits and returns, etc. shall be included and no extra shall be payable.

16.2 Definition of Terminology

16.2.1 Surface Sealing

Surface to be painted shall be sealed to have uniform suction and prevent lye from oozing out.

16.2.2 Spot Puttying

All cracks and depressions shall be filled flush with putty.

16.2.3 Puttying

All surfaces to be painted shall be puttied uniformly flat surface.

16.2.4 Spot painting

Spot puttied area shall be touched up by paint

16.2.5 Touch-up

Any damaged area after the prime coat has been applied shall be touched up

16.2.6 Drying hour

The drying time of double-coated paint shall be measured at the temperature of 20°C and humidity of 70%.

16.2.7 Amount of paint

The amount shall be standard amount of paint itself not including thinner. It shall increase or decrease depending on shape and surface condition in the process of painting.

16.3 Paint Finish Symbols

| | |
|--------------|---|
| OP | Synthetic resin mix paint finish |
| VP | Solvent-polyvinyl chloride resin paint finish |
| EP | Polyvinyl acetate resin emulsion paint finish |
| AEP | Synthetic resin emulsion paint finish |
| CL | Clear lacquer finish |
| EXP | Epoxy resin paint finish |
| Stipple (OP) | Stippled finish (oil mix paint finish) |
| Stipple (EP) | Stippled finish (polyvinyl acetate resin emulsion paint finish) |

16.4 Painting in General

16.4.1 Preparation of Paint

16.4.1.1 Mixing: Paint content with pigment shall be thoroughly stirred to make a uniform consistency.

16.4.1.2 Thinning: Portable water shall be used for thinning of emulsion paint and water-soluble paint. Proper thinner, product of the same manufacturer as paint, as a rule, shall be used for other types of painting. Percentage of thinning and viscosity shall be conducted with direction of manufacturer or catalogue as they vary with the method of paint, temperature, type of material to be painted.

16.4.1.3 Allowable period of Use: Paint mixed with more than 2 types shall be used with direction of a manufacturer or catalogue as allowable period of use, mixing ratio and mixing method vary. The paint which has passed allowable period of use shall not be used.

16.4.2 Conditions of Painting

16.4.2.1 Work shall not be executed in the following situations

16.4.2.1.1 When humidity is above 85%

16.4.2.1.2 When raining or it is forecast

16.4.2.1.3 When dusts are present

16.4.2.1.4 When temperature of surface is high under hot weather and bubbles are likely to develop on the painted surface.

16.4.2.2 Conditions of Surface to be painted: Work shall not be executed or proper means shall be taken in the following situations.

16.4.2.2.1 When surface is damp and wet

16.4.2.2.2 When condensation is likely to develop on the surface.

16.4.2.2.3 All nail holes on veneer, board. etc., shall be covered with proper rust-proof paint before the subsequent painting is applied in accordance with this specification.

16.4.3 Performance

Paint shall be evenly and uniformed applied on the surface. Areas of difficult application such as pointed part, internal angle, welded part, etc. shall be thoroughly painted and double coated as necessary to deep uniform coating thickness.

Painting shall be properly done by carefully selecting the painting method by the shape of surface and types of paint.

16.4.4 Protection

16.4.4.1 Dangerous material such as paint, thinner, etc., excluding emulsion paint and water-soluble paint shall be kept in accordance with regulations concerned.

16.5 Procedure of Painting

16.5.1 Exterior - Surface of Mortar, Plaster and Concrete

AEP- Weather shield Exterior paint

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|------------------------|--------------|---|-------------------------------------|
| 1. Surface preparation | | Dry, clean and free from impurities | |
| 2. Surface sealing | 1 | Exterior Wall Sealer | As per manufacture's specifications |
| 3. Texture base | 2 | texture base putty mechanically sprayed uniformly | As per manufacture's specifications |
| 4. Surface finishing | | Flatten with masonry trowel uniformly surfaced | |
| 5. First coating | 1 | Weather shield paint | As per manufacture's specifications |
| 6. Finish coating | 2 | Weather shield paint | As per manufacture's specifications |

Notes:

Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5

Puttying and sanding process shall allowed to omit depending on the conditions of the surface. Drying time of putty shall be long enough for sanding to proceed.

Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

16.5.2 Exterior - Iron Products in General

OP - Synthetic resin mix paint

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|-----------------|--------------|---------------|-------------|
|-----------------|--------------|---------------|-------------|

| | | | |
|------------------------------|---|--|-------------------------------------|
| 1. Surface preparation | | Completely remove rust, moisture, oil and other impurities by sander, cleaner and surface. | |
| 2. First Coating 24 hours | 1 | Rust proof oil paint | As per manufacture's specifications |
| 3. Touch-up | | Touch-up rustproof oil paint | |
| 4. First Coating | 1 | Rustproof oil paint | As per manufacture's specifications |
| 5. Second coating | 1 | Synthetic resin mix paint | As per manufacture's specifications |
| 6. Finish coating | 1 | Synthetic resin mix paint | As per manufacture's specifications |

Note:

Paint for touch-up painting shall be the same as used for first coat in process No. 2

16.5.3 Exterior - Wood

OP - Synthetic resin mix paint finish

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|------------------------|--------------|-----------------------------------|-------------------------------------|
| 1. Surface preparation | | Clean and sand to plane surface | |
| 2. Knot treatment | 1-2 | Lacquer varnish | As per manufacture's specifications |
| 3. First coating | 1 | First coat paint of oil mix paint | As per manufacture's specifications |
| 4. Second Coating | 1 | Oil mix paint | As per manufacture's specifications |
| 5. Finish coating | 1 | Oil mix paint | As per manufacture's specifications |

Note:

Puttying and sanding shall be done after process No.2 when there are cracks, etc. on the surface putty shall be oil-putty, but drying time shall vary depending on conditions.

16.5.4 Interior - Mortar, board, etc.

Stipple (EP) - Polyvinyl acetate resin emulsion paint finish

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|------------------------|--------------|-------------------------------------|-------------------------------------|
| 1. Surface preparation | | Dry, clean and free from impurities | |
| 2. Surface sealing | 1 | Sealer for emulsion paint | As per manufacture's specifications |

| | | | |
|-------------------|---|--|-------------------------------------|
| 3. Puttying | | Putty for emulsion paint | |
| 4. Grinding | | Grind with proper grinding tool | |
| 5. Spot painting | | Second coating paint of polyvinyl acetate resin emulsion paint | |
| 6. Second Coating | 2 | Polyvinyl acetate resin emulsion paint | As per manufacture's specifications |
| 7. Finish Coating | 1 | Polyvinyl acetate resin emulsion paint for stipple-finish | As per manufacture's specifications |

Notes:

Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5

Puttying and sanding process shall allowed to omit depending on the conditions of the surface.

Drying time of putty shall be long enough for sanding to proceed.

Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

16.5.5 Interior - Mortar, plaster, concrete, etc.

VP Solvent - Polyvinyl chloride resin paint finish

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|------------------------|---------------------|--|-------------------------------------|
| 1. Surface preparation | | Dry, clean and free from impurities | |
| 2. Surface sealing | 1 | Sealer for emulsion paint | As per manufacture's specifications |
| 3. Puttying | | Putty for polyvinyl chloride resin paint | |
| 4. Grinding | | Grind with proper grinding tool | |
| 5. Spot painting | | Solvent-polyvinyl chloride resin enamel emulsion paint | |
| 6. Second Coating | 1 | Solvent-polyvinyl chloride resin enamel emulsion paint | As per manufacture's specifications |
| 7. Finish Coating | 2 | Solvent-polyvinyl chloride resin enamel emulsion paint | As per manufacture's specifications |

Notes:

(a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5

(b) Puttying and sanding process shall allowed to omit depending on the conditions of the surface.

(c) Drying time of putty shall be long enough for sanding to proceed.

(d) Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

16.5.6 Interior - Mortar, plaster, concrete, etc.

EP Polyvinyl acetate resin emulsion paint finish

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|------------------------|--------------|--|-------------------------------------|
| 1. Surface preparation | | Dry, clean and free from impurities | |
| 2. Surface sealing | 1 | Sealer for emulsion paint | As per manufacture's specifications |
| 3. Puttying | | Putty for emulsion paint | |
| 4. Grinding | | Grind with proper grinding tool | |
| 5. Spot painting | | Polyvinyl acetate resin emulsion paint | |
| 6. Second Coating | 1 | Polyvinyl acetate resin emulsion paint | As per manufacture's specifications |
| 7. Finish Coating | 1 | Polyvinyl acetate resin emulsion paint | As per manufacture's specifications |

Notes:

- Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5
- Puttying and sanding process shall allowed to omit depending on the conditions of the surface.
- Drying time of putty shall be long enough for sanding to proceed.
- Amount of sealer for surface sealing shall be adjusted with direction of the Consultant as it varies with the surface conditions.

16.5.7 Interior - Iron products, steel.

OP - Synthetic resin mix paint

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|------------------------|--------------|---|-------------------------------------|
| 1. Surface preparation | | Completely remove rust, moisture, oil and other impurities by sander, cleaner and surface | |
| 2. First Coating | 1 | Synthetic resin rust-proof. Red lead-type, lead compoundtype | As per manufacture's specifications |
| 3. Touch-up | | Touch-up rust proof paint | |
| 4. First Coating | 1 | Synthetic resin rust-proof paint. Red lead-type, Lead compoundtype | As per manufacture's specifications |

| | | | |
|-------------------|---|---------------------------|-------------------------------------|
| 5. Second Coating | 1 | Synthetic resin mix paint | As per manufacture's specifications |
| 6. Finish Coating | 1 | Synthetic resin mix paint | As per manufacture's specifications |

Notes:

- (a) Paint for touch-up painting shall be the same as used for first coat in process No.2
- (b) When oil rust-proof paint is used instead of synthetic resin rust proof, its specification shall conform to No. 5 and No.6.

16.5.8 Floor - Concrete and Mortar

EXP - Epoxy resin paint finish

| Coating Process | No. of Coats | Type of Paint | Drying hour |
|----------------------|--------------|-------------------------------------|-------------------------------------|
| 1. Surface treatment | | Dry, clean and free from impurities | |
| 2. First coating | 1 | First coating paint for epoxy | As per manufacture's specifications |
| 3. Finish Coating | 2 | Epoxy resin paint | As per manufacture's specifications |

Notes:

- (a) Degree of dryness on the surface to be painted shall be kept under 6% in water content and below PH 9.5.
- (b) Amount of paint and number of paint shall be as directed by the Consultant as they vary with the conditions of surface and required thickness of coating.
- (c) Painted surface shall be kept out of use for more than 7 days after application of final coat.

MINISTRY OF ISLAMIC AFFAIRS

PROTOTYPE MOSQUE

TECHNICAL SPECIFICATIONS FOR BUILDING MEP SERVICES

Consultant Project Number: R24002MIA
Consultant: Riyan Pvt. Ltd.



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1 GENERAL MEP EXTENT OF WORKS

1.1 GENERAL DESCRIPTION

The scope of work under this specification covers manufacture/ procurement, assembly, shop inspection & testing, shop painting, transportation of materials to site, storing, unloading and transportation from store to site and handling at site, erection, testing, commissioning and performance guarantee tests of equipment and accessories of all mechanical Services of the Project.

The scope of work by the Contractor shall include but shall not be limited to the following:

- a. To select, manufacture and supply the complete of all Services and associated equipment specified under this technical specification.
- b. To supply at site required materials in order to execute incidental works at site associated with of all Services Systems specified under this technical specification, supporting drawings, and documents providing first charge of consumables as required. The quantity and specification of such consumables shall be indicated during the tender stage.
- c. Supply of commissioning spares as may be required during erection, start up and initial operation of all the units/ systems till successful completion of commissioning. The price for the commissioning spares shall be deemed to be included in the contract price for the offered systems.
- d. Supply of recommended spares for two years' normal operation of the total Services with item wise price breakup. The price for the two years' spares shall be deemed to be included in the contract price for the offered systems.
- e. Supply of special tools & tackles required for maintenance of all Services with preparation and submission of a necessary load calculations, general arrangement drawings, shop drawings, fabrication & erection drawings, as built drawings, drawings of fast wearing parts etc. Approval shall be taken on the load calculation, system layout drawings and equipment general arrangement drawings before start of manufacturing or procuring.
- f. Erection of all the equipment and complete of total Services system as per approved drawing and instructions of site engineer of customer / Owner/ Consultant.
- g. Minor civil work like breaking of wall / floor / roof to make duct / pipe / cable passage and adjustment to civil foundations as required for erection and finishing and making good of the same after erection work including painting thereof. Fixing of anchor fastener on wall and ceiling for support is included.
- h. Any other item /nature of work which is specifically not appearing in the technical specification but directly associated with the efficient working / completion of the system covered in the specifications.
- i. Submission of operation, maintenance and service manuals
- j. Inspection and testing by Owner/Client's representative at works and at site
- k. Performance testing of various equipment associated with all Services at manufacturer's works and also performance testing all mechanical Services System at site.

- l. All necessary skilled/unskilled personnel, cranes, hoist, tools and tackles, instrument and accessories shall be arranged free of cost by the Contractor for assembly, erection, performance testing and commissioning of the systems.
- m. Tenderer must note that completeness of System for safe, smooth, trouble free operation and compliance with Local/International regulation is the sole responsibility of the Contractor i.e., the successful Tenderer. With this objective in mind, the Tenderer should include all the items essential for the efficient operation of the systems and other items which are required to complete the erection and foolproof commissioning of systems in respects. Whether the items are mentioned in the specification or not, all such items are treated/considered to be included in the specifications.
- n. When any services passing the fire rated compartments/Wall or any barriers all sleeves or opening to be properly sealed with fire rated sealants.
- o. Contractor i.e., the successful Tenderer shall be solely responsible to provide the above items at site without any extra cost implication to Client.

1.2 GENERAL INSTRUCTIONS

- a. The technical specification inclusive of instructions/special instructions to Tenderer shall be read along-with general conditions of contract and instructions to Tenderer, for the supply and erection of services systems, machinery, and equipment.
- b. All items of equipment in this specification shall be complete in all respect including mechanical and electrical equipment as specified including fasteners, bolts and nuts, gaskets, base frames, stiffeners, supports etc. and any item not covered in this specification but essential for superior design, operation and guaranteed performance of the system shall be included by the Tenderer.
- c. The equipment shall be designed, manufactured and tested in accordance with the relevant standards. In cases where suitable Maldivian Standards are not available, the equipment shall conform Good Manufacturing Practice followed in the industry.
- d. The equipment offered shall be suitable for continuous, smooth, efficient and trouble-free services in the climate prevailing at the site, continuous duty condition.
- e. The Contractor shall not off-load the contract or part thereof to any sub-contractor without written permission of the Purchaser. In the event of subletting the contract or any part thereof is permitted by the Purchaser, the fact that such permission has been accorded shall not establish any contractual relationship between the approved sub-contractor and the Purchaser and nor shall release/ free the Contractor from the obligations under the contract. Facilities shall be provided by the Contractor to enable the Purchaser's authorized inspector to inspect the equipment and their auxiliaries at all stages of manufacture to satisfy themselves as to the use of proper material and workmanship and apart from this the equipment shall be tested or suitable test facility shall be provided by the Contractor to enable checking of operational parameters.
- f. At the time of inspection, the Contractor shall furnish internal routine inspection certificate, material certificates, approved drawings, etc. to the inspector. Inspection shall be regarded as check-only and shall in no way relieve the Contractor of his responsibilities to provide systems & equipment functions as designed.

- g. The Contractor Shall take full responsibilities for the guaranteed operation and achieving rated out-put and performance of the systems offered as per relevant clause of specifications.
- h. The Tenderer shall information required for smooth functioning of the systems including operation, day to day maintenance, preventive maintenance, capital repairs, schedules and programs and any other information required by the Purchaser for trouble free operation of the systems along-with the supplies.
- i. The scope of work for the Tenderer shall not include provision of room and foundation for the systems. However, the necessary load data shall be furnished along with the offer by the Tenderer so as to complete the civil work at site as per the schedule of completion of respective buildings.
- j. The Contractor shall ensure that all rotating elements viz impellers of fans and crank-shaft, piston assemblies shall be statically and dynamically balanced as per the relevant International / ISO standards.
- k. The Contractor shall ensure that the speed of operation of all the mechanical and electrical equipment including technological auxiliaries and service equipment shall be kept low enough to reduce noise, vibrations and wear. When design parameters require higher speeds of operation of certain equipment, more than one stage shall be chosen over preference to choosing higher speeds.
- l. The Contractor shall adhere to the schedule for supply, erection, testing and commissioning etc.
- m. The Contractor shall ensure that each equipment is provided with name plate engraved in English language with the details like Supplier's address, operation and design parameters, weight, and precautions etc.
- n. The Contractor shall ensure that the systems are designed considering the fire safety norms and adequate fire safety measures in the form of hardware interlock provided accordingly.
- o. This section applies to all sections of Building Services except as specified otherwise in the individual sections.
- p. The works to be done under this section of the Specifications consists of the fabrication, complete in all details, of the Building Services, at the subject premises, and all work and materials incidental to the proper completion of the installation, except those portions of the work, which are expressly stated to be done by others. All works shall be in accordance with the governing Codes and Regulations and with the Specifications, except where it conflicts with such Codes, etc., the former shall then govern. The requirements in regard to materials and appliances necessary for the complete installation of the work specified herein and indicated on the drawings. These specifications are intended to provide a broad outline of the required equipment, but are not intended to include all details of design and construction.
- q. Complete Building Services shall be furnished and installed as shown on drawings and specified under this section. Coordinate timing of installation with work of other trades.
- r. Systems provided shall be complete and operable, and shall include required accessories, fastening, and supports. One coat of primer shall be provided for all fastenings and supports.

1.3 STANDARD CODES AND REGULATIONS

- a. All works performed, and equipment and materials supplied and installed under the contract shall comply in every respect with the rules and regulations of:
 - Relevant Maldivian Standard Specification
 - Local Fire Regulation
 - Current Edition of The Relevant British Standard Codes of Practice.
- b. The relevant British Standard Specifications (BS) or approved equivalent.
- c. All other authorities having jurisdiction over the installation

1.4 STANDARDS COMPLIANCE

- a. Materials and equipment specified to conform to referenced standards and codes require proof of such conformance. Labels or listings indicating such compliance are acceptance evidence. In lieu of label or listings provide a certificate from an independent testing organization acceptance to the Engineer.
- b. For materials and equipment whose compliance with organization standards or specifications is not regulated by listing or label, provide manufacturer's certificate of compliance.
- c. Certificates of compliance shall identify manufacturer, product, referenced standards and manufacturer's certification that the product conforms to all requirements of the project specification and listed reference standards.

1.5 AUTHORITIES INSPECTION, TESTING AND APPROVAL

- a. The Contractor shall file all plans, application permits, etc., and shall complete all tests, forms, etc., arrange all inspection etc. as required by all rule's regulations, etc., of all the Government Authorities having jurisdiction and such shall be completed by personnel of proper caliber, in particular, Professional Engineers, where so required.
- b. The works shall not be cover up prior to the inspection and the approval of the authorities. The Contractor shall give due notice as required by the Authorities whenever such works are ready or about to be ready for inspection and testing. They shall afford full opportunity and co-operation of the authorities to carry out the inspection and testing and shall deemed to have allowed in the tender sum for such inspection, any fees payable any necessary phasing and temporary suspension of works and other cost resulting thereby.
- c. Should any works be covered without prior inspection and approval, the Contractor shall uncover any parts or part of the work or make openings in or through the same, as the Authorities may direct for inspection. The Contractor shall at its own expense reinstate and make good any such part or parts to the satisfaction of the authorities and Superintending Officer.
- d. The Contractor shall furnish all required Certificates of approval.
- e. Schedule of Technical Data and Manufacturer's Technical Pamphlets.
- f. Manufacturer's Technical Pamphlets giving full technical data for all equipment to be offered by the Tenderer i.e., the successful Contractor, shall be submitted together with the Tender. The Schedule of Technical Data shall be dully filled. Equipment to be offered by the Tenderer shall bear both Manufacturer's Name and List Number.

- g. Phrases like “As Specified”, or “Equivalent”, “Submit at a later date”, “Maldivian Made” will not be acceptable in the Schedule of Technical Data.
- h. Where there is discrepancy between the Schedule of Technical Data attached to the Tender Documents and the Specifications mentioned on Manufacturer’s Technical Pamphlets, the Schedule of Technical Data should prevail.
- i. Tenderers must fill-in their tender strictly in compliance with the Engineer’s base specification in regards to nominated makes of equipment/material. Any error in specifications must be clarified with the Engineer before submission of tenders, who will issue addenda thereof.
- j. The original form of Schedule of Technical Data must be filled in accordance with the Engineer’s base specification or amendments thereof, failing which the client reserves the right to ask the Tenderer to comply with Engineer’s base specification at tendered price or else the client reserves the right to forfeit the Tenderer’s Tender Deposit and Tender Bond.
- k. Tenderers are fully encouraged, however, to propose alternative specifications which can achieve genuine economy in cost or technical benefits, but these same alternative and their cost implication thereof must be filled separately in a separate covering letter with a Schedule of Technical Data and not the original Tender Schedule.

1.6 EQUIPMENT AND MATERIAL APPROVALS AND SAMPLES REVIEW:

- a. Within 14 days after the award of any contract, the Contractor shall submit for approval a list of manufacturers of equipment and material proposed for the work. The Contractor’s intent to use the exact makes stated in their tender does not relieve them of the responsibility of submitting such a list. All equipment and materials shall be new and unused.
- b. Wherever the words “equal”, “approved equal”, “as approved” appear in the specification, this shall mean approved in writing by the Consulting Engineer.
- c. Each item of equipment shall be a standard catalogue product of an established, reputable, approved manufacturer. All similar equipment shall be of the same manufacturer, type, class and finish, unless otherwise specified.
- d. Where manufacturer’s catalogue numbers or types are specified or shown on the drawings, they are generally intended to be used as a guide, and are not intended to take precedence over the basic duty and performance specified or shown. In all cases, verify the duty with the particular characteristics of the equipment offered for approval.
- e. Where no alternative materials are noted in the specification or on the drawings and where the words “equal”, “approved equal”, or “as approved” etc., do not appear, the exact make specified must be supplied and installed.
- f. Orders must be placed within thirty (30) days of tender award. Major equipment orders shall be forwarded to the Consulting Engineer for approval before purchase.
- g. Samples: Where approval of products is specified submit samples or other evidence of suitability for review by the Engineer. Resubmit samples as necessary until an acceptable standard is reached. Do not confirm orders, commence manufacture or use products until approval of samples have been obtained.

- h. Materials Application: Materials submitted for review shall be forwarded using a standard application form format to be agreed with the Engineer. Enter the date by which review information is required. Allow a reasonable time for review and indicate urgency where necessary.
- i. Supply and installation of transformers & cabling up to MSB also will be in contractor's scope of work and the contractor shall co-ordinate with MEA / URA / STELCO for obtaining necessary information from MEA / URA / STELCO to construct the HT/Transformer room and obtaining the above supply on time.
- j. The HT/ transformer room construction shall be done by the main contractor. Main contractor shall coordinate with MEA / URA during transformer room construction works and shall obtain approval from MEA / URA.
- k. Where manufacturers are nominated in the Specification or in the following schedule, they are intended to define acceptable standards of equipment.
- l. Performance testing of various Equipment associated with of LV System at manufacturer's works and also performance testing of LV and extra Low Voltage System at site.
- m. All necessary skilled/unskilled personnel, cranes, hoist, tools and tackles, instrument and accessories shall be arranged free of cost by the Contractor for assembly, erection, performance testing and commissioning of the systems.
- n. Tenderer must note that completeness of System for safe, smooth, trouble free operation and compliance with Local/International regulation is the sole responsibility of the Contractor i.e., the successful Tenderer. With this objective in mind, the Tenderer should include all the items essential for the efficient operation of the systems and other items which are required to complete the erection and foolproof commissioning of systems in respects. Whether the items are mentioned in the specification or not, all such items are treated/ considered to be included in the specifications.
- o. Contractor i.e., the successful Tenderer shall be solely responsible to provide the above items at site without any extra cost implication to Client.
- p. When any services passing the fire rated compartments/Wall or any barriers all sleeves or opening to be properly sealed with fire rated sealants.
- q. Review Categories: Shop drawings, Materials Samples, Mock Ups and similar submittals will be reviewed and classified in one of the following categories:

| | | |
|---|--|------------------------------------|
| A | approved without comment | - no resubmission required |
| B | approved when comments are fully complied with | - to submit compliance indications |
| C | resubmit with revisions | - to be resubmitted |
| D | disapproved | - to be resubmitted |
- r. Mock-ups: Provide mock-ups as required by the specifications. Mock-ups will be subject to review and are to be adjusted until an acceptable standard is achieved. These are then to be protected and remain in place to form a minimum standard for comparison of subsequent work. Mock-ups may form part of the final construction as may be agreed with and directed by the Engineer.

1.7 EQUIPMENT AND MATERIAL DEVIATIONS

- a. The dimensions and ratings of equipment specified herein or indicated on the drawings are intended to establish the outlines and characteristics of equipment furnished by the particular manufacturer or manufacturers specified.
- b. Where the Contractor intends to use an item of equipment or material other than that specified or shown on the drawings or in the Schedules, the Consulting Engineer's approval therefore must be obtained in writing.
- c. Should any tenderer include in his offer equipment or material other than that shown in the drawings and schedules, such equipment or material must conform fully to the requirements for these items as shown in the drawings and schedules. Acceptance of any tender which includes equipment and material which differ in any respect to that equipment and material shown on the drawings and Schedules, in no way relieves the Contractor from complying with the specification, drawing and Schedules.
- d. Where such approved equipment deviations require a different quantity and arrangement of piping, wiring conduit and equipment from that specified or shown on the drawings, the Contractor shall furnish and install any such additional piping, structural supports, electrical materials, insulation, controllers, motors, starters and equipment required by the system without additional charge.

1.8 SUBMITTAL

The following items shall be requiring to be submitted to the Engineer for review and certification

- a. System Design Calculation – Assumptions and basis of selection for the system components. Design calculations as required by the Engineer for review.
- b. Design and Shop Drawings – Complete system design layout and description of components for all equipment and material schedules.
- c. Test certificates for the system.
- d. Current active welder's certificate and welding procedures for welding works to be done together with tender document.

1.9 INTENT OF DRAWINGS AND SPECIFICATIONS

- a. It is the intent of the Specification and drawings relevant to this Contract to call for finished work, tested and commissioned. Any apparatus, appliance or material not shown on the drawings but which is mentioned in the specification or vice versa, or any incidental appliance or materials, services which may be necessary to make the work complete and perfect in all respect and ready for operation, even if not particularly specified, shall be furnished, delivered and installed without any additional costs.
- b. The plan as drawn are based upon architectural plan and detail and show conditions as accurately as it is possible to indicate them in scale. The plans are diagrammatical and do not necessarily show all accessories, fixings etc., necessary to fit the building conditions.

- c. The locations of outlets, apparatus and equipment shown on the plans are approximate. The Contractor shall be responsible for the proper location of all devices to make them fit with architectural details and instructions from Engineer's representative at the site.

1.10 SHOP DRAWINGS, WORKING DRAWINGS AND DETAILS

- a. After receiving approval of the equipment manufacturers submit for approval, without delay, and prior to purchase or fabrication, not less than six (6) copies of detailed, dimensioned shop drawings or cuts of equipment showing general construction, size, arrangement, levels and setting out details, fixing details, operating clearances, related builders work information and requirements, performance characteristics and capacity of all specialties, together with sufficient engineering data to indicate substantial compliance with the respective specifications
- b. Positions of all control equipment, including related components, shall be shown on shop drawings.
- c. Each item shall be identified by name and numbers as shown on the equipment schedules, control drawings and specification.
- d. Working drawings of the complete installation, prepared by the Contractor shall be submitted in triplicate for examination and comment. Each drawing will be examined and approved or corrected or disapproved by the M&E Engineers, and returned to the Contractor, who shall then print the necessary copies of each approved submission for distribution. Disapproved drawings shall be corrected and resubmitted.
- e. Drawings shall be of 1:100 scale minimum except in critical areas where 1:50 or larger scale as appropriate shall be used.
- f. Inspection of shop and working drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings are inspected, such inspection does not in any way relieve the Contractor from his responsibility nor from the necessity of furnishing material or performing work required by the contract drawings and specification, which shall, in the event of a dispute, take precedence over shop drawings.
- g. The submission of shop and working drawings (in either the original submissions or resubmitted with corrections) constitutes evidence that the Contractor concerned has checked all information thereon and that they accept and are willing to perform the work as shown in a workmanlike manner and in accordance with the best standard practice. It also constitutes evidence that all control diagrams, all electrical diagrams and all submissions of any kind are fully understood by the Contractor and that in their opinion the equipment will perform as specified. No claim for extra shall be based on work shown on shop and working drawings, unless such claim is so noted on the Contractor's transmittal letter accompanying the drawings.
- h. A responsible person of the Contractor's staff shall sign all drawings submitted, including those by suppliers.
- i. Submit for approval within fourteen (14) days of the contract being awarded two (2) copies of a schedule of shop drawings showing the following:
 - Drawing Number
 - Title

- Planned Date of Submission
- j. Dates of submission and approval shall be coordinated with the Building Program. Shop drawings shall be submitted for inspection to the M&E Engineer, minimum of 14 days prior to the required return date.
 - k. Failure of the Contractor to include all shop drawings on this schedule shall not relieve them of their responsibility to submit all required shop drawings on time to permit correct processing as specified herein.
 - l. The Sub Contractor is responsible for ensuring that shop drawings are kept up to date incorporating modifications arising from instructions. Reissue updated shop drawings as may be required by the Engineer

1.11 RECORD DRAWINGS, AS-BUILT DRAWINGS, AND OPERATION & MAINTENANCE MANUALS

- a. Record Drawings: During the course of the works the Sub Contractor shall maintain fully detailed records of all changes from the tender drawings to facilitate easy and accurate preparation of the record drawings and to ensure that these drawings are in all respects a true record of the installation.
- b. Content: The drawings shall show the complete installation, including the size and runs of all ducts and pipework. The scales shall be such that details, particularly of the plant, can be clearly shown. The drawings shall show the names of the manufacturer, model and type numbers and all the details of duty and rating of all items of the plant, including thermostatic control equipment. The drawings shall include the geographical location and identification number of each circuit control valve in accordance with the labeling and circuit control diagram.
- c. Diagrams: A print of each of the composite record circuit and layout diagrams shall be fixed securely to the inside of the hinged front of the main electrical control panels as appropriate, or in such other alternative positions as may be agreed by the Engineer and shall be protected by nonflammable transparent material. Where inadequate space exists, the prints shall be suitably reduced in size.
- d. Operations and Maintenance Manuals: The Contractor shall also provide Operations and Maintenance Manuals, Wiring diagrams, valve charts, test certificates and the like as required by these Specifications. Three copies of the Operations and Maintenance Manual shall be handed to the Engineer before Practical Completion. 2 copies of the O & M manual In CD format shall also be submitted. The files in the CD shall be in PDF or text format.
- e. Manual Format: The format of the manual shall be A4 size white paper for typed pages with neatly typewritten text, and manufacturer's printed data. Drawings shall be sized that they may be folded to the size of the text pages. Each volume title of the manual shall be identified with the typed or printed title, 'Operations and Maintenance Manual', the title of the project and the identity of the general subject matter covered in the manual. The text and drawings shall be placed in commercial three ring binders with durable and cleanable plastic covers. When multiple binders are used, the instructions shall be correlated into related consistent groupings. Each manual volume shall contain a neatly typewritten table of contents arranged in a systematic order giving: Sub

Contractor, name of responsible principal, address and telephone number, a list of the name, address and telephone number of the subcontractor or installer. Only the manufacturers printed data, which is pertinent, is to be included.

- f. Each sheet of manufacturer's instructions shall be annotated to identify clearly the specific item or part installed and the instructions applicable to the installation. All inapplicable information shall be deleted.
- g. Supplementary Data: Data shall be supplemented with drawings as necessary to illustrate clearly component parts of equipment and systems, control diagrams, flow diagrams and test procedures covered in the manual. Written text shall be organized into a consistent format under separate headings for different procedures and in a manner to provide a logical sequence of instructions for each procedure.
- h. Organization: Organize the Operations and Maintenance Manual as follows:

Volume 1

- Part 1 : Introduction
- Part 2 : System Description
- Part 3 : Operating Procedures
- Part 4 : Fault Finding
- Part 5 : Preventive Maintenance
- Part 6 : Appendices
- List of Drawings
- Equipment Data and Spare Parts
- List of Manufacturers and Agents

Volume 2

- Publications (catalogues, selection tables, etc.)

1.11.1 Contents

The content of the manual shall include those items contained in the above schedule and for each item shall cover the following points:

- Description of Plant, Equipment, Component Parts and Finishes
- Operating Procedures, Including Step by Step Instructions for Pre-Start, Starting Up, Normal Operation and Shutting Down of The Plant, Equipment and Components, Safety Features
- Maintenance Procedures, Including Routine Operations, Guide to Troubleshooting and Fault Finding, Procedures for Assembly, Repair and Reassembly, And Procedures for Alignment, Adjusting, Checking and Cleaning
- Servicing, Lubrication and Cleaning Schedule, Including List of Lubricants Required and Filter Replacement
- Manufacturer's Printed Operating and Maintenance Instructions
- Circuit Directories of Panel Boards, Dial Servicing and Instrument Checking
- As installed color, coded wiring diagrams.
- Details of each item of plant, including the name and address of the manufacturer and local agent, type and model, serial number, duty and rating.

1.11.2 Operations and Maintenance Instructions

The Contractor shall demonstrate and explain the plant and the method of starting, running and stopping to the Architect or Employer's representatives. During the defects liability period the Contractor shall allow for providing trained operators to attend, operate and maintain the plant as directed by the Architect. Demonstrate the purpose, function and operation of the installations including all items and procedures listed in the Operations and Maintenance Manual. Over this period the operators shall also instruct the Employer's staff in the correct maintenance and operation of all plant and equipment. The Contractor shall also assist the Employer in formulating any maintenance contracts with suppliers of equipment and Contractors that the Client may require. The Contractor shall provide five sets of operations and maintenance instructions (hard copies) and two (2) soft copies of the O & M manual In CD format. The files in the CD shall be in PDF or text format.

1.12 RECORD SHOP DRAWINGS

Unless otherwise indicated, the Contractor shall provide before the Practical Completion the following drawings:

- Four sets of installation working drawings.
- Four sets of detailed plant room drawings.
- Four sets of purpose made diagrams detailing separately all the composite electrical circuit and wiring layouts.
- Four sets of builder's work drawings.
- One set of reproducible as fitted drawings, process negatives and computer discs for use with AutoCAD upon completion of the work

1.13 COMPLETION

Adjust copies of all Shop Drawings to record final installation. Submit five (5) complete finalized sets before Practical Completion. Supply copies of all associated supplementary manufacturers or other data necessary to form a full and complete record of work done.

1.14 ADDITIONAL DATA

Provide details of any errors, variations, omissions or additional information which is not instructed, directed or indicated on the sub contract drawings, but which becomes apparent from construction. Information is to enable record drawings to form an accurate record of final construction. Details to be submitted as the work progresses and shall be complete by the Practical Completion.

1.15 MANUFACTURERS INPUT

Retain copies of maintenance instructions and documents delivered with components and equipment or obtain from manufacturer as necessary and submit before Practical Completion.

1.16 SPARE PARTS

On completion of the testing and commissioning of the building services installation, spare parts required by the specification shall be supplied and submitted.

1.17 LISTS

At time of handover provide a comprehensive list of all manufacturers, suppliers and local agents for all items used in the construction of the works. Include the following data:

- Product/ service
- Specification/ instruction reference
- Company name
- Address
- Telephone and fax numbers
- Contact name, title and position.

Upon completion of the job, the Sub-Contractor shall furnish to the Owner, their original tracings or reproducible transparencies of all electrical works, shop drawings and equipment layouts. They shall note on the as-built drawings, furnished by them, the corresponding number of the applicable shop drawings. Where shop drawings are not available, the Contractor shall neatly indicate the changes on the as-built drawings.

1.18 QUALITY ASSURANCE

- a. The Contractor shall operate and maintain a Quality Assurance programme to ensure that the Contract is completed in accordance with the approved programme and to the standard specified.
- b. Work procedures shall be documented and shall be available to satisfy the Architect of the effectiveness of this programme in the following areas at contract execution.
 - Design
 - Procurement, manufacture and packaging
 - Construction and erection
 - Manufacturer's Instructions
- c. Where installation procedures are specified to be in accordance with the manufacturer's instructions, provide published copies prior to installation. Installation of materials and equipment will not be allowed until the instructions are received.
- d. Failure to furnish manufacturer's instruction can be cause for rejection of the materials.

1.19 PROGRESS PHOTOGRAPHS

In addition to progress photographs required for monthly progress reports keep a portfolio of progress photographs on site which act as a record of the progress of key areas of the works and key events as directed by the Engineer.

1.20 COMPLETION AND PROTECTION

- a. Protection – Protect building finishes, fixtures and fittings and prevent damage to existing property. Move, cover and protect as necessary to enable the works to be executed and replace in original positions upon completion.
- b. Special Protection – Wherever work is of an especially vulnerable nature or is exposed to abnormal risks provide special protection to ensure that damage does not occur. Replace or repair any damaged components or finishes.

- c. Waste Material – Remove rubbish, waste, debris and surplus material regularly and keep the site orderly and clean. Remove all rubbish, dirt and residues from voids and cavities in the construction before closing in. Dispose of waste material at an approved location and obtain all necessary permits.
- d. Cleaning and touch up – Remove all temporary markings, coverings and protective wrappings unless otherwise instructed. Clean finished work thoroughly, remove all surplus material. Cleaning materials and methods shall be as recommended by product manufacturers. Touch up minor faults in finishes or repaint badly marked areas back to suitable breaks or junctions.

1.21 LUBRICATION

Adjust, ease and lubricate moving parts of new work as necessary to ensure easy and efficient operation.

1.22 DEFECTS

Defects are to be reported to the Engineer without delay. Obtain directions before proceeding with work which may cover up or otherwise hinder access to defective construction or be rendered abortive by the carrying out of remedial work.

1.23 PRACTICAL COMPLETION

- a. Preparation – During the weeks leading up to Practical Completion, the Architect and engineering Consultants will monitor commissioning tests with the Contractor and his subcontractors. A programme of such tests is to be agreed well in advance to ensure a systematic and progressive approach towards building handover. The Contractor shall pay particular attention to the production of Record Drawings and Maintenance Manuals. Their production will be progressively reviewed in order that they are finished by the Date of Completion.
- b. Preparatory Inspection – Two weeks prior to the anticipated date of Practical Completion a formal inspection of the works will be undertaken jointly by the Architect, engineering Consultants and the Contractor. The Employer will be invited to send representatives to this inspection. Lists of defective and incomplete work are to be prepared together with the Architect and engineering Consultants, together with a check list of outstanding documentation related to the documents required to be handed over by the Sub Contractor at Practical Completion. The Architect will consolidate these lists and forward to the Sub Contractor for action. Action related to the lists will be monitored in the remaining period to Practical Completion.
- c. Handover – As soon as the Architect is of the opinion that Practical Completion has been achieved, he will arrange a formal Handover Inspection with the Employer. Any remaining defects or pending documentation will be listed for immediate action by the Sub Contractor within seven days unless otherwise instructed by the Architect.
- d. Defects Liability Period – Defects will be reviewed at joint site inspections with Consultants and Contractor. The Architect will coordinate input from all disciplines and prepare a Defects List that will be updated and reissued following inspections throughout the Defects Liability Period. Permission for access to accommodation for making good defects is to be obtained strictly in accordance with Employer, Contractor and user requirements. Defects are to be made good promptly and expeditiously.

- e. Training – The Contractor shall allow in his Contract price the service of a competent personnel to instruct the Owner's maintenance staff in the operation and maintenance of the installation and equipment during the initial operation of the system, subsequent to the issue of the Certificate of Practical Completion or handing over of the Works to the Owner whichever is earlier.
- f. Maintenance and Guarantee – All equipment supplied and installed shall be in good working order and shall be guaranteed for a period of 12 months from the date of handing over the completed installation to the Owner. This guarantee shall include the equipment manufacturer's standard warranties and the Contractor's own guarantee on all other materials supplied and installed by them.
- g. The Contractor shall make good any defects to the components of the equipment that may arise from fair wear and tear during the guarantee period.
- h. Any component of the installation which fail to achieve the guaranteed performance to be replaced by the Contractor without delay and without any charge.
- i. During the above-mentioned guarantee period the Contractor shall provide free regular monthly maintenance to all Mechanical Services and ensure that all systems are maintained in first class running order. The maintenance shall include systematic examination, cleaning, adjustments, testing and lubrication and shall cover replacement of parts due to fair wear and tear.
- j. During this guarantee period the Contractor shall also provide emergency breakdown maintenance.
- k. The Contractor shall maintain a detail record of all services, maintenance and repair work carried out. Such record shall be prepared in duplicate and should be in a form of Maintenance/ Repair sheet, with one copy to be retained by the Owner upon the execution of such services. Record of such service, maintenance or repair shall also be entered in the maintenance log book provided at the site.

1.24 DAY WORKS

Submittals – Day work sheets shall be submitted regularly not later than the end of the week following that in which Day works were done. The Contractor is to submit Day works sheets to the Architect's site office. These will then be distributed to respective Consultant disciplines for review, checking, verification and approval. Submittals will not be accepted if Day works sheets are incorrectly filled out or submitted unsigned. Submittals will not be accepted which, in the opinion of the architect and/ or engineer, do not accurately reflect actual Day works done.

1.25 FORMATS

Day works sheets shall be in standard format to be approved by the Architect. The format is to run on a weekly basis. As a minimum form shall include:

- Date
- AI reference
- Hours worked
- Cost column
- Labor type/ trade
- Name of person

- Work done by room number and/ or system
- Signature and date of subcontractor foreman
- Architect approval signature and date box.

1.26 CONTRACTORS AUTHORIZATION

The Contractor shall provide the Architect with names and position/ responsibility of each person authorized to sign Day works sheets.

1.27 CONSULTANTS AUTHORIZATION

The senior resident architect, senior resident engineer or designated counterparts are authorized to sign Day works sheets.

1.28 DISTRIBUTION

All approved Day works sheets are to be returned to the Architect and thence to the Quantity Surveyor at regular intervals, at least monthly. Rejected Day works sheets will be returned to the Contractor not later than 14 working days after the date of receipt by the Architect.

2 FIRE DETECTION & PROTECTION SYSTEM TECHNICAL SPECIFICATIONS

2.1 GENERAL

This section outlines the minimum acceptance standards for equipment and materials which are to be provided. Any deviation therefrom or alternative offer of materials must be approved by the Consulting Architect or Services Engineer prior to placement of orders and installation.

Minor equipment and materials not specified herein shall be provided in accordance with the best trade practice and standards.

Contractor shall supply and install the fire detection and protection systems in the location as shown in the drawings.

The Contractor shall be responsible for obtaining approval from the Local Fire Authority for all extinguishers installed. The approval fee required for this purpose shall be deemed to have been included in the tender price.

2.2 STANDARDS & CODES

Fire Detections & Protection System should comply with following standards.

- Maldives Ministry of Defence – Requirement for Fire Prevention Equipments in Buildings
- Fire extinguishing systems – BS EN 3.
- Fire extinguishing installations and equipment's – BS 5306
- Fire Detection and Fire Alarm System – BS EN 54-20
- Fire and Accident Underwriters Association
- NFPA Codes including 72, 75, and 2001

2.3 PORTABLE FIRE EXTINGUISHERS

2.3.1 General

The Contractor shall supply and install portable type fire extinguishers in the location as shown in the local authority approved drawings.

All extinguishers provided shall meet with the requirements of the Local Fire Authority and with the relevant BS and NFPA Standards.

2.3.2 Location and Installation

Extinguishers shall be conspicuously located where they will be readily accessible and immediately available in the event of fire. They shall, in general, be located along normal paths of travel and not to be obstructed or obscured from view.

In locations where visual obstruction cannot be completely avoided, means shall be provided to indicate the location.

Hangers, hooks and mounting brackets used for the installation of the extinguishers shall be to the approval of the Engineer. Where extinguishers are installed under conditions subject to dislodgement, such brackets shall be specifically designed to cope with the problem. Extinguishers installed under conditions where they are subject to physical damage shall be protected from impact. The exterior finish of the extinguishers shall be suitable for external or internal location as required. All extinguishers shall be installed such that the extinguisher operating instructions face outward. Extinguishers having a gross weight not exceeding 40 lbs. (18 kg) shall be installed so that the top of the extinguisher is not more than 5 ft. (1.5m) above the floor. Except for wheeled types, all heavier extinguishers shall be so installed that the top is not more than 3 1/2 ft (1m) above the floor. In no case shall the clearance between the bottom of the extinguisher and the floor be less than 4 in (0.1m).

The words 'FIRE EXTINGUISHERS' shall be painted using luminous paint on the wall above where the fire extinguisher is installed.

2.3.3 Approval from Fire Authority

The contractor shall be responsible for obtaining approval from the Local Fire Authority for all extinguishers installed. The approval fee required for this purpose shall be deemed to have been included in the tender price.

2.3.4 Types of Extinguishers

All extinguishers shall be provided according to the type and capacities as indicated in the drawings. Classifications of five classes are according to BS4547.

2.3.4.1 Water Types

These shall be general purpose extinguishers of Gal Cartridge type approved to BS EN 3, suitable for Class 'A' fires. Each extinguisher shall be supplied fully charged complete with plunger, hose, nozzle, and mounting brackets. Water type extinguishers shall be painted in red.

2.3.4.2 Compressed Gas Types

These shall generally be CO₂ type intended primarily for Class 'B', Class 'C' and Class 'E' fires, being provided complete with Aluminum alloy body approved to BS5045 Part 3 or any other equivalent International Standard. Extinguisher shall also be supplied fully charged with the valve assembly, hose, mounting brackets, and discharge horn. Extinguishers shall be painted red with black band or black colored head cap, English screen, and generally comply with BS 3326 or equivalent.

2.3.5 Extinguisher Cabinets

Extinguisher cabinets shall be of stainless steel with glass-fronted doors. The color of the cabinet shall be red or suited to the requirements of architectural surroundings (to be confirmed by project manager, client, or consulting architect). Cabinets shall be weather proof with recessed latch type handle and approved by local authority having jurisdiction. Cabinets with single extinguisher should be of dimension no more than 190mm in width, 640mm in height, 180mm in depth. Cabinets with double extinguishers should be of dimension no more than 440mm in width, 640mm in height, 180mm in depth.

2.4 FIRE DETECTION & ALARM SYSTEM

2.4.1 Fire Alarm Panel

The system shall be of the conventional type fire alarm panel with two-wires connection to the detection and alarm devices such as sounders, manual call points, smoke detectors, heat detectors, and control devices. The panel shall be powered by 230V supply voltage and 50Hz frequency with appropriate wire size and insulation.

The control unit shall continuously monitor the status of all sensing devices, triggering action upon detecting fire, smoke, or heat. Alarm management shall be customizable on-site through the control panel using a keypad, ensuring adaptability even during power outages. The fire alarm panel shall establish communication with sensors and field devices, functioning as a microprocessor-based unit compliant with relevant NFPA standards. The panel shall facilitate easy monitoring and configuration through LED indicators, control keyboard, and an LED display.

A 16x2 character LED equipped with the panel shall allow for intuitive monitoring and programming through menu options. Alarm and fault indications shall be displayed by zone basis, with the ability to disable zones as necessary. Priority shall be given to alarm messages on the LED display, while all events—including alarms, faults, and disablements—shall remain visible.

Clear visual indicators, such as amber for faults and red for alarms, shall ensure easy identification of warnings. Audible signals shall offer tone variations to distinguish between different alarms. Outputs shall be available for audible alarms, control functions, and remote repeaters. The panel shall accommodate the required number of zones and shall be field-programmable to allocate sensors accordingly, providing flexibility to adapt to site conditions.

The panel shall also be supplied with 24 hours capacity battery backup (battery charger shall be integrated with the panel). The battery and charger shall be monitored and any failures shall be indicated on the panel's LED display or relevant LED indications.

At a minimum, the following LED indicators shall be provided.

- System ON
- AC Power ON
- Standby ON
- Hooter Fault
- Silenced
- Zone wise Fire
- Zone wise Fault
- Zone wise Isolate
- Battery Fault

The panel's LED display must be able to display the following information simultaneously.

- Type of alarm (Fire/ Fault)
- Alarm count
- Total number of alarms
- Total number of Faults

The panel shall also have the following keyboard functionality.

- Numeric keyboard
- System reset button
- Silence alarm button
- Menu button
- Enter button
- Left / Right Arrow button

The following zone circuit specifications shall be implemented for initiating devices.

- All zones are Class B wiring supervisory
- Normal Operating Voltage: Nominal 24 VDC
- Alarm Current: 20 -35mA threshold
- Short Circuit Current: 40mA Maximum
- Loop resistance: 50 ohms Maximum
- End-Of-Line Resistor: 4.7K, 1/4watt
- Standby Current: 6.8mA (2.4mA for Detectors)

The following zone circuit specifications shall be implemented for notification devices.

- Class B wiring Supervisory
- Operating Nominal Voltage: 24 VDC
- Hooter (NACs) output: 1 Amps.
- End-Of-Line Resistor: 4.7K, 1/4watt

2.4.2 Optical Smoke Detectors

Provide and install optical smoke detector as indicated on drawings for detecting slowly developing fires incorporating an infrared emitter/sensor combined to give maximum effect. Detector should be capable of switching to an alarm condition when a predetermined level of particle presence is attained. Sensitivity setting should meet BS-5445 and detectors tested to UL requirement. The detector shall incorporate LED indicator and latches on alarm. It should be compatible within voltage range of the fire alarm control panel.

2.4.3 Ionization Smoke Detectors

Provide and install ionization smoke detector as indicated on drawings, to detect visible and invisible by-products of fire at the earliest stage. Low radiation source of 0.7mc tested to UL217 requirement with dual chamber ionization smoke sensor with sensitivity standards meeting BS-5445.

2.4.4 Heat Detectors

Provide and install heat detectors with combined functionality (fixed and rate of rise) as indicated on drawings, to detect changes in temperature. The detector shall be UL approved with a fixed temperature rating of 59 °C and rate of rise of 11.1 °C/min.

2.4.5 Manual Call Points

Provide and install manual call points as indicated in drawings or as appropriate. Call points shall have resettable plastic element and clear lift-up flap for security and manufactured to IP66. The device shall have a LED to indicate alarms, and manufactured of ABS type and red in color.

2.4.6 Conventional Sounders

The conventional type sounders shall conform to the relevant standards and have an audibility level of minimum 85 dB. The device shall be built with ABS type plastic and red in color. It shall be UL listed and have the capability of being tested from the FACP.

2.4.7 Sounder with Strobe

The sounders with strobe lights shall conform to the relevant standards and have an audibility level of minimum 75 dB at 1 meter distance. The strobe shall have four luminous intensity levels at 15, 30, 75, 1120 candela flashing capacity at 1 Hz for visual indications. The device shall be built with ABS type plastic and red in color. It shall be UL listed and have the capability of being tested from the FACP.

2.4.8 Batteries

The battery shall have sufficient capacity to power the fire alarm system for not less than two hours during an alarm condition and at least 24 hours in normal condition. The batteries shall be maintenance free and of lithium-ion type.

2.4.9 Cables

All cables and conduits shall be laid on wall, hangers, and ceiling where necessary and as required by local authority and manufacturer specifications. The cables shall be FRLSH (Flame Retardant Low Smoke & Halogen) type of appropriate size and twisted copper conductor conforming to the relevant NFPA or BS standards. The cables shall be properly terminated and appropriately labelled.

3 PLUMBING TECHNICAL SPECIFICATIONS

3.1 SCOPE OF WORKS:

- a) Works under plumbing works shall include solely on all water and sewerage trade works which includes water distribution, sewage collection and conveyance, venting system, AC and Storm water drainage system, tanks, pits, and plumbing fixtures installation.

3.2 PURPOSE

- b) The purpose of this specifications is to set a minimum acceptable standard and reference to safeguard and protect life and properties from the potential dangers associated with supplying potable water to plumbing fixtures and outlets and the conveyance of bacteria-laden wastewater from fixtures.

3.3 GENERAL

- a) Preferred standard to be followed would be International Plumbing Code (IPC) which is a model code that regulates the design and installation of plumbing systems including plumbing fixtures in all types of buildings.
- b) Soil and waste water from kitchens and bathrooms are discharged into a fully vented stack system before running off to the Sewer Treatment Plants.
- c) Fabricated fittings shall not be permitted in sanitary system.
- d) Vent pipes shall be as per BS EN Standard or ASTM standards or compliant with codes stipulations of the IPC.
- e) UPVC pipes and fittings to BS, ASTM or IPC standards with sound barrier insulation (whenever required) subject to discussion and approval of the Consultant.
- f) Storm drainage pipes shall be BS EN, ASTM or IPC Standards.
- g) All drains on surfaces not intended for promenade should have dome strainers; others should have flat strainers with free area equal to twice the outlet area.
- h) All pipework materials shall be new, free from defects and conforming to the standards as specified below.
- i) Piping Installations
 - i. Install hangers and supports at intervals specified in the applicable Plumbing Code and as recommended by pipe manufacturer.
 - ii. Support vertical piping at each floor and as specified in the applicable Plumbing Code.
 - iii. When installed in systems with pumps in excess of 7.5 HP, piping shall be protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method

shall be a temperature relief valve or comparable level of protection, set to a maximum temperature of 185°F.

- iv. Drawings are diagrammatic and indicative of the work to be installed. Routing and arrangement of piping shown are subject to modifications as required to suit site conditions and to avoid interference with the work of other trades. Allow in the tender cost for reasonable offsets as may be required.
 - v. Gravity pipework shall be installed with correct falls to ensure adequate venting and draining.
 - vi. For sanitary drainage pipework of the socket and spigot type, cleaning eyes shall be provided at bends, tees and other fittings and access openings shall be provided at the lowest accessible point of pipes. The access openings shall be sealed with a rubber or synthetic washer and secured by bolts.
 - vii. All pipework run in wall chases, recesses, pipe shafts etc., shall be carefully examined and tested prior to cover-up.
 - viii. Piping shall be run straight and run parallel with the walls and other piping.
 - ix. During construction, all open ends shall be plugged to prevent ingress of dirt and on completion, each system shall be thoroughly flushed out with clean water.
 - x. Provide pipe sleeves where pipes pass through walls and floor slabs.
 - xi. All pipes and fittings shall be thoroughly cleaned before installation and any burrs removed.
 - xii. Pipe off-cuts shall not be used to fabricate length of pipes or other fittings. Standard manufacture fittings are to be used in all cases
- j) Installation of Sanitary Fixtures:
- i. The drawings only indicate the approximate positions of sanitary fixtures, exact positions are to be approved by the Architect before the fixtures are finally set in position.
 - ii. The Contractor will be responsible for setting all fixtures in their respective positions. The Contractor is responsible for fixing all fixings to fixtures, i.e., pillar taps, waste outlets, overflow outlet, plugs and chains, cisterns, flushing pipes, outlets, etc.
 - iii. The Contractor is to set all basins, sinks, urinals and cisterns and water closets (WC) in final positions and fix rigidly to the floor or wall by screw fixings into raw bolts.
 - iv. The Contractor shall supply all white cement, mortar, lead plugs and other accessories materials, cut and pin or raw plug, brackets and make all connections to water supply services, overflows and wastes.

- v. Compression couplings to connect copper water tubing to pillar taps bib taps, stop valves, etc. compression couplings or soldered capillary jointed couplings to connect wastes and overflows and connections to polyvinyl chloride tubing are to be provided by the Contractor.
- vi. Water closet pan connections to cast iron, pipes are to be made with Butyl compound. Waste outlets to lavatory basins, sinks, baths and showers are to be embedded in walls, floors or unless stated otherwise.
- vii. The Contractor shall supply and install flushing tail pipe in UPVC pipes connecting the automatic flushing cistern to the urinal spreader supplied by Nominated Supplier. The tail pipes shall be chased in wall for a complete concealed installation.
- viii. The wall closets and urinals shall be fitted with automatic sensor operated flush valve system. Every flush valve shall preferably be concealed with only the activating sensor exposed to the user. Every flush valve shall be corrosion resistant. All exposed surfaces shall be bright chrome plated or in stainless steel. The Contractor shall do necessary wiring from nearest power point to the sensors.
- ix. The Contractor shall submit fixing proposal to the Architect for review before commencement of work.
- x. Recommended brands for sanitary fitting are KOHLER and Tap fitting GROHE with suitable models for high luxury apartments.

3.4 COLD WATER SUPPLY

- a) Size piping and equipment to include future anticipated loads and to provide for normal flexibility in rooms & common areas.
- b) All valves shall be accessible for equipment maintenance.
- c) Provide mains with sectionalizing valves at strategic locations per toilet so that it can be isolated independent. In buildings, where practical, loop mains and generously provide them with sectionalizing valves. Valve all connections for future extension.
- d) Peak flows in the piping should be calculated and the pipe sized by using fixture units and the proper friction curves and tables for the proper material.
- e) In providing water connections to the equipment, the connection should be as large as the connection on the equipment or larger if required to deliver the flow rate (GPM) required with reasonable pressure loss.
- f) Provide all fixtures and equipment requiring water with water in adequate quantities and at required pressures.
- g) Size each service for the full demand of the building.

- h) All water systems shall be included back flow prevention device.
- i) The cold-water system must be designed to provide a 2.5Bar and a maximum pressure as per manufacturer pressure at any plumbing fixture. Water velocities in the piping system should not exceed 2 m/s for quiet operation and where quick closing valves are installed, shock absorbing devices, must be added to prevent water hammer.
- j) Provide hose bibs in all machinery rooms, Landscape areas with floor drains whenever required. All hose bibs should be provided with vacuum breakers.
- k) Use cold water as potable since cold water is being chlorinated periodically.
- l) Pipe and Fittings for Cold and Potable Water Supply
 - i. Cold and potable water distribution pipes should be in uPVC pipes Class C for Risers & Horizontal piping. Pipes shall conform to ISO-4422 or ASTM D 1784/85 and shall be installed in accordance with the manufacturer's guidelines. All jointing for shall be solvent welded joints. The pipes shall have an integral socket end designed by the manufacturer.
 - ii. Solvent cement shall conform to ISO 8588:1987 or BS 4346 and shall be mixed in strict accord with the manufacturer's instructions. Any impurities in the cement shall be cause for rejection. Data on the pot life of the cement shall be approved by the Engineer.
 - iii. Use pipe and fittings of the same material but of not equal brand is prohibited. Any deviation from or alternative materials must be approved by the Engineer prior to placement of orders.
 - iv. Testing of pipes and fittings shall be carried out in accordance with ASTM or equivalent standard such as BS EN EU or JIS. Other standards not mentioned herein is not accepted. Each pipe and fitting shall be tested under an internal hydrostatic pressure of not less than 118 Pa for the duration of 60 seconds. The Contractor shall furnish test certificates of tests carried out for quality control during the manufacture of the pipes in accordance with ISO-4422 and Appendices A to E of BS 3505:1986 and shall, if required by the Engineer, undertake such additional tests as the Engineer considers necessary.
 - v. The use and installation of unplasticized PVC pipework shall comply with the relevant provisions of ASTM and BS Standards. Solvent welded joints and fittings for PVC-U pipes shall comply with the relevant provisions of BS 4346: Part 1. Mechanical joints and fittings for PVC-U pipes shall comply with the relevant provisions of BS 4346: Part 2 or equivalent ASTM.

3.5 SOIL, WASTE, VENT AND DRAINAGE PIPES

- a) Internal soil and waste pipes shall rigid uPVC pipes conforming to BS 4514, BS EN 1401 & BS EN 1329 or equivalent ASTM standards, installed complete with standard molded fittings. It shall have the wall thickness and stiffness to satisfy SDR 35/41 classifications.
- b) Blue colored pipes shall not be accepted for use in conventional sewage, waste, vent and drainage (SWVD) line or systems.
- c) The soil branch that will directly receive waste from water closet shall be short and direct as practicable. It should be tight and free from liquid/gas leakage. Installation workmanship shall be strictly in accordance with the standard practice of the trade involve. All soil pipes shall be anchored rigidly by any means of metal hangers.
- d) Do not use short radius fittings on a vertical to horizontal directions or horizontal to horizontal changes. Use long sweep fittings on horizontal changes. For vertical to horizontal changes, the wye and 45° fittings are most appropriate.
- e) The ideal and recommended slope for horizontal piping is 1% or 2%.
- f) Connections from basins, sinks, etc., to floor traps shall be uPVC pipe. All fixtures shall be provided with a trap seal. Traps shall not be placed more than 1.50-meter pf horizontal developed length. The line distance should be measured along the central line of the waste pipe or soil pipe from the vertical inlet to the trap to vent opening.
- g) No trap shall be less than 38mm diameter. The vent pipe shall be of the same diameter size as the waste pipe. All vents and branch vent shall be free from drops or sags and shall also be graded and connected so as drip back water to the soil or waste pipe.
- h) The seal of the trap shall be 75mm deep minimum, and shall be of the anti-symphonic type. Vent and anti-syphon pipes shall be UPVC pipes Type 600 (PN 6) up to and including 65mmØ. Vent pipes shall rigid UPVC pipes to Type 600 for 75mmØ and over.
- i) All roof extensions of soil or waste stack shall become a main or collecting vent stack and shall run full size at least 30 centimeters above the roof. Vent and waste connection shall be connected with the main soil vent at least 1.00 meter above the highest fixture branch.

3.6 ANCHORS AND GUIDES

- a) Anchors shall be positioned in association with change in pipework direction and expansion compensators such as to transmit the forces due to expansion and internal pressures to the ground or structure at appropriate points.
- b) Testing shall also be taken into account when designing anchors.
- c) All details and sizes of anchors shall be submitted for approval prior to installation.

- d) Guides shall be mild steel riders welded to the pipes on roller or sliding supports restrained with U-bolts on brackets.

3.7 PIPE PENETRATIONS

- a) Where pipes pass through internal brick or concrete walls or concrete floors, sleeves of PVC or other approved material of internal diameter at least 30mm greater than the outside diameter of pipes shall be built-in. The space between the sleeve and pipe shall be packed with suitable materials which will ensure water tightness and maintain the fire rating of the works and floors. Sleeves through floor slabs shall extend a minimum 20mm beyond the surface of concrete and shall be fitted with a continuously welded 50mm wide external flange located at approximately center of thickness of the slab. Pipes penetrating basement floor or wall shall be cast in or otherwise set in later in blocked out penetrations of sufficient size to accept the pipe with a puddle flange and made up on both faces of the penetration with an approved expanding grout to be completely water tight on completion.

3.8 PIPES THROUGH ROOFS

- a) Where pipes pass through concrete roofs, provide and fix 450mm x 450mm x 1.8 kg lead slates and collars for pipes, the slates being sandwiched between the layers of the asphalt or membrane roofing and collars bound to the pipes with galvanized screw clips.

3.9 PAINTING AND LABELLING

- a) Painting
 - i. Provide all paint, painting equipment etc. required for the painting of services. All plant and equipment including motors, pumps, hangers, brackets and supports etc. shall be painted.
 - ii. All metallic surfaces shall be wire-brushed and cleaned from rust, scale, dirt and grease and shall then be painted one coat approved priming paint, not less than two approved undercoats and approved high gloss finishing coat.
 - iii. The primer shall be red lead paint, the remainder oil paint.
 - iv. All paints to be heat resisting. Color for painting to be selected by the Architect and different colors will be selected for different items and locations. The type of paint to be used shall be approved by the Employer's Representative before use.
- b) Labeling and Identification
 - i. All plant and equipment provided under this Contract are to be labeled in English as to duty or services. All such labeling to correspond to schedules, diagrams etc. to be provided as part of the Record Drawings. Labels generally to be of 'Perspex' reverse engraved with red lettering, or as otherwise required by the Architect.
 - ii. The following refers to specific items requiring labeling:

- a. All valves, motor starters, distribution boards, control panels, isolators and pumps etc.
- b. Labels to be attached to valves (or pipe adjacent thereto) with a light gauge metal band.
- c. Control Panels, starters, etc. are to be labeled to indicate the circuit number, phase and item controlled.
- d. Provide color banding of pipework as advised by the Architect.
- e. The color bands are to be approximately 50 mm wide and paint stenciled to pipes or insulation at intervals not exceeding 3m. Additional bands are to be provided adjacent to valves, crossovers and elsewhere, where required for identification.
- f. At reasonable intervals on straight pipes and adjacent to valves, colored arrows are to be stenciled to the insulation or pipe work to indicate direction of flow. Where the finish is unpainted, metal bands and discs are to be fitted for color identification specified above.

3.10 ACCEPTED MANUFACTURERS

- a) The following is a list of manufacturers and/or brands of major items which are acceptable.
- b) Tenderers may submit equipment not listed herein but shall clearly identify all such equipment.
- c) Equipment and items not listed shall be of the best quality. Tenderers shall ensure that the equipment offered will suit the space available for their installation and servicing.
- d) Any variation in cost for structural, architectural and any other alterations necessary due to using equipment other than the core selection shall be paid for by the Contractor.

| | Equipment | Manufacturer |
|---|--------------------------------|---|
| 1 | Water Transfer & Booster Pumps | Grundfos Worthington KSB (Germany) |
| 2 | Sump & Sewerage Pumps | Grundfos KSB (Germany) Toyo |
| 3 | Pump Motor | Baldor Newman ASEA |
| 4 | UPVC pipes | Wavin EPCO uPVC Kubota Chemix APEX |
| 5 | Valves | Toyo Kitz Crane Showa |

4 AIR CONDITIONING & MECHANICAL VENTILATION TECHNICAL SPECIFICATIONS

4.1 GENERAL

The scope of the project covers the Design check, Supply, Installation, testing and commissioning of ACMV system for the specified project.

This section consists of the general rules that apply to the design, manufacture, shop testing, delivery to site, installation, commissioning, site testing, maintaining and handing over the material, equipment, plant and services required for the ACMV System of the project.

All equipment being supplied shall be suitable for operation under tropical conditions with ambient temperature up to 35°C and relative humidity up to 90% but not both simultaneously.

Tenderer must note that completeness of System for safe, smooth, trouble free operation and compliance with Local/International regulation is the sole responsibility of the Contractor i.e., the successful Tenderer. With this objective in mind, the Tenderer should include all the items essential for the efficient operation of the systems and other items which are required to complete the erection and foolproof commissioning of HVAC systems in respects. Whether the items are mentioned in the specification or not, all such items are treated/ considered to be included in the specifications.

The Contractor shall submit Shop drawings with showing all details of the installation including the equipment layout, size & routing of duct work, refrigerant piping, run of cable and any other information required by the Consultants.

The successful tenderer after award of work shall furnish submittals for various items incorporating complete technical details for the approval of the Consultants.

On completion, the installation shall be tested for conformity with the stipulated performance specifications. Any defect, shortcoming detected in the system/material/workmanship shall be rectified by the Contractor to the entire satisfaction of the Consultants without any extra cost to the Owner. The installation shall be tested again after the removal of the defects and shall be commissioned only after approval by competent inspecting authority or the Consultants and the Owner. All tests shall be carried out in the presence of the Consultants and Owner's representative.

The entire installation shall comply fully with all relevant requirements of governmental and local authorities and the equipment provided for the installation shall comply in all respects.

The tender drawings, which are enclosed herewith, shall serve as scope drawings. They indicate the general scheme of the HVAC system requirement. However, actual location, distance, levels, etc. will be governed by actual field conditions. The contractor shall check architectural, structural, water supply, drainage, false ceiling, lighting and other services plans to avoid possible installation conflicts

The contractors shall submit highlighted photocopy set of all the equipment /materials catalogues/specifications along with the tender.

4.2 BASIS OF DESIGN

Maldives has tropical climate with moderate summer and winter temperatures, hence space no heating have been considered, only cooling shall be provided.

The design condition is based on the ASHRAE fundamentals 2021 weather data. Following data shall be used to size the mechanical cooling systems

| PARAMETER | VALUE | DATA SOURCE |
|--------------------------------------|---------------------|-------------|
| Latitude | 4.1927N | ASHRAE |
| Longitude | 73.5281E | ASHRAE |
| Elevation | 2M Above mean level | ASHRAE |
| Peak summer Dry Bulb Temperature | 32.2 °C | ASHRAE |
| Mean Coincident Wet Bulb Temperature | 27.1 °C | ASHRAE |
| Monthly Mean Daily Temperature Range | 3.7 °C | ASHRAE |

4.3 REGULATIONS AND SHOP DRAWINGS

All work shall be carried out in keeping with the rules and regulations of the relevant local authorities and will comply with the latest codes of practice in this field. The minimum capacities, drawings and bills of quantities will serve only as a guide line.

The contractor will be totally responsible for the ability of the system to achieve the conditions set out in these specifications, and as such will have to provide shop drawings, for the approval of the Engineer.

The drawings prepared by the Consultants are indicative only of the general arrangement of the entire installation. The Contractor shall follow these drawings and specifications in preparation of his shop drawings and subsequent installation. He shall check the drawings of other trades to verify space for his installation.

The Contractor shall examine all relevant architectural, structural, plumbing, electrical and other services layout drawings before preparing the shop drawings for this installation, and report to the Consultants any discrepancy and obtain clarifications. Any changes found necessary for co-ordination and installation of this work with other services and trades shall be made with prior approval of the Architects/Consultants and Project Managers.

The Contractor shall submit shop drawing for the entire installation including installation details for all items required or asked for approval of the Consultant. Approved by the Consultant of shop drawing for any material, apparatus, devices and layout, shall not relieve the Contractor from the responsibility of furnishing same of proper dimension, size, quantity and all performance characteristic to efficiently perform the requirements and intent of the Contract Documents. Such approval shall not relieve the Contractor from responsibility for errors of any sort in the shop drawing.

If the shop drawings deviate from the contract Documents the Contractor shall advise the Consultants of the deviations in writing accompanying the shop drawings including the reasons for the deviations.

At the start of the Project the Contractor shall periodically and thereafter submit to the Consultants list of all shop drawings which will be submitted in the course of the project. The list shall show the disposition of each item including date of submission approval etc. The list shall be kept up to date through the entire course of construction. The Contractor shall co-ordinate the air conditioning installation with installation work of all trades involved in the project and avoid interference with lighting fixtures, piping, ducts, etc.

Vibration and noise control of equipment installed is of prime importance. The Contractor shall pay special attention to the problem of vibration and noise and is required to guarantee that the installation will not generate vibration or noise of the intensity to exceed the specified limits or cause annoyance to the occupants in the area.

4.4 ACMV SYSTEM

4.4.1 Air Conditioning System (VRV/VRF)

4.4.1.1 Air cooled- Condensing/compressor unit (Outdoor unit)

The outdoor unit shall be energy efficient and integrally built multiple type light weight with weatherproof construction (Factory assembled) suitable for balcony/roof top installation.

Air cooled VRF / VRV system working in R410A or equivalent refrigerant. The system shall be suitable to operate on single phase/ Three phase, 220-240V, 50Hz /380-415 V, 50Hz AC power supply & shall comprises with multiple no's of inverter digital scroll/screw compressors, air cooled condenser fan with motor, microprocessor control panel, starter controls for all scroll/screw compressors and condenser fan motors along with internal control and power wiring, cooling coil with internally interconnected refrigerant pipes, charging port and all other required accessories, & hardware's.

The outdoor unit shall have two screw/scroll compressors and be able to operate even in case that one of the compressors is out of order. The outdoor unit shall comprise of sub cooling feature to effectively use the entire coil surface through proper circuit/bridge in order to prevent flushing of refrigerant owing to large length of piping. The entire unit shall be with anti-corrosive and weather resistant powder coating paint for withstanding all ambient conditions for continuous outdoor operation.

The compressor shall be highly efficient screw/scroll type with a COP of more than 3.5 and capable of inverter control. It shall change the speed in accordance to the variation in cooling or heating load requirement: All outdoor units shall be designed for automatic capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed. Oil heater shall be provided in the compressor casing.

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form across fin coil. The aluminum fins shall be covered by anti-corrosion resin film. The unit shall be provided with necessary number of direct driven low noise level propeller type fans with digital controlled motor arranged for vertical discharge. Each fan shall have a safety guard

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valve at condenser end. All necessary safety devices shall be provided to ensure safe operation of the system. Following safety

devices shall be part of outdoor unit; high pressure switch, fuse, crankcase heater, fusible plug, over load relay, protection for inverter, and short recycling guard timer. Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths. The system shall have the capability to control the refrigerant temperature based on the variable heat load value automatically

All interconnecting piping, joints and U bends within the condensing unit shall be painted with two coats of clear transparent polymer coating for protection against corrosion from ambient air pollution. Two coats of protective coating shall be applied. Each coat shall have dry film thickness of 35 micron or more. The coating shall be strong, flexible and durable. It shall have good adhesive and abrasion resistance. It shall be resistant to moisture, UV, acid, alkali and other chemicals and capable of functioning between -250 C and 1500 C. The polymer shall be obtained by the mixing of base or monomer with a hardener or polymerizer. It may brush applied or with the use of a suitable gun.

4.4.1.2 Cassette Unit

The cassette units Suitable for install between the bottom of finished slab & top of false ceiling. The unit must have in built drain pump, suitable for vertical lift of 750mm. The unit casing shall be Galvanized Steel Plate. and must be insulated with sound absorbing thermal insulation material, Poly urethane foam.

Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit. The unit shall be supplied with suitable decorative panel flush with the ceiling matching interiors. The unit shall be supplied with wall mounted controller, wired remote, direct drive/ belt drive, remote controllable minimum 3 (three) speed turbo fan, self-closing 4 motorized vanes. It shall have an LED display with Status and Temperature display and operatable on Remote.

The unit shall be supplied with Resin Net filter with Mold Resistance. The filter shall be easy to remove, clean & reinstall. The unit will be connected in series to a suitable outdoor unit & it must be possible to operate the unit independently, through corded/cordless remote. The unit should be further connectable to a third-party Intelligent Building Management System & it shall be possible to operate the unit through the BMS system.

4.4.1.3 Air Filtration System

Air filtration system comprising of primary filter shall be provided for fan coil units (FCU). The filter media consists of high density, micro fine, glass fibre shall be of non-combustible throughout or with exposed surfaces of Class O flame spread rating and shall not generate toxic gas when subject to heat or fire. Each filter section shall be capable of handling the specified air quantity with face velocity not exceeding 500 FPM and its performance characteristics shall meet the requirements of ASHRAE 52-76.

Filters shall be installed in accordance with manufacturer's recommendations complete with all accessories necessary for their proper performance. Air filter connections to adjoining equipment, paneling or support framing shall be sealed airtight to ensure that no air bypasses the filter media. The filter assembly shall be easily accessible for inspection, maintenance and removal.

Filter housing shall be factory fabricated and assembled of 16-gauge galvanized steel. Framework shall be sturdy galvanized steel angle members. Each housing shall be complete with two access doors, tracks, holding frame and pressure differential sensing device.

4.4.1.4 Controls

Entire system shall have Microprocessor Controls. Microprocessor should have Auto Check Function to indicate Piping and cabling errors. Microprocessor should control speed or switching or by pass of Compressors, Condensers, Fans, and liquid management Functions along with the system for proper oil return and stable and safe operation of system.

4.4.1.5 Wired / Cordless Remote Controller

Wired / Cordless remote controller shall be supplied. The controller must have large crystal display screen, which displays complete operating status. Remote shall be able to individually program by timer the respective times for operation start and stop within a maximum of 72 hours Remote must be equipped with thermostat sensor in the remote controller that will make possible more comfortable room temperature control the remote shall be able to monitor room temperature & preset temperature by microcomputer & can select cool/ heat operation mode automatically.

4.4.1.6 Individual DX System

The individual DX air conditioner (single split type) shall be composed of wall mounted type indoor unit with inverter type outdoor unit. The wall mounted unit suitable for wall hang and comprising of DX Cooling coils, blower, electric motor, insulated sandwiched drain Tray, junction box for electrical connections, HDPE washable filter. wall mounted wireless remote control. The unit shall be supplied with remote controller, direct drive, minimum 3 (three) speed turbo fan, motorized vanes. It shall have an LED display with Status and Temperature display and operable on remote

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panel and coated with backed enamel finish. The outdoor unit shall comprise of compressor, condenser coil, fan motor, drive casing, supporting stands etc. The unit should be completely factory wired with all necessary control and switch gears. Refrigerant pipe shall connect the outdoor units to indoor unit with copper pipe and refrigerant shall be environmentally friendly type R32/R410A or similar.

4.5 REFRIGERANT AND CONDENSATE PIPEWORK

The drawings are indicative only, positions of the Pipes shall be finalized after coordinating with other services and architectural plans. All pipes shall be installed generally as per the drawings and in strict accordance with approved for construction shop drawings prepared by the contractor.

4.5.1 Refrigerant Pipework

Refrigeration systems should comply with ASHREA 15 and ASME B31.5.

The copper tubing should be confirmed to ASTM 280/BS 2871 and ASTM B68. The refrigerant piping shall be carefully sized with necessary headers and should consist of accessories including Y-joints.

The copper tubing shall be super clean quality with low residual content below the permissible level of 0.038 gm/sqm for compatibility with use of CFC-free refrigerant. Tubes shall be 100% Eddy Current tested

The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits. All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturers specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed there on.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using dry nitrogen at pressure of minimum 580 PSIG. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum of 700mm hg and held for 24 hours. All refrigeration pipework shall be pressure tested to evacuated and dehydrated to 736 mm Hg. +/- (2-1/2) % and charged with refrigerant

The whole refrigeration pipe lines including gas suction line, all fittings, valve and strainer bodies, flanges, etc., shall be insulated with minimum 19/25mm thick closed-cell elastomeric thermal insulation.

The insulation material shall be confirming to ASTM C534 and comply with the requirements of NFPA 90A and NFPA 90B standards. Thermal conductivity shall be 0.04W/m K at 0°C max. and Water vapor permeability 0.065ng/Pa. s.m max.

Insulation materials shall be manufactured without the use of CFCs, HFCs, or HCFCs and also be free of formaldehyde, fibers and dust. All surfaces over which the insulation is to be applied shall be dry and grease free.

4.5.2 Condensate Pipework

All drain and air vent pipework shall be PVC/UPVC with insulation. All drain pipes shall be connected to a separate main line or connected to waistline. U Trap shall be provided in the drain piping (wherever required).

4.5.3 Pipe installation

- a) All pipework's shall be so installed and supported so that it is free from excessive stressing due to its own weight and its contents, equipment vibration or movement, and thermal movement.

- b) Care shall be taken to achieve a neat installed appearance. All pipes and fittings shall be cleaned before erection and free from scales, burrs, sand and other foreign matters.
- c) Sufficient unions or flange joints shall be allowed for satisfactory removal and reassembly of equipment, valves fittings for inspection or repair.
- d) All pipes shall be laid to correct fall for venting and drainage. All high sections of pipework where air may collect shall be provided with an automatic air vent and drain provided at low point of horizontal run.
- e) Piping shall be run in ducts, cavity walls, within ceiling spaces or through floor slabs. The Contractor shall ensure that spaces between pipes and pipe penetrations through floors, walls or ceilings are properly sealed
- f) All open ends of pipework during erection shall be blanked off by a metal or plastic cap.
- g) Where possible, pipes shall be grouped on pipe racks made up of shaped steel frames securely fixed to walls, ceilings or beams. The pipes shall be supported by saddles or rollers, bolted to the racks.
- h) Pipe hangers or supporting brackets shall be isolated to prevent transmission of noise and vibration to the building, especially at situations where these are connected to pumps and other sources of vibration, spring or rubber in shear hangers shall be used.
- i) All supports for pipe shall be ferrous when electrolysis may occur between copper pipes and steel supports, the latter shall be fixed in the copper tubing using an insulating material (neoprene, PVC, etc.,) to avoid direct metal contact. Hangers for pipe runs shall be of adjustable steel clevis type, or other approved design hung on round steel rods. Brackets or clamps may be used where pipe lines run along walls, columns or ceilings.
- j) All refrigeration pipe work passing through walls and concrete floor slabs shall have P.V.C. sleeves of minimum 3mm thickness for the full depth of the wall and/or floor
- k) Maximum pipe length shall be as per equipment manufacturer recommendations
- l) Aluminum cladding or two layers of 25mm thick insulation with poly-shield coating over the insulation for the exposed refrigerant pipe work on roof.

4.6 AIR DISTRIBUTION SYSTEM

The drawings are indicative only, positions of the ductwork, grilles and diffusers shall be finalized after coordinating with other services and architectural plans. All ducts shall be installed generally as per the drawings and in strict accordance with approved for construction shop drawings prepared by the contractor. The materials, construction features, manufacturer, inspection, testing and performance of air distribution system shall comply with all currently applicable statutes, regulations, codes and standards in the locality where the system is to be installed. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

4.6.1 Sheet Metal Ductwork

- a) All duct construction, installation, and commissioning shall be in accordance with SMACNA standards. Ducting shall be fabricated from Galvanized steel sheet (GSS). GSS duct shall be Factory Fabricated zinc coated with 120 gsm or better and conforming to BS 2989 or ASTM A653A, 653M, G90 (Z275). The galvanizing shall be carefully done and the sheets shall be of such quality that they may be bent flat on themselves with no fracture to the coating or the base metal.

- b) All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
- c) Longitudinal seams at Corners / Folded edges only to obtain the duct rigidity and low leakage characteristics. No longitudinal seams permitted along any side of the duct.
- d) All edges to be machine treated using lock formers, flanges and rollers for turning up edges.
- e) All the transverse duct connectors (Flanges/Cleats) and accessories related hardware such as support system shall be zinc coated (galvanized).
- f) All circumferential joints shall be GI angle flanged joints.
- g) For transverse angle flanged joints, neoprene gasket (minimum 3mm uncompressed thickness and width equal to flange face) adhered to the flange face shall be used. The bolt holes in gasket shall be the same as bolt diameter and shall be punched prior to insertion of gaskets
- h) All flanges shall be factory fabricated slip-on Galvanized Steel
- i) Ductwork shall be provided with flanged connections in plant rooms to allow for easy removal for future replacement of equipment.
- j) All exposed ducts within conditioned spaces shall have only slip joints and no flanged joints. The internal ends of slip joints shall be made in the direction of air flow.

4.6.2 Construction Features

| LARGER SIDE OF DUCT mm | THICKNESS OF SHEET mm/G | | TYPE OF TRANSVERSE JOINT | TYPE OF REINFORCEMENT |
|------------------------------|----------------------------|-----------|--|--|
| | GSS / SS | AL | | |
| Up to 250 | 0.63 / 24 | 0.80 / 22 | 25x25x3mm GI angle flanged joint | -- |
| 251 to 750 | 0.63 / 24 | 0.80 / 22 | 25x25x3mm GI angle flanged joint | 25x25x3mm GI angle @1250 mm c/c. |
| 751 to 1000 | 0.80 / 22 | 1.00 / 20 | 25x25x3mm GI angle flanged joint | 40x40x3mm GI angle @ 1250 mm c/c. |
| 1001 to 1500 | 0.80 / 22 | 1.00 / 20 | 40x40x3mm GI angle flanged joint | 40x40x3mm GI angle @ 750 to 800 mm c/c. |
| 1501 to 2100 | 1.00 / 20 | 1.25 / 18 | 40x40x3mm GI angle flanged joint | 50x50x6mm GI angle @ 750 to 800 mm c/c. |
| 2101 to 2400 | 1.25 / 18 | 1.50 / 16 | 65x65x6mm GI angle flanged joint | 65x65x6mm GI angle @ 750 to 800 mm c/c. |
| Greater than 2401 | 1.25 / 18 | 1.50 / 16 | 50x50x3mm GI angle flanged joint with tie rod(s) of 10 mm dia. | 50x50x3mm GI angle @ 750 to 800 mm c/c with the rod(s) of 10mm dia, evenly spaced along reinforcing angle, spacing not exceeding 1500 mm. |

All Longitudinal seams shall be Pittsburgh lock type at corners as shown on sheet. Longitudinal joints shall not be provided for rectangular ducting at locations other than corners, except where larger side of duct exceeds 2500mm. Longitudinal joints of ducting having side larger than 2500mm other than corner shall be grooved or standing seam.

All circumferential joints shall be MS angle flanged joints.

Flanges used for transverse joints shall be joined with each other with Galvanized Steel (GS) bolts, washers and nuts. The bolts shall be of minimum M8 size and the spacing between bolts shall be maximum 150 mm for low pressure system and 100 mm for high pressure system.

For transverse angle flanged joints, neoprene gasket (3mm uncompressed thickness and width equal to flange face) adhered to the flange face shall be used. The bolt holes in gasket shall be the same as bolt diameter and shall be punched prior to insertion of gaskets.

All flanges shall be applied with two coats of zinc-chromate, silver or zinc paint. (Red oxide is prohibited)

4.6.3 Duct Supports and Hangers

Rectangular duct shall be supported from ceiling using trapeze hangers. Ducts shall rest on supporting painted Factory-made GI Slotted channel and this supporting angle or slotted channel shall be supported by CS rods on both sides of ducts with weld or bolts.

| LARGER SIDE OF DUCT mm | SUPPORTING ANGLE mm | VERTICAL ROD DIAMETER mm | MAXIMUM SPACING BETWEEN SUPPORTS mm |
|-----------------------------------|--------------------------------|-------------------------------------|--|
| Up to 900 | 40x40x6 | 10 | 2400 |
| 901 to 1500 | 40x40x6 | 10 | 2400 |
| 1501 to 2400 | 40x40x6 | 10 | 2400 |
| 2401 and above | 65x65x6 | 12 | 2400 |

4.6.4 Duct Installation

The contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. This work shall meet with the approval of the Architect/Consultants in all its parts and details.

All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the buildings, whether or not the same are shown on the drawings. Where it becomes necessary to avoid beams or other structural work, plumbing or other pipes, and or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained as approved or directed by the Architect/Consultants.

If a duct cannot be run as shown on the drawing, the contractor shall install the duct between the required points by any path available, subject to the approval of the Architect/Consultants.

Ducting on top of the ceiling shall be supported from the slab above, or from beams with the help of adequate strength dash fasteners, after obtaining approval of the Architect/Consultant. In no case shall a duct be supported from the ceiling hangers or be permitted to rest on a hung ceiling.

All metal work in dead or closed down spaces shall be erected in time to occasion no delay to other contractors in the building.

All ducts shall be totally free from vibration under all conditions of operations. Whenever duct work is connected to fans, that may cause vibrations in the duct, ducts shall be provided with two flexible connections located close to the unit in mutually perpendicular directions.

Flexible connection shall be constructed of fire resistant flexible double canvas sleeves at least 100mm deep, secured properly and bolted at both ends. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.

The two mating flanges of the ducts being joined with each other shall be made air tight by providing Minimum 3mm thick foam rubber insertion fixed on both mating flanges by means of good quality adhesive. Rubber strip shall also be provided between bottom surface of duct and angle iron at each duct support to avoid metal to metal contact

Insulated flexible ducts shall be provided to connect the supply air ducts to all air delivery devices such as grilles and diffusers. The length of the flexible duct shall not exceed 1.5 m. The airflow velocity through the flexible duct shall not be more than 3.0 m/s.

4.6.5 Flexible Connections

Flexible connections shall be fitted at all expansion and settlement joints in the building structure, equipment connections, inlet and outlet of all supply and exhaust fans, on fan coil units where these connect to ductwork, and at all sound attenuator connections.

Flexible connections shall be renewable without dismantling the ductwork which shall be suitably supported adjacent to all flexible connection shall be designed for the air pressure involved. They shall generally have a length of 100 to 150 mm and shall also reduce noise breakout by having a mean sound reduction index of not less than 22 dB in the 100 to 3200 Hz range.

Flexible connections shall be constructed from neoprene material of approved type and insulated with foil back 25 mm thick fiberglass blanket.

Joints shall be installed to ensure careful alignment of adjacent joints and to prevent air leakage. Each flexible connector shall be fastened tautly to matching flanges by 2 pieces of adjustable clips/clamp bands.

In critical location where noise breakout must be controlled, special joints having the correct sound breakout alternating properties must be used.

For ambient air temperatures, flexible connectors shall be of loaded PVC on a jute base, approximately 3 mm thickness and having surface density not less than 5 kg/sq.m.

For high temperature or smoke extract application, fire retardant type flexible connector shall be fitted. They shall be made from loaded PVC on woven asbestos base, of a minimum 3 mm thick and rated Class 2 when tested to B.S. 476 Part I, 1953 surface spread of flame. Manufacturer test certificate be provided on request.

4.6.6 Volume Control Dampers (VCD) and Splitter Damper

All dampers shall be multiblade type of robust construction of galvanized steel and tightly fitted. The design, method of handling, and control shall be suitable for the location and service required.

Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation control or setting devices shall be made robust, easily operable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.

Dampers shall be placed in ducts and at each supply air collar, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

Splitter dampers shall be fabricated of minimum 18G GSS and shall be of robust construction. The position of splitter damper shall be adjusted by use of the splitter rod.

VCD shall be fabricated of minimum 16G/18G Aluminum/Galvanized sheet and shall be of robust construction. VCD shall be single blade type for round duct and opposed blade type for rectangular duct. VCD shall have a locking device mounted outside the duct to hold the VCD in a fixed position without vibration. Fully open and fully closed position shall be marked for easier operation of VCD.

Motor operated VCD fabricated with 16G/18G Aluminum/Galvanized sheet shall be provided, if specified. Actuator for dampers shall develop sufficient torque for easy operation of VCD. Necessary spindle to fix actuator to be provided. The damper shall be operated with white hard PVC gears. The gears shall be covered with sheet cap to prevent leakages.

Manually operated damper shall be provided with adjustable locking quadrant of approved manufacture. After balancing, has been satisfactorily completed, the position of each damper lever is to be locked. The vapor seal on the ductwork shall be suitably protected by 16g galvanized steel plate to avoid damage by an adjustable quadrant in the immediate vicinity of the locking quadrant.

VCD shall be provided with Teflon or brass bushing for blade shaft. Motor operated VCD shall be provided with Teflon bushing or sealed ball bearing for blade shaft.

All dampers shall be capable of performing their service without causing vibration or noise. Splitter dampers shall be provided with fully adjustable locking quadrants with the "open", "normal", and "closed" positions clearly marked

4.6.7 Back Draft Damper (BDD)/Non-Return Damper (NRD)

All Back Draft Dampers should of robust construction with multi blade construction with necessary duct GI flanges for duct connection. The outer casing shall be made out of 1.6mm thick GI welded frame should be suitable for flange connection.

The blade should be made with flat type with necessary groove with minimum of 0.63mm.GI sheet / 1mm thick Al. sheet as required. The blade should be with galvanized steel spindle, provided with self-lubricating sintered bronze bushes.

The blade should open on one direction towards air relieving side only when the air pressure built on other side. Required stopper with gasket to provide to ensure the blade get closed tightly when there is no air movement or air pressure built on blade opening side. However, the blade thickness selection should be done by the supplier by knowing the maximum movement of air quantity and pressure to avoid any noise because of blade movement.

4.6.8 Air Diffusers/Grilles/Louvers

The Contractor shall provide and fix all necessary supply and extract diffusers and grilles as shown on the drawings. All fittings shall be capable of adjustment by means of a key operated opposed blade multi-leaf volume damper to achieve correct air flow and the design and type of fitting must provide correct air distribution, diffusion and air movement within the space served without creating objectionable noise, chatter and draft.

All diffusers, grilles, louver and registers shall be supplied completely extruded aluminum factory powder coated. Finish color shall be to the approval of the Interior Designer. All supply grilles and diffusers will have opposed blade balancing dampers. All will have foam rubber sealing band around the edge to seal to the structure

All diffusers shall be appropriately selected to meet the noise criteria of the space they are serving. Generally, two requirements are to be fulfilled:

If the diffusers are spaced far apart, each diffuser shall be selected with acoustic performance to meet the noise criteria of the space.

If the diffusers are spaced close to each other, group acoustic performance shall be considered for the selection in order to meet the criteria of the space.

4.6.8.1 Grilles

These shall be fabricated out of extruded aluminum sections. Flanges shall be of 1.3mm thick extruded aluminum. Louvers shall be of extruded aluminum sections 3.7mm thick at the front and 2.2 mm at the rear with suitable deflection strong enough to withstand site abuse during installation. The sample of grille shall have to be got approved by the consultants before delivery. The linear grilles shall be provided with removable/fixed internal core. All sections of linear grille shall be powder coated in color/shade approved by the Architects/Consultants. The linear grilles shall be fixed into a plenum chamber having GI spacers with concealed screws. End pieces or corner pieces shall be provided as required.

4.6.8.2 External Louvres and Bird/Insect Screen

These shall be provided unless otherwise shown in the Drawings, External louvres with fix insect screens for air intake and air exhaust shall be supplied and fixed by the Contractor. The screens shall be of suitable mesh and fixed in such manner so as to facilitate easy removal for periodic cleaning. The louvers at least 50mm deep will be made of powder coated extruded aluminum construction. The blades shall be inclined at 45 degrees on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door / wall on which it is mounted.

Air transfer grilles in extruded aluminum construction shall be provided at the door of pantry and toilets wherever required. The air transfer grille shall be complete with matching rear flange. The grilles shall be anodized or powder coated in color and shade as approved by the Architects/Consultants.

4.6.9 INSPECTION, TESTING AND BALANCING

After completion of the installation of the complete air distribution system, all ducts shall be tested for air leaks.

The ducts, branches, elbows etc. shall be inspected and the joints and connection shall be checked before these are assembled in position. After assembly the system shall be checked for tightness, vibration and noise.

All duct work not insulated shall be painted externally with one coat of primer and two coats of anticorrosive paint.

The air distribution system shall be tested and balanced so that the requisite temperature and air flow are maintained throughout the space to be air-conditioned or ventilated

All instruments required for testing and balancing of air distribution system shall be provided by the Contractor.

Complete air balance report shall be submitted for scrutiny and approval. Three copies of the approved balance report shall be provided with completion documents.

Splitter damper and VCD adjustments shall be permanently marked after air balancing is complete so that these can be restored to their correct position if disturbed at any time.

4.7 MECHANICAL FANS

Fans shall be carefully selected and be entirely suitable for their particular service, position of fittings and chosen with respect to corrosion, in flammability or other hazardous application. The fans shall be capable of handling the air quantity necessary for the specified system performance against the resistance of the system.

The resistance shown on the Schedules are for tendering purposes only and the Contractor shall be held responsible for checking the final system resistance before ordering the equipment. Fans shall be balanced and free from vibration. All fans shall have complete impeller assemblies including drive components, and statically and dynamically balanced to the following maximum allowable vibration criteria.

Performance test of up to 100% normal running speed shall be conducted. The rotor and pulley shall be further balanced on site to the approval of the Engineer. The rotors shall be selected for "QUIET" operation in accordance with the relevant British Standard Code, unless otherwise specified.

Fans shall be designed and constructed for continuous operation. All fans shall be fitted with engraved identification and directional labels giving full details of speed, h.p. pulley and belt sizes and type of

grease required and mechanically fixed where they can be easily seen and not subject to potential damage.

After manufacture, the casing, impeller shaft and belt guards shall be thoroughly cleaned and given two coats of "Anodize" anti-corrosive paint or other approved treatment. Filter shall be provided on fresh air purpose

4.7.1 Duct In Line Fans

In line duct fans, shall have non-overloading characteristics to suit the performance duty specified. In line duct fans, shall be of direct driven type. The fan blades shall be aerodynamically designed, backward/forward curved, constructed of aluminum plate and combining the impeller with the rotor of the external rotor motor.

Motors and impeller shall be factory matched and statically and dynamically balanced. Motors shall be suitable for operating in atmosphere of up to 95% and up to 40 deg. C.

The fan housing or casing shall be constructed in heavy gauge (1.4 mm minimum) mild steel with paint finish or epoxy powder coating and stored dried, and flanged at both ends for bolting direct to connection ductwork.

Inline fan shall have all accessories like fan, motor, 20-micron washable filter with frame [For fresh air purpose], flanges non-canvas type fire retardant flexible connections etc., The motor shall be with IP21 protection, class 'F' insulation.

4.7.2 Toilet Exhaust Fan

The fan shall be suitable for wall mounted/ceiling mounting and comprising of Automatic reverse flow shutter, condenser motor with thermal cut-off. The fan shall be energy efficient with low noise

4.8 TESTING AND COMMISSIONING

The contractor shall perform all the equipment and devices standard testing as directed by the consultant. The Contractor shall bear the cost for such tests and any items found defective shall be replaced at no extra cost. Such replaced items shall be re- tested for verification.

Testing and commissioning of the entire Air conditioning and Ventilation system shall be done in the presence of the consultant.

Each and every device & equipment supplied under this contract shall be tested for its functionality. The contractor shall submit a total test report on the system. The test report shall be approved by the consultant. All tests shall be to the satisfaction and witnessed by the consultant performed by qualified acceptable staff.

The Contractor shall guarantee all equipment and materials used in the whole installation from inherent defects for the specified duration of the Maintenance Period.

Testing shall be carried out in accordance with the relevant national standards, Codes of practice, applicable practices including ASHRAE: HVAC Application SMACNA: Manual for the Balancing and Adjustment of Air Distribution System

All the necessary instruments tools and tackles shall be provided by the contractor. The initial tests shall include, but not limited to the following.

- To operate and check the proper functioning of all electrically operated system components; compressors, condenser fans, evaporator fans etc. as well as the electrical motors.
- To test and check the proper functioning of electrical switch gears, safety and other control to ensure their proper functioning.
- To check the air distribution system and to provide design air flow in all areas by adjusting the grilles, diffusers, and dampers for proper temperature profile and submit to consultants the chart for such readings for approval and documentation.

The contractor shall provide all necessary tools, instruments, gauges, flow meter, anemometer, etc., as may be required for conducting the various tests. He shall also provide necessary lubricant etc., and adequate required personnel for the tests.

On completion of the contractor shall submit to the Project Managers 3 hard copies of Manufacture/Vendor list inclusive of Names, Address, Contact Numbers and Email etc. The Contractor shall submit 3 hard copies of Operation & maintenance Manuals, which shall contain Product literature, Specific operating instructions and Maintenance instructions.

5 ELECTRICAL SYSTEMS TECHNICAL SPECIFICATION

5.1 GENERAL

- a) The work shall be carried out strictly in accordance with the standard specifications and shall also conform to the requirements of Electricity Rules in force in Male', Republic of Maldives
- b) All materials to be used in the Works shall be of standard make and shall bear the certification marks of local authorities. All materials shall be approved by the Consultant before use in the Works.
- c) Earthing shall invariably be done in the presence of the Consultant or his representative.
- d) All the conduits shall be continuously earthed. Check nuts shall be provided at the point where the conduct enter the I.C. box and junction box.
- e) The Contractor shall arrange for the inspection of all Medium Pressure Installation by the Electrical inspector of the local electric supply authority from where the electricity connections have to be obtained, and see that they are passed by him.
- f) The Contractor shall be responsible for all necessary permits, approvals, fees, deposits etc., required to complete the Electrical works in accordance with the Contract.

5.1.1 Scope of work

The work consists of furnishing all tools, plants, labor, materials and equipment and performing the internal electrical Works (including installation, testing, and commissioning) comprising of:

- a) Light and power wiring
- b) Fans and fixtures
- c) Wires and Cables
- d) Telephone System
- e) Sub-Station Equipment's
- f) Distribution Switch gears
- g) Earthing System
- h) Lightning Protection System
- i) Fire Alarm System
- j) Air Conditioning System
- k) Computer Network Cabling outlet work

5.1.2 Prequalification

The Electrification Work shall be carried out only by a licensed contractor authorized to undertake such work under the Utility Regulatory authority (URA) of Maldives.

5.1.3 Qualification

A licensed Electrical Contractors should have the following qualifications:

- a) Must have in his employment a competent Electrical Engineer registered with Utility Regulatory Authority.
- b) Must have in its employment an Electrical Engineer or Consultant having certificate of competency who will exclusively supervise this work.
- c) Must have necessary tools, plant and instruments.
- d) Must have adequate experience of similar works.
- e) If the contractor does not possess the above qualifications, he shall be allowed to sublet the Work to a competent Sub-Contractor provided an application for his prequalification is made to the Consultant and/or Client for his approval. Decision of the Engineer in this case shall be binding on the Contractor.

5.1.4 Rules and Regulations

The installation in general shall be carried out in conformity with the regulations by the Maldives Utility Regulatory Authority, Electricity Rules, 1937 (UK), and the latest edition of the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers, London (I.E.). However, in case of conflict between these Specifications and the I.E. Regulations, these Specifications shall be followed and approval for such situations should be obtained from the Consultant and/or Client.

5.1.5 Standards

The latest relevant British Specifications, and I.E. recommendations shall be applicable and be followed for the equipment specified herein.

5.1.6 Climatic Conditions

All equipment supplied shall withstand, without developing any defect, the following climatic conditions:

| | |
|-----------------------------|---------------------|
| Maximum Ambient Temperature | = 113° F or 45° C |
| Minimum Ambient temperature | = 28° F or - 2.2° C |
| Maximum Humidity | = 98% |

5.1.7 Specifications

- a) The Contractor shall furnish all material and equipment at site, confirming fully to the specifications given herein and to the accepted standards, the Institution of Electrical Engineers and the Utility Regulation Authority Unit.
- b) It is not the intent of these Specifications to include all details of design and construction of various material and equipment to be supplied under this contract.

- c) The Contractor shall supply and install all material and equipment specified herein and also all installation and small material such as nuts, bolts, washers, shims angles, leveling material, insulation, tape, soldier, etc. and all such required for complete installation as intended by the Specifications.
- d) The contractor shall provide for all the required technical and non - technical personnel, skilled and non-skilled labor, construction equipment, transportation etc., as required for the completion of Work in strict accordance the Technical Specifications laid herein-after. All skilled workers specially for MEP and electrical works shall be well trained and shall be at least holding a training certificate to carry out any electrical related works to maintained proper installation and all MEP and electrical standards and satisfaction of the client.
- e) All electrical works and installation shall be under the direct supervision of license electrical engineers to obtained the proper execution of works and maintained the quality of works to required specification and consultant /client's satisfaction.
- f) All material and equipment supplied by the Contractor shall be new and within the standard as being required for installation and in all respects conforming to the high standard of engineering design and workmanship.
- g) All material and equipment which have to be supplied and installed by the Contractor shall be passed/approved by the Consultant; even if the same is exactly in accordance with the Bill of Quantities and Drawings. For Equipment's such as Generator sets, transformers, switchboards, synchronization Panels, Switchgears and other large machine shall be passed with Factory Acceptance testing under the direct supervision by the designated contractors, consultant or client representative prior delivery on site.
- h) All testing equipment such as Megger/Insulation Test devise, Grounding test kit, electrical phase sequence test kit, Data cables test kit and other related testing equipment shall be well calibrated by the lab test institute. The Calibration date and expiration shall be specified or labeled on each testing equipment.

5.1.8 Submittal

After awarding of works, the contractor shall submit all necessary documents for approval of the Consultant such as materials specifications, Catalogues, drawings, shop drawing, SLD and other related document and shall be clearly marked to indicate the item being furnished.

The Submittals shall include the following:

- (a) Shop Drawing
- (b) Materials and components Data sheets.
- (c) Material specification which includes the technical requirements and manufacturer statement for the life span of the product assembly.
- (d) List of tests performed and Test certification
- (e) List of proposed supplier and subcontractor for future usage in the project.
- (f) Preliminary method statement and Quality Plan
- (g) Summary of deviations which is not captured or reflect from the specification.

- (h) Report certification from authorized personnel or license electrical engineer.

5.1.9 Approval of Drawings and Data

The Contractor shall provide detailed electrical drawings and single line diagram, wiring diagrams for all electrical switch gears, Switchboards, fuse gear, Transformers, Control Panels, Generators and all other power systems for the Consultant to review and approval. Three sets of equipment drawings shall be provided for obtaining approval.

5.1.10 Drawings & Data

Three sets of drawings and data for each equipment shall be furnished by the Contractor for the Consultant approval before commencement of work. The drawings to be supplied by the Contractor shall be as follows: -

5.1.10.1 Electrical Drawings showing:

- a) Single-Line diagram
- b) Detailed wiring diagram
- c) All interconnections
- d) Relays, their locations, and internal wiring diagrams
- e) Other electrical devices including meters instruments and their wiring
- f) Lighting, power, and ELV layouts.

5.1.10.2 Shop Drawings

The design drawings do not show conduit routes and depict only the position of various fixtures and outlets. All the planning for the conduit and wiring routes shall be carried out well in advance of the actual execution of work by the Contractor to the satisfaction of the Consultant. For this purpose, the Contractor shall prepare all necessary shop drawings for all related works and submit to the Consultant for approval prior execution of works. The shop drawing shall include the following:

- a) Detailed shop drawings of Electrical Layouts
- b) Section and dimensions
- c) Detailed Single line diagram showing all necessary equipment, devices, wiring, enclosures and including rating, brand, specs and labels.

No piece of work shall be allowed to be executed at site without the confirmation and approval of all shop drawings as being mentioned.

Time required for the preparation and approval of shop drawings shall be considered to have been included in the total time allowed for the completion of the work.

5.1.10.3 Spare Parts list

A list of spare parts required for the one year's operation of each equipment where deemed necessary together with unit price of each part, shall be supplied by the contractor.

5.1.10.4 Guarantee/warrant

- a) The Contractor shall furnish written guarantee/Warranty in triplicate of the manufacturer for successful performance of each equipment. Such guarantee/ corticate shall be for replacement which may be found defective in material or workmanship.
- b) The guarantee shall cover a minimum period of 12 months effective from the date of completion certificate and shall be signed by the contractor managing director.
- c) The contractor shall submit all warranty certificate of each equipment being installed after the completion of the project.
- d) The Contractor shall furnish written guarantee/Warranty in triplicate of the manufacturer for successful performance of each equipment. Such guarantee/ corticate shall be for replacement which may be found defective in material or workmanship.
- e) The guarantee shall cover a minimum period of 12 months effective from the date of completion certificate and shall be signed by the contractor managing director.
- f) The contractor shall submit all warranty certificate of each equipment being installed after the completion of the project.

5.1.10.5 As-Built Drawings

- a) The Contractor shall do day to day as build drawing of all completed works and during the progress of work keep a careful record of all changes and revisions where the actual installation differs from that shown on shop drawings. These changes and revisions shall be accurately carried out on the shop drawings and submitted to the Consultant for approval. After approval these drawings shall become the property of the Project manager. These updated and approved shop drawings depicting clearly all changes and revisions made on site shall be called As-Built Drawings.
- b) All as build drawing shall be clearly and precisely done in accordance with the approved design and concept of the project.
- c) As built drawing shall include all the following parameters:
- d) Electrical plan layouts of (lighting, power and equipment's) inside and outside building
- e) Proper circuiting layout and labeling in accordance to the design layout, SLD and installations.
- f) All shop drawing shall be made by the designated engineer of each field. This is to meet the required and accurate as built drawing specially in Electrical Power System.

5.1.10.6 Test Reports

- a) The Contractor shall be responsible to conduct and submit the test reports/certificates of all installed electrical facilities such as equipment, Distribution boards, devices, Fixtures, cables and other related materials which requires testing and commissioning.

- b) All testing report shall be conducted with Initial and Final test and shall be signed and supervise by the designated contractor engineer and project management team/client representative.
- c) Calibrated testing equipment shall be used for all testing procedure which include but not limited to:
 - Factory assembly Test
 - Insulation Resistance and Continuity Test
 - Phase sequence test
 - Grounding test
 - Functionality test
 - others

Note: Calibration of testing equipment shall be certified traceable to the National Bureau of standards or qualified calibration company. Date calibrated and expiration shall be provided. All calibration certificate shall be submitted to engineers for approval prior to performing the testing.

5.1.10.7 General Care and Precaution

- a) All materials delivered are subject for inspection and approval by the engineer/client representative in accordance to approved shop drawings and specification prior installation to site and shall be stored and handle in compliance to manufacturer recommendations and instruction.
- b) Contractor is fully responsible for any damage materials and equipment due to mis handle during delivery and improper testing procedures. Damaged item shall be replaced to new product without any additional cost to clients or engineer.
- c) Contractor/ suppliers shall provide qualified personnel to perform any testing procedures.

5.1.10.8 Quality Control

- a) All installed Electrical materials and equipment other MEP services shall be properly tested in accordance to the above testing procedure to perform.
- b) Contractor is responsible to correct all deficiencies or fault found during testing.
- c) Uses of International Electrical testing Association (NETA) guidelines for all testing procedures and acceptable range of the result.
- d) All testing shall be completed prior to commissioning and Acceptance.
- e) All testing procedure and method statement shall be submitted to engineer or client representative for approval prior testing and commissioning activities.
- f) All test includes but not limited to
 - All wiring
 - All Protection
 - Grounding System
 - Bolted connection; Proper torque application for connections.
 - Motor controls
 - GFCI or RCCD tripping range and settings.
 - Protective relays.
 - Switch boards, panel board, UPS.

- Feeder lines
- Motor rotation and insulation resistance.

5.1.10.9 Minimum Acceptable Test Result

- Grounding System- The minimum grounding resistance test of grounding electrode shall be equal or lower than 1 ohm.
- Electrical apparatus and Insulation resistance
 - Maximum voltage of 250 volts: use 500Vdc test kit at 1 mega ohm minimum insulation resistance test.
 - Equipment with 600 Volts: use 1000 Vdc test voltage at 1 mega ohm minimum insulation resistance test.
- Wire and Cables below 600V
 - For 300V and below rating: use 500Vdc test voltage
 - For Maximum 600V rating: Use 1000Vdc test voltage.

5.2 CONDUIT AND CONDUIT ACCESSORIES

5.2.1 Conduit Pipe

- All conduit use for the electrical wiring and other systems shall be made of PVC confirming to BSS 3505/1968 Class-D unless otherwise provided in the specification or load schedules.
- The conduit shall have following wall thickness and standard weights:

| Pipe Size | Wt/100ft. | Wall thickness |
|-----------|-----------|----------------|
| 20mm dia | 3.4 Kg | 0.04 to 0.05 |
| 25mm dia | 4.5 Kg | 0.045 to 0.055 |

- Steel conduit shall conform to BSS 31/latest. The conduit shall be enameled with good quality non-cracking and non-flaking black paint.
- The wires running throughout the ceiling and walls should be inside hard conduit.

5.2.2 Conduit Accessories

- The use of factory-made round PVC junction boxes shall be used and should have provision to receive PVC pipe with force fit. The wall type junction box shall also be PVC.
- All junction boxes shall be covered.
- Conduit accessories such as switch boxes, socket outlet boxes, pull boxes and inspection boxes shall be made of PVC having dust tight covers. All boxes shall have required number of conduit entry holes. All the rectangular or square shaped boxes shall have provisions to receive PVC conduit force fit.
- Manufactured smooth bends shall be used where conduit changes direction. Bending of Conduit by heating or otherwise shall be allowed only at special situations with the permission of the Consultant. Use of sharp 90-degree bends and tees is prohibited.

- e) Bends shall have enlarged ends to receive the conduit without any reduction in the internal diameter of the PVC pipe.
- f) All accessories e.g., boxes, coupling, bends, solid plugs, bushes, reducers, check nuts etc. shall be equal in quality to the specified conduit.
- g) The drawings do not show conduit routes and all the planning for arranging conduit routes shall be carried out by the Contractor to the satisfaction of the Consultant.
- h) The entire conduit system shall be essentially completed before the wiring pulling is taken in hand. Each conduit run shall be tested for continuity and obstructions. All obstructions shall be cleared in an approved manner. Water and moisture that has entered any section of the conduit installation must be dried with suitable swabs to the satisfaction of the Consultant.
- i) Adequate expansion joints shall be provided in all conduit runs passing across the expansion joints in the concrete slab of the buildings.
- j) All the free ends of conduit shall be solidly plugged till such time as final and proper terminations are made.

5.2.3 Wires, Cables and Cords

5.2.3.1 Wires & Cords

The wires & cords for the conduit wiring shall be single core, made of stranded copper conductors, PVC insulated, tested to B.S. 6004, 1975. The voltage grade shall be 300/500 volts or 450/750 V unless otherwise specified on Drawings and Bills of Quantities.

5.2.3.2 Wire and Cable Standards

- a) All the wire and cables shall be of the approved standard of Maldives Utility Regulatory Authority.
 - i. For light or fan point wiring minimum size shall 2.5 mm square or as specified in the BOQ or in electrical plan and load schedules
 - ii. For Power circuit wiring minimum size shall be 2.5 mm square or as specified in the BOQ or in electrical plan and load schedules.
 - iii. For power point having 15A, wiring shall be in 4mm square or as specified in the BOQ or in electrical plan and load schedules.

5.2.3.3 Installation Instructions

- a) All wiring shall be continuous between terminations and use of connectors or joints is not be allowed. Spur and tee connections are strictly prohibited.
- b) Manufacturers recommended lubricant shall be allowed to facilitate pulling of wires. Use of any kind of oil and soap is prohibited

5.2.4 Wiring Accessories

5.2.4.1 Switches

- a) Indoor switches controlling lights and fans shall be single pole, 5A, one or two ways, suitable for 250V, 50 Hz. The body of the switches shall be made of molded plastic, one, two, three or four gang with integral built in molded plastic face plate.
- b) Weatherproof switches shall conform to B.S. standard.

5.2.4.2 Switch Socket Outlet Units

- a) Switch & socket units shall be single, pole, 3 pin rated 5A, 15A or 20A, 250V, 50 Hz. These shall be molded plastic type with white integral built-in face plate. Each socket shall have its control switch by the side of it on a common face plate. Thus, the complete unit specified in BOQ shall be as switch and a socket outlet unit.
- b) All the circuits, sockets, switches, ELCB and MCCB must use Legrand or products in equivalent standards to this.
- c) Waterproof sockets must be used for areas which come in contact with water or water motors.
- d) All the lights and sockets inside and outside the building must follow the Maldives Electricity Bureau regulations while placing the circuit. (13Ampere with 2 socket- 1 circuit, 15Ampere with 1 socket and one circuit, and for six fans or 6 lights, there must be one circuit placed)
- e) Lights should have a circuit of 10 Amperes, and normal sockets should have a Socket of 16 Amperes. Air conditioner and high voltage appliances must have a circuit of 16 Amperes.

5.2.4.3 Fans

- a) All fans shall be capacitor type Deluxe models or equivalent and suitable for operation on 200/220 volts, 50 Hz, A.C Supply. All ceiling fans shall have five speed dimmers. The air displacement shall be 10,000 c.f.m for 48" (1219 mm) Sweep and 12,000 c.f.m. for 56" (1423 mm) Sweep at maximum speed. The fan motor shall be capacitor type and bearings shall be grooved type to give noiseless and quiet operation. The noise level relative to a frequency of range 1000 Hz should be within the limits of +3 dB.
- b) Ceiling fans used must be at least 1400mm in diameter and from Usha brand or equivalent to this
- c) Exhaust fans used must be plastic.

5.2.4.4 Dimmer

- a) The dimmer shall be recessed type as required and shall be approved by the consultant

5.2.4.5 Fan Hook

- a) The fan hook shall be made of 12 dia mild 5/5 steel rod bent to shape of approved design. It should be in the form of a loop about 3-1/4" (87.5 mm) long and about 2" (50 mm) wide. The

rod shall be bend to have at least 8" (200 mm) extension on both sides for tying to the reinforcement steel of the slab. All ceiling fan shall be of one make only.

5.3 LIGHT FIXTURES

5.3.1 General

- a) The description of light fixtures is given in the Bills of Quantities, and stated on the Drawings, and all relevant material are described in this Section.
- b) The determination of quality is based on certified photometric data covering the coefficient of utilization, light distribution curves, construction material, shape, finish, operation, etc.
- c) The Contractor shall submit data sheet/catalogue and samples of each lighting fixture specified for approval of the Consultant.
- d) The type of fixtures with manufacturer catalogue reference are given in bill of quantities. If not specified, the contractor shall provide the item (c) for further approval.

5.3.2 Incandescent Light Fixtures

- a) The glass globes/ shades/ diffusers of the incandescent light fixtures shall be first class quality glass free from any air bubbles or voids. The glass shall generally be of opal white color unless otherwise specified. The shape of the glass may be spherical, hemispherical, flattened bottom or tablet shaped as required.
- b) Surface mounted fixture shall have stove enameled sheet steel body. It may also be satin brass or aluminum anodized finish as required. The fixing holes shall match the outlet box. Wall bracket light fixtures shall have back plates with matching holes of the outlet box and decorative finish as required.
- c) All the lighting fixtures shall be suitable for local climatic conditions.
- d) All lighting fixtures shall be certified from any of the following Testing laboratories.
 - i. Underwriter Laboratories (UL)
 - ii. Electrical Testing Labs (ETL)
 - iii. Compliance, standards and accountability Group (CSA)
 - iv. Energy Star Program
 - v. European Conformity Certification (CE)

5.3.3 Fluorescent Light Fixtures

- a) All the light fixtures shall have lamps and electronic ballasts of the wattage specified. The fluorescent lamp shall be either 2 ft - 18 watts or 4 - 35 watts and the color shall generally be day light, cool day light in the order of preference or as mentioned specifically.
- b) The ballast shall be totally enclosed electronic type suitable for operation on 100 to 230 V, 50Hz, single phase supply, a wiring diagram, wattage, voltage and current ratings shall be

printed on the body of the ballasts. The power loss shall not more than 10 watts for 36 watts ballast. The ballast shall be noiseless in operation without any whistling sound.

- c) The manufacture shall be called upon to guarantee a trouble-free life of 3 years, effective from the date of completion certificate.
- d) The starters shall have radio-interference suppressers.
- e) The internal wiring of the light fixtures shall be carried out at manufacturers factory with heat resistance wires of size not less than 1.5 mm square.
- f) The louvers of light fixtures shall be made of anodized aluminum and/or molded plastic. The diffusers shall be made of acrylic Perspex.
- g) All the lighting fixtures shall be suitable for local climatic conditions.
- h) All lighting fixtures shall be certified from any of the following Testing laboratories.
 - i. Underwriter Laboratories (UL)
 - ii. Electrical Testing Labs (ETL)
 - iii. Compliance, standards and accountability Group (CSA)
 - iv. Energy Star Program
 - v. European Conformity Certification (CE)

5.3.4 LED Light Fixtures

- a) All lighting fixtures shall be as per the client and consultant requirements.
- b) All lighting fixtures shall be certified from any of the following Testing laboratories.
 - i. Underwriter Laboratories (UL)
 - ii. Electrical Testing Labs (ETL)
 - iii. Compliance, standards and accountability Group (CSA)
 - iv. Energy Star Program
 - v. European Conformity Certification (CE)

5.3.5 Installation Instructions

- a) The light fitting shall be installed according to manufacturer's recommendations or as approved by the Consultant.
- b) Flexible connecting wires from outlet box to the fixture shall be provided by the contractor; connector made of porcelain or thermoplastic material shall be provided and installed in the outlet boxes for connecting flexible wires to the point wires
- c) Outlet boxes or any openings in the ceilings and walls shall be covered with appropriately fabricated accessories to provide an architectural entity to conceal them.
- d) All the lights outside the building and in the garden should be in accordance with the drawings with photocell switches placed.

- e) Each light should be assigned to a different switch. Each switch should light up one light only.

5.4 L.T. SWITCHBOARD AND PANEL BOARD.

- a) The L.T. switchboard shall be indoor type, free standing, free supporting, floor mounted, totally enclosed, sheet clad, dust and suitable for operation on 3 phase 4 wire system, 400 v, 50 Hz, AC supply.
- b) The panel board shall be suitable for installation back to the wall and capable of front attendance. The switch board shall be designed to suit service conditions and ensure security and safety during operation, inspection, operation, cleaning and maintenance.
- c) The switch board shall be designed and tested to IEC recommendations. Each panel shall withstand strain of 1000 volts insulation level for one minute power frequency test
- d) All Panel board shall be based on BS standard or EIC standard and as per the Guidelines of Maldives Utility Regulation Authority.
- e) All Single line diagram shall be as per the Maldives utility regulation authority Guidelines and approved by the consultant prior to procurement and delivery on site.
- f) Main switch board shall have a Fat test and shall be witness by both parties' prior delivery on site.

5.4.1.1 Distribution Board

- a) The distribution boards shall be either free standing, cubical type or wall mounting type. Each distribution board shall be tropical in design, fully dust, vermin proof and liquid repellent. The electrical components and rating such as MCCB, MCB, ELR, OCR, RCCD, CT's, Kwh, DPA shall be in accordance to Bs standard or IEC standard and as per the URA guidelines. All DB shall be as per the approved SLD and Load schedules.

5.4.2 Installation Instruction

- a) The contractor shall submit method of statement or installation methodology of all large equipment and plats such as Generator sets, heat exchangers, fuel tanks, water tanks, Ro plants, STP plant, borewell, Waste management plants, water pumps and other equipment shown in the BOQ prior to proceed with the installation.
- b) Only qualified personnel or electrician shall do the electrical works under the fully supervision of electrical engineer until the work is completed.
- c) All safety measure and usage of proper PPE shall be strictly monitored and implemented for all work on site.
- d) All incoming and outgoing feeders of Panel Board shall be made from the bottom and provided with earth cable.

5.5 TELEPHONE SYSTEM

- a) The design drawings do not show conduit routes and depict only the position of various telephone outlets. All the planning for the conduit routes shall be carried out well in advance of the actual execution of work by the Contractor to the satisfaction of the Consultant. For this purpose, the Contractor shall prepare shop drawings and obtain prior approval of the Consultant. Three prints of each shop drawings shall be submitted for obtaining approval before commencement of work.
- b) No piece of work shall be allowed to be executed at site without the availability of these approved shops drawings. Time required for the preparation and approval of shop drawings shall be considered to have been included in the total time allowed for the completion of the work.
- c) The contractor shall furnish and install the type of Telephone outlets approved by a local Telecommunications Provider (approved by. All the floor mounted telephone boxes shall be concealed in a PVC box with openable cover for easy access.
- d) Both ends of each set of conductors shall be properly identified with durable tags with the same identifications of both ends at the outlet and the telephone terminal cabinets to facilitate the installations of the telephone instrument in the future and for trouble shooting purposes. Cable used shall be twisted and shielded 3 cables in the office area and the rest as shown in the drawing.

5.6 CCTV SPECIFICATION

5.6.1 System Design

- a) The system shall be designed taking into account following specification, tender drawing and the client requirement by specialist contractor with experience in the trade to provide a high-quality uninterrupted CCTV image at each and every viewing points.
- b) The CCTV system shall be capable to handle 512 IP camera streams in 25 frames per second in D1 resolution. IT should be able to handle 1.2 Gbps data throughput. The CCTV system consist of indoor network fixed dome cameras, Outdoor network bullet cameras, pan tilt zoom cameras positioned in the building premises. All the cameras' streams video to four Network Video Recorders installed in server room. The CCTV control room in ground floor is equipped with dedicated video decoders, monitors and a CCTV network keyboard. The viewing channel changing on monitor, split setup changes & PTZ controlling could be conducted via this keyboard. Any camera shall be viewed in any monitor via keyboard.
- c) The video client software shall be installed in EACS PC in ground floor CCTV room (check EACS client PC configurations, it should match CCTV client software requirements (otherwise provide a CCTV client PC). The image play back & backup shall be conducted via this client PC. The video management server shall manage all user authentication, and video streams with e-map facility.

- d) 3m extra cable provision shall be kept inside ceiling for small scale changes. The system should view at highest resolution when single camera is viewed on a monitor. The lower resolution video stream shall be automatically set when multiple cameras are viewed on a monitor. Simultaneous ten client users should be able to view images simultaneously over the network.
- e) Installer shall provide 30 days of recorded images under D1 resolution, 8 IPS in continuous recording of all cameras. The system shall have provision for expanding NVR storage up to 144TB for each NVR using external storage devices. The NVR should also have provision for RAID levels 0,1,5,6. The system also should have provision for N+1 redundancy of NVRs.
- f) Exact location of cameras shall be proposed by architect. The positions shown are suggested locations in public areas as shown in the drawings.

5.6.2 System Performance Criteria

- a) The system performance criteria shall follow international agreed standards and local regulations. They shall be, but not be limited, to the following:
 - i. Live video clarity in real time
 - ii. Achieving record duration
 - iii. PTZ tour programming and tour function
 - iv. Image record water mark testing
 - v. Play back image via calendrer

5.6.3 General Requirement of CCTV Equipment

- a) All equipment to be supplied under this specification shall be new and the current model of a standard product of a Manufacturer of record. A Manufacturer of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied.
- b) Maintains a factory production line for the item submitted
- c) Maintains a stock of replacement parts for the item submitted.
- d) Maintains engineering drawings, specifications, and operating manuals and for the items submitted.
- e) Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the tender issue.
- f) Specifications of equipment as set forth in this specification are minimum requirements, unless otherwise stated, and shall not be construed as limiting the overall quality, quantity or performance characteristics of items furnished in the CCTV system. When the Contractor furnishes an item of equipment for which there is a specification contained herein, the item of equipment shall meet or exceed the specification for that item of equipment.

- g) The total CCTV system shall be installed so that the combination of equipment actually employed does not produce any undesirable visual or aural effects such as signal distortions, noise pulses, glitches, hum bars, transients, ghosting, etc.
- h) The Contractor shall make all the necessary setting of the equipment after installation. The gain, IPS, resolution, recording channel frequencies of camera shall be adjusted to suit the usage. All settings shall be clearly marked upon final adjustments.
- i) The contractor shall carry out performance tests in the presence of the Engineer with prior approved test methodology which shall incorporate a spectrum analyzer before handing over the system.
- j) It shall be the Contractor's responsibilities to ensure that the whole CCTV system shall comply with all statutory, regulations and requirements of all authorities having jurisdiction over the work.

5.6.4 Item Specification

| Network Video Recorder | | |
|--|------------------|---|
| Make | | |
| Model | | |
| Country of origin | | |
| Features | | |
| System throughput capacity | | 340 Mbps |
| Throughput allocation @ D1 resolution in real time | Live Video | 128 channels or better |
| | video playback | 20 channels or better |
| | video forwarding | 20 channels or better |
| Network | | 2 x 1Gbps Ethernet (Dual) |
| RAID controller | | SAS 9260 (6Gb/s per port) |
| Maximum storage support | | 48TB |
| Storage | | 30TB |
| Expansion Maximum total storage | | 144TB |
| Hardware Redundancy | | Power supply and fan module redundancy |
| Video Compression | | H.264, MPEG4 |
| Video Resolution | | 1080P / 720P / Megapixel / D1 / 4CIF / VGA / CIF |
| Frame Rate | | 25 fps (PAL) |
| Recording Mode | | Time and events, alarm, manual trigger, continuous video |
| Hard Disk Hot Plug | | Support |
| Expansion Interface | | SAS |
| RAID Level | | RAID 0, 1, 5, 6 |
| Rack Mountable | | Support |
| Certification | | CE, FCC |
| Accessories | | Any required accessory not specifically referred to install/use the equipment |

| | |
|---|---|
| Video Management Server | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| Live Video Display with Different Layouts | Support |
| Digital Zoom In/Out | Support |
| Instant Playback from live view window | Support |
| Alarm / Event / Status / Log Management | Support |
| Digital Virtual Matrix (Any camera to any monitor) | Support |
| E-map support | Support |
| Record searching by time, camera number, event, devices | Support |
| Archive evidence at local storage / central storage / remote site | Support |
| playback modes | 8 / 16 / 32 / 64x |
| Configurable tours and patrols on workstation monitors or video walls | Support |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| | |
|------------------------------|---|
| Network Video Decoder | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| Network | 1 Gigabit Ethernet |
| Video Compression | H.264, MPEG4 |
| Display Resolution | 1080P / 720P / Megapixel / D1 / 4CIF / VGA / CIF |
| Video Split | Full Screen, 2x2, 3x3, 4x4, 6, 8, 9, 13, 16 split screens |
| Video Output | 4 x HDMI ports to digital display screen |
| Certification | CE, FCC |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| | |
|--|---|
| Video Matrix Controller (CCTV keyboard) | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| Joystick | 3-axis proportional control |
| Connection | LAN & USB |
| Password Protection | Support |
| Camera Functions | Pan/Tilt/Zoom |
| | Program and run presets |
| | Program and run tours |
| Decoder functions | change monitor split matrix |
| | Assign any camera to any split screen slot |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| | |
|-----------------------|---|
| LED Monitor | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| Video Input interface | HDMI |
| Design | Color |
| Panel type | Wall Mount |
| Resolution | 1366 x 768 |
| Size | 24" or better |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| | |
|-----------------------------------|---|
| Outdoor Network PTZ Camera | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| IP rating | IP66 |
| 360° continuous rotation | Support |
| True Day/Night (TDN) | Support |
| Wide Dynamic Range (WDR) | Support |
| High Light Compensation (HLC) | Support |
| Zoom | 37x |
| Resolution | D1 |
| Presets | 50 or better |
| Tours | 4 or better |
| IR beam | 100m |
| Digital Zoom | OFF / ON (X2 ~ X16) |
| Min. Illumination | IR LED ON - 0 Lux IR LED OFF - Color: 0.02 Lux, F1.6 B/W: 0.001 Lux, F1.6 |
| Focus length | f=3.5 - 129.5mm |
| Iris Control | Auto / Manual |
| Day/Night | Auto |
| Manual Speed | 0.1° - 150°/s |
| Auto Pan | Continuous |
| Dual Streams | Support |
| Network Protocols | IPv4, TCP, UDP, HTTP, HTTPS, SMTP, FTP |
| Frame Rate | 1fps - 25fps |
| Power Supply | DC12V |
| Certificate | FCC |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| Network IR Bullet Camera | | |
|-------------------------------|--|--|
| Make | | |
| Model | | |
| Country of origin | | |
| IP rating | | IP66 |
| Power over Ethernet | | IEEE 802.3af |
| True Day/Night (TDN) | | Support |
| Wide Dynamic Range (WDR) | | Support |
| High Light Compensation (HLC) | | Support |
| Resolution | | 1080P (1920 x 1080), |
| IR beam | | 30 - 40m |
| Min. Illumination | | IR LED ON: 0 Lux Color: 0.02 Lux B/W: 0.005 Lux @ F1.4 IR LED OFF: @ F1.4 |
| Focus length | | 2.8 - 12mm |
| Iris Control | | DC IRIS |
| Day/Night | | Auto |
| Dual Streams | | Support |
| Network Protocols | | IPv4, TCP, UDP, HTTP, HTTPS, SMTP, FTP |
| Frame Rate | | 1fps - 25fps |
| Certificate | | FCC |
| Accessories | | Any required accessory not specifically referred to install/use the equipment |

| Network Fixed Dome Camera | |
|----------------------------------|---|
| Make | |
| Model | |
| Country of origin | |
| Power over Ethernet | IEEE 802.3af |
| True Day/Night (TDN) | Support |
| Wide Dynamic Range (WDR) | Support |
| Resolution | 1280x1024 |
| IR beam | 15m |
| Min. Illumination | Color: 0.2 lux @ F1.2; B/W: 0 lux (IR on) |
| Focus length | 3.3 - 12mm |
| Iris Control | DC IRIS |
| Dual Streams | Support |
| Network Protocols | IPv4, TCP, UDP, HTTP, HTTPS, SMTP, FTP |
| Frame Rate | 1fps - 25fps |
| Certificate | FCC |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| Power Over Ethernet Lightning Arrester | |
|---|---|
| Make | |
| Model | |
| Country of origin | |
| Power over Ethernet | IEEE 802.3af |
| Connection Method | RJ45 In/Out |
| Data Rate | Gigabit Ethernet |
| Max Continuous Current | 1.5 Amps |
| Protection Modes | Line-Ground (All) |
| Service Voltage | 48V |
| Clamp Voltage | 72V |
| Peak Surge Current | 30A/pair |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| Rack | |
|-----------------|---|
| Features | |
| Type | 19" floor standing |
| Size | Suitable to install all CCTV room items inside the rack |
| Ventilation | Suitable for heat dissipation from rack mounted items |
| Finish | heavy gauge steel with baked on paint finish |
| Security | Lockable, Two keys |
| Free Rack Space | 9U |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

5.7 PUBLIC ADDRESSING SYSTEM & BACKGROUND MUSIC (PA&BGM) SYSTEM

5.7.1 System Design

- a) The system shall be designed taking into account following specification, tender drawing and the client requirement by specialist contractor with experience in the trade to provide a high-quality audio broadcasting at each and every speaker of the building.
- b) The PA & BGM is based on 100V audio system. The all-in-one digital audio unit (Digital Multi-audio Player) will be used as a CD/DVD player, FM tuner and USB loaded MP3 file player. There are four paging consoles in three locations to manage public addressing.
- c) The system is based on IP distributed architecture. The Digital Integrated System Manager manages IP audio streams and it delivers the desired audio channels to Power amplifiers connected to it. The power amplifier will drive speakers connected. One backup power amplifier for each Digital Integrated System Manager is available and it should be automatically taken over function of faulty power amplifier.
- d) The system should capable to switch any audio source to any speaker zones depicted in the schematic diagram. Further the system should allow creating zone groups which consists with multiple physical zones. For an example, there are several waiting area zones in different floors. The system must be capable to define a global waiting area logical zone and it should be able to call from paging selector. The volume controllers should be overwritten during paging. The zones and logical zone groups could be selected from paging console.
- e) The fire alarm panel should provide three dry contacts. One is to broadcast "Fire Alert Message" the second contact is to broadcast "Fire Evacuation Message", third is to broadcast "All clear Message". Predefined zones will receive corresponding messages on activation of dry contact. The volume controllers should be overwritten during message broadcasting.
- f) The power amplifier wattages shall be selected according to the total speaker load it drives. 20% power margin should be kept in every power amplifier. The volume controller's wattage must be equal or greater than that of the total speaker load it handles. It is PA & BGM installer's responsibility to cable up to the fire alarm panel for integration.

5.7.2 System Performance Criteria

- a) The system performance criteria shall follow international agreed standards and local regulations. They shall be, but not be limited, to the following:
 - i. The required sound pressure level shall be 70 dBA.
 - ii. STI shall be greater than 0.45

5.7.3 General Requirements of PA & BGM Equipment

- a) All equipment to be supplied under this specification shall be new and the current model of a standard product of a Manufacturer of record. A Manufacturer of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied.

- b) Maintains a factory production line for the item submitted.
- c) Maintains a stock of replacement parts for the item submitted.
- d) Maintains engineering drawings, specifications, and operating manuals and for the items submitted. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the tender issue.
- e) Specifications of equipment as set forth in this specification are minimum requirements, unless otherwise stated, and shall not be construed as limiting the overall quality, quantity or performance characteristics of items furnished in the PA& BGM system. When the Contractor furnishes an item of equipment for which there is a specification contained herein, the item of equipment shall meet or exceed the specification for that item of equipment.
- f) The total PA & BGM system shall be installed so that the combination of equipment actually employed does not produce any undesirable visual or aural effects such as signal distortions, noise pulses, glitches, hum bars, transients, ghosting, etc.

5.7.4 Regulations and Code of Practice

- a) It shall be the Contractor's responsibilities to ensure that the whole PA & BGM system shall comply with all statutory, regulations and requirements of all authorities having jurisdiction over the work. The system and its components shall be applicable to the following standards:
 - i. NFPA – 72, 101
 - ii. EVAC compliance acc. to IEC 60849
 - iii. EMC emission acc. to EN 55103-1
 - iv. EMC immunity acc. to EN 55103-2
 - v. Safety acc. to EN 60065

5.7.5 Installation

- a) Installation shall be as per approved shop drawings, and as recommended by the major equipment manufacturer.
- b) All cables, junction boxes, cables support and hangers shall be concealed in finished areas and may be exposed in unfinished areas. If construction is on-going during this period, measures shall be taken to protect detectors/ sensors from contamination and physical damage.
- c) All speakers/controllers/amplifiers/call stations shall be installed in accordance with installation instructions provided by the manufacturer.
- d) All speakers shall be installed in the exact locations as per approved shop drawings thus providing the best possible coverage.
- e) All speakers shall be securely fixed to approved boxes and allow for easy fitting and removal of it.

- f) Fibre optic cable for Networking between all floors of the building shall be scope of contractor. Please refer schematic for same.
- g) Cable and wire entries to speakers shall be fitted with grommets to prevent possible damage to the insulation.

5.7.6 Testing

- a) The Contractor shall make all the necessary setting of the equipment after installation. The power tapping of each speaker shall be adjusted to suit the usage. All settings shall be clearly marked upon final adjustments.
- b) The contractor shall carry out performance tests in the presence of the Engineer with prior approved test methodology which shall incorporate a spectrum analyzer before handing over the system.

5.7.7 Item Specification

| Digital Integrated System Manager | | |
|--|--|---|
| Make | | |
| Model | | |
| Country of origin | | |
| Features | | |
| Input | Amplifier interfaces | 4 or better |
| Ethernet interfaces | Ethernet speed | 10 M / 100 M |
| | Number of Ethernet interfaces | 4 or better |
| Output | 100V line dry contacts (Output channels) | 4 or better |
| | circuit detection function fault | Available |
| | Max. output load | 500W or better |
| | Monitoring loudspeaker | Available |
| Storage space to upload audio files | | 1 GB or better |
| Ability to store voice file & play via paging console | | Available |
| Ability to store voice file & play via BGM software | | Available |
| Ability to play message when trigger input is activated in designated zones | | Available |
| Run designated audio file in predefined recurrent schedule in predefined zones | | Available |
| Power supply | | ~100 - 240 V,50/60 Hz |
| Operating Temperature | | -10 °C ~ +55 °C |
| Humidity | | < 95 %, non-condensing |
| Certifications Voice Alarm | EN 54 (Part 16) | Available |
| Certifications Safety | CE | Available |
| 19"Rack mountable | | Available |
| Control parameter memory | | Retains after power off conditions |
| Accessories | Program | Software base full configuration with |
| | | Any required accessory not specifically referred to install/use the equipment |

| Power Amplifier | | |
|--|---------------|---|
| Make | | |
| Model | | |
| Country of origin | | |
| Features | | |
| Audio signal input | Ethernet | Available |
| ventilation | | forced air cooling fan |
| Fault detection | overheat | Available |
| | overcurrent | Available |
| | overvoltage | Available |
| | under voltage | Available |
| Audio outputs | | 100V |
| 19"Rack mountable | | Available |
| Power supply | | ~ 220 - 240 V, 50/60 Hz |
| Operating Temperature | | 0 °C ~ +40 °C (0 ~ 104 °F) |
| Humidity | | < 95 %, non-condensing |
| Safety Certifications | CE | Available |
| Available nominal power output (capacities)) | 500W | Available |
| | 250W | Available |
| | 125W | Available |
| Accessories | | Any required accessory not specifically referred to install/use the equipment |

| Digital Multi-audio Player | | |
|----------------------------|-------------|---|
| Make | | |
| Model | | |
| Country of origin | | |
| Features | | |
| Inputs/sources | DVD player | Available |
| | USB | Available |
| | SD | Available |
| | Mp3 file | Available |
| | FM/AM tuner | Available |
| DVD videos | | Available |
| Output | Stereo RCA | Available |
| Band frequency range (FM) | | FM : 87.5MHz ~ 108MHz |
| Band frequency range (AM) | | AM : 531KHz ~ 1710KHz |
| Antenna input impedance | | FM:75Ω |
| Power supply | | ~ 230V 50/60Hz |
| Accessories | | Any required accessory not specifically referred to install/use the equipment |

| Network Resource Interface | | |
|--|-----------------|---|
| Make | | |
| Model | | |
| Country of origin | | |
| Features | | |
| Auxiliary input | No. of Channels | 4 or better |
| | S/N | > 85 dB |
| Trigger inputs | No. of Channels | 8 or better |
| Audio Storage | | 4 GB SD CARD 500MB FLASH |
| Power supply | | |
| Operating Temperature | | -10 °C ~ +55°C |
| Humidity | | < 95 %, non-condensing |
| Ability to store voice file & play via paging console | | Available |
| Ability to store voice file & play via BGM software | | Available |
| Ability to play message when trigger input is activated in designated zones | | Available |
| Run designated audio file in predefined recurrent schedule in predefined zones | | Available |
| Accessories | | Any required accessory not specifically referred to install/use the equipment |

| Ceiling Speaker | |
|-------------------------------------|---|
| Make | |
| Model | |
| Country of origin | |
| Features | |
| IP Code | IP54 |
| Rated power | 6 W |
| Power taps @ 100 V | 6 W / 3 W / 1.5 W |
| SPL at 6 W /1 W (120 Hz-18 KHz,1 m) | 97 dB / 89dB |
| Materials | ABS |
| Frequency range (-10 dB) | 80 Hz - 20 KHz |
| Dispersion angle (1 Khz / -6 dB) | 184 / 90 |
| Certification | CE |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| | |
|--------------------------------|---|
| Wall Speaker | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| Rated power | 15 W |
| Power taps @ 100 V | 15 W / 5 W / 3W |
| SPL at 10 W / 1W (2k Hz, 1m) | 87 dB |
| Material | ABS |
| Frequency response (- 10 dB) | 20 Hz - 20k Hz |
| Dispersion angle | H: 90° - V: 90° |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| | | |
|-----------------------|------------|---|
| Horn Speaker | | |
| Make | | |
| Model | | |
| Country of origin | | |
| Features | | |
| Rated power | | 30W |
| Power taps @ 100 V | | 10 W / 20 W / 30W |
| SPL at 1W (2k Hz, 1m) | | 98 dB |
| Material | Horn cover | ABS |
| | Bracket | Stainless steel |
| Frequency response | | 120Hz-15k Hz |
| IP Code | | IP65 |
| Accessories | | Any required accessory not specifically referred to install/use the equipment |

| | |
|-------------------------------|---|
| Network Paging Console | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| LCD | 4.3-inch color |
| | touch screen |
| Microphone | gooseneck |
| Communication | TCP/IP |
| Built-in monitor loudspeaker | Available |
| MIC Frequency response | 80Hz~16KHz |
| Power supply | DC 12V / 24V |
| Operating Temperature | -10 °C ~ +55°C |
| Humidity | < 95 %, non-condensing |
| Accessories | Any required accessories not specifically referred to install/use the equipment |

| | |
|------------------------------|---|
| Volume Control | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| Rated power available | 6W / 30W/ 60W/ 120W |
| 24V DC forced override relay | Available |
| wire systems | 4 wire |
| Size | standard 86 × 86 electrical back box |
| Accessories | Any required accessory not specifically referred to install/use the equipment |

| | |
|---------------------------------|--|
| System Management System | |
| Make | |
| Model | |
| Country of origin | |
| Features | |
| Network Display | Display as a visual map |
| Device status monitoring | Available |
| Event logs | Available |
| Fault logs | Available |
| Backing up the system data | Available |
| Shedule playback configuration | Available |
| Logicl Zone groups | Available |
| Accessories | Any required acessory not specifically referred to install/use the equipment |

| | |
|-----------------|--|
| Rack | |
| Features | |
| Type | 19" units mountable |
| Size | Suitable to install service duct equipment |
| Ventilation | Suitable for heat dissipation from rack mounted items |
| Finish | heavy gauge steel with baked on paint finish |
| Security | Lockable, Two keys, Fire rated |
| Free Rack Space | 9U |
| Accessories | Any required acessory not specifically referred to install/use the equipment |