



**PROJECT IMPLEMENTATION UNIT
GOVERNMENT OF SINDH**

EDUCATION CITY

**REHABILITATION OF DUMLOTTEE WELL
(Well No. 09)**

TENDER DOCUMENTS

Volume - II

Technical Specifications

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Technical Specifications

Civil and Architectural Works



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1.
DESCRIPTION

The works covered by this section of the Specifications, consist of furnishing all plant, labour, equipment, protection methods, appliances and materials, and in performing all operations in connection with earthworks and protection of existing works done by others and/or executed by the Contractor, in accordance with this section of the Specifications and the applicable drawings, subject to the terms and conditions of the Contract.

2.
GENERAL

- i The Contractor shall acquaint himself with the nature of the ground, existing structures, conditions of all excavation and related works performed by others/contractor for foundations and sub-soil conditions which may be encountered during excavation or other earthworks.
- ii The Subsoil Investigation Report is available with the Engineer for reference. However, the Employer does not guarantee or warrant in any way that the material to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the Report, Drawings or in any other Contract Documents or to material obtained from boring or trial holes. The Contractor shall be deemed to have made local and independent inquiries as to, and shall take the whole risk of the nature of the ground, sub-soil or material to be excavated or penetrated and the Contractor shall not be entitled to receive any extra or additional payment nor be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.
- iii. All excavation, cutting, embankments and fill shall be constructed to the lines, levels and gradients specified with any necessary allowance for consolidation, settlement and drainage so that at the end of the Period of Maintenance the ground shall be at the required lines, levels and gradients. During the course of the Contract and during the Period of Maintenance, any damage or defects in cutting and embankments, to structures and other works, caused by slips, falls or wash-ins or any other ground movement due to the Contractor's negligence shall be made good by the Contractor at his own cost.
- iv. Arrange for inspection by Local Authority to verify and approve the discharge of surface water and to verify the location of the sewer connection.

3.

DUST CONTROL

- i Control dust on and near the work and near off-site borrow areas if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the Site.
- ii Thoroughly moisten surfaces as required to prevent dust being a nuisance to the public, neighbours, and concurrent performance of other work on the Site.

4.

ANTIQUITIES

Any ancient carvings, relics of antiquity, coins, or other curiosities, which are discovered or excavated during the progress of the work will remain the property of the Employer and are to be handed over to the Engineer.

5.

SITE PREPARATION

- i The Contractor shall set out the works including protection of the existing excavated earth work performed by others if any and shall be responsible for true and perfect setting out of the same and for correctness of the positions, levels, dimensions and alignments of all parts thereof. If, at any time, any error in this respect should appear during the progress of the works, the Contractor shall at his own expense rectify such an error to the satisfaction of the Engineer.
- ii The Contractor shall construct and maintain accurate bench marks, so that, the lines and levels can be easily checked by the Engineer.
- iii The Contractor shall construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction, at no extra cost to the Employer.
- iv Clearing shall consist of filling and cutting up, or the trimming of trees and the satisfactory disposal of the trees and other vegetation designated for removal, together with downed timber, snags, bushes and rubbish occurring within the areas to be cleared. Trees, other vegetation, stumps, roots, and bushes in areas to be cleared shall be cut off flush with or below the original ground surface except such individual trees, group of trees, and vegetation as may be indicated on the drawings or designated by the Engineer to be left standing. Individual trees, group of trees, and other vegetation, to be left standing shall be thoroughly protected from damage incident to construction operations, by the erection of the barriers or by such other means as the circumstances require, as approved by the Engineer. Clearing operations shall be conducted, so as to prevent damage by falling trees to trees left standing, to existing structures and installations, and to those under construction, and to provide for the safety of workers, so as to provide for the safety of employees and others.
- v Grubbing shall consist of the removal and disposal of all stumps, roots, larger than 1-1/2" (38 mm) in diameter, matted roots in the designated grubbing areas. Stumps,

roots, logs or other timber larger than 1-1/2" (38 mm) in diameter, matted roots & other debris shall be excavated and moved to a depth not less than 18" (450mm) below any subgrade, shoulder or slope. In areas, where the cut is over 3ft (1.0m), grubbing shall not be necessary. In areas to be paved, or in areas indicated on the drawings as future paved areas, where, excess excavation from grading operations is placed, or in areas designated by the Engineer as future paved areas, where excess excavation from grading operations is placed, grubbing will be necessary.

- vi Timber and other refuse to be disposed off by burning, shall be burned at locations specified by the Engineer in a manner that will avoid all hazards such as damage to the existing structures, construction in progress, trees and vegetation. The Contractor shall be responsible for compliances with all pertinent laws and regulations. Disposal by burning shall be kept under constant attention until the fires have been burned out or have been extinguished. No materials will be permitted to be pushed or placed on adjacent private property without prior written approval of the Engineer.

Existing Utilities

Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protecting during excavation operations.

Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult the utility Employer immediately for directions. Cooperate with Employer, and public and private utility companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility Employer.

Do not interrupt existing utilities servicing facilities occupied and used by the Employer or others, except when permitted in writing by the Engineer and then only after acceptable temporary utility services have been provided.

Demolish and completely remove from the site existing underground utilities indicated to be removed. Coordinate with local utility companies for shut-off of services if lines are active.

Use of Explosives

The use of explosive is not permitted without specific and written approval from the Engineer.

Protection of Person and Property.

Barricade open excavations and existing works occurring as part of this work. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, under mining, washout and other hazards created by excavation operations.



6.
EXCAVATION

- i Excavation shall include the removal of all material including material left over by others of every name and nature.
- ii The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Engineer full details of his proposals. The Engineer, may require modifications to be made if he considers the Contractor's proposal to be unsatisfactory and the Contractor shall effect such modifications but shall not be relieved of any of his responsibilities with respect to such work.
- iii For all or any excavation performed by contractor or others, the Contractor shall submit for prior approval of the Engineer, full details and drawings showing the proposed method or procedure of supporting and strutting, de-watering and maintenance of adjacent structures. The design, provision, construction, maintenance and removal of such temporary works shall be the responsibility of the Contractor, and all costs in this respect shall be included in the billed rates for the permanent works.
- iv The Contractor shall preserve the completed excavation from damage resulting from slips and earth movements, ingress of water from any source whatsoever and deterioration by exposure to the sun and the effect of the weather.
- v All excavation of every description in whatever material encountered shall be performed to the elevations and dimensions shown on the drawings in such a manner as to avoid interruption to work in other parts of the Site. The Contractor, shall be responsible for damage to the permanent works caused by excavation in other parts of the work.
- vi Excavation shall extend to sufficient distance from walls and footing to allow for placing and removal of forms, installations of services, and for inspection, except where it is required to deposit concrete for walls and footings directly against excavated surface.
- vii All excavations in foundations shall be taken to 6" (150 mm) above the final excavation elevations shown on the drawings and the last 6" (150 mm) shall be trimmed carefully to a smooth and level surface. Immediately after trimming to the final elevation a layer of blinding concrete shall be placed to the thickness shown on drawings. All excavations for foundations which have been trimmed shall be covered by oversite concrete by the end of the day. It is specifically brought to the notice of the Contractor, that, any excavation taken down to the trimmed elevation which is left overnight or for any length of time thereafter, uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation as directed by the Engineer and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.
- viii No excavation shall be refilled nor any permanent work commenced until the foundation has been inspected by the Engineer and his permission to proceed given.



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- ix If excavation for footings are carried below the required level, as shown in the Drawings or as directed by the Engineer, the surplus depth shall be filled with concrete having $f'c = 1.5$ ksi at the sole cost of the Contractor.
 - x All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient equipment for this purpose. Adequate precautions shall be taken to prevent any erosion due to undercutting from underneath the previously constructed adjoining foundations. Any dewatering required for this purpose shall be deemed to be included in Contractor's rates for this excavation.
 - xi Shoring, including sheet piling, where required during excavation, shall be installed to protect workmen and the banks, adjacent paving, structures and utilities. The term shoring shall also be deemed to cover whatever methods the Contractor elects to adopt, with prior approval of Engineer, for upholding the sides of excavation and also for planking and strutting the excavation against the side of public roadways and adjoining properties in existing hardcore of any other material. The Contractor will be held responsible for upholding the sides of all excavations and no claim for additional excavation, concrete or other material will be considered in this respect.
 - xii Excavations, for deep retaining walls, shall be protected from drying out by covering with tarpaulins or other means, if excavation is to stand open more than 24 hours. This is a precaution to prevent excessive surcharge loads acting on the wall, from the drying out and subsequent swelling of the clay soils when saturated either by rain or capillarity of ground water.
 - xiii If rock is encountered, it shall be removed carefully and without excessive noise and vibration. Blasting, if required shall be done by persons skilled in such work and as directed by the Engineer. Necessary permission for blasting should be obtained from respective Government Authorities by the Contractor. All necessary precautions shall be taken to see that the general public and the properties in the vicinity shall not receive any damage by such blasting. Rock, to receive footings shall be stepped and leveled.
 - xiv Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation, which are to be retained, as well as those utility lines constructed during excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor at his own expense. Any existing utility lines, which are not known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor at his own cost. When, utility lines which are to be removed, are encountered within the area of operations, the Contractor shall notify the Engineer in ample time for the necessary measures to be taken to prevent interruption of the service.
 - xv Excavated material suitable for use as filling material shall be deposited as directed by the Engineer. Surplus or material unsuitable for use as filling shall be disposed off by the Contractor to areas approved by relevant authorities for this purpose.

7.
FILLING

- i After completion of foundation work, walls, and other construction below the elevation of the final grades, and prior to filling, forms shall be removed and the excavation shall be cleaned of trash and debris.
- ii Filling shall be approved selected material from excavation or other predominantly granular material and free from slurry, mud, organic or other unsuitable matter and capable of compaction by ordinary means.
- iii Filling in trenches and foundations shall be placed in 6" (150 mm) layers and compacted to optimum moisture content by mechanical means, where possible.
- iv Filling around pipes and cables shall be carefully placed fine material to cover the pipe or cable completely before the normal infilling is placed.
- v Material for bulk filling shall be as approved by the Engineer and shall be placed in layers of 6" (150 mm) and saturated with sufficient water or otherwise compacted to produce not less than 95% in-situ density with respect to the maximum density, at optimum moisture content, as per ASTM D- 1557 method C. In place determination of dry density of soil shall be by ASTM D-1556-64.
- vi All filled areas shall be left neat, smooth and well compacted, the top surface consisting of the normal site surface soil, unless directed otherwise.
- vii Filling shall not be placed against foundation walls prior to approval by the Engineer. Filling shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the filling shall not be operated closer to the wall than a distance equal to the height of the filling above the top of footing.
- viii All structures retaining the earth shall have a filling of granular material for drainage through the weep holes or rubble drain as shown on the drawings or as additionally directed by the Engineer. This granular material shall consist of following gradation requirements.



SIEVE % PASSING BY WEIGHT

1-1/2"	100
3/4"	80-90
#4	60-70
#10	45-55
#40	15-25
#100	5-15
#200	less than 5

Drainage mediums shall be free of dirt, chemically inert and well graded so that when placed and compacted this filling shall be stable.

- ix Fill material to bring subgrade for slab on grade, exterior pavements, steps etc. to underside of slab shall be free draining granular material such as concrete sand or approved fill material with fineness modulus between 2.7 & 3.0.



8.
EMBANKMENT

- i No embankment shall be commenced until the foundations have been approved by the Engineer. When approved as suitable by the Engineer, material arising from the excavations may be used for filling as required. Mud, slurry, organic matter, peat and any other unsuitable material shall not be used for filling for any purpose on the Site. Where suitable materials from the excavations are insufficient for filling, the requirements shall be made up of other granular material which the Contractor shall obtain from sources approved by the Engineer.
- ii The location of sources of supply of this filling material will be left to the Contractor, but the quality of the filling material brought from outside will be subject to the approval of the Engineer. The Engineer shall require the Contractor to carry out various tests of the filling material. All such tests, shall be made at an approved laboratory at the cost of the Contractor.

Once, a material from a specific source has been approved, the material of the same quality and from the same source shall be used. Any filling material from borrow pits, which has not been approved or the quality of which differs from the approved material shall be rejected outright without recourse. The Engineer reserves the right to order the removal of any such materials brought to the Site of the works, at Contractor's expense. In order to ensure satisfactory compaction, it will be necessary to carry out, depending upon the type of material, particle size distribution tests, determination of organic content tests, maximum and minimum density tests and determination of optimum moisture content for the filling material.

- iii The method of compaction, namely type of roller, weight of roller and number of passes proposed by the Contractor for any particular filling material shall be subject to the approval of the Engineer, after the completion of satisfactory field tests, subsequent to the laboratory analysis, using the materials and equipment proposed to be used for the earthwork in conditions similar to those likely to be encountered during construction. The final selection of the soil moisture content, the thickness of layers, the type of compaction equipment and the number of passes shall be decided after these tests, which shall be conducted at Contractor's expense.
- iv Having established the method of compaction to be used, no departure from this approved method shall be permitted without the prior approval of the Engineer. The adequate control of the filling and compacting operations shall be ensured by in-situ density tests and in order to obtain significant results, not less than two measurements shall be carried out per one thousand square feet (100 square meter) of area compacted. The frequency of tests shall be determined on Site and may be varied at the discretion of the Engineer as the work proceeds. Tests shall be carried out in accordance with ASTM D - 1557 method C or such other standards as approved by the Engineer. The standard of acceptance of the compaction be not less than 95% in-situ density with respect to the maximum density, at optimum moisture content, achieved in accordance with ASTM D - 1557 method C.
- v The exact thickness of layers and the method of placing and compacting the filling shall be determined by the field tests, as stated above, but not withstanding the



results of these trials, filling shall not be placed in layers exceeding 6" (150 mm) in thickness. The full width of the embankment shall be placed in one operation. In order to maintain control of the thickness of layers, timber profiles shall be used. The Contractor shall provide adequate supply of water and sufficient capacity of mechanical water carriers to ensure uniform and uninterrupted operation of compaction. The Engineer may forbid the Contractor to proceed with paving and/or compaction of filling and/or removal and re-compaction of such filling if he finds that the Contractor has insufficient or defective equipment or that the work is improper.

If it is found necessary to alter the moisture content of the filling material in any way, then very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests shall be made.

- vi Where directed, earth slopes shall be protected with handset stone pitching, either dry or in mortar as specified. Pitching stones shall be approved rock rubble, each stone having a minimum depth of 10" (250 mm) and a minimum volume of 0.5 cubic ft (0.015 C.M).

9.
MEASUREMENT
AND PAYMENT

- i Unless otherwise specifically stated in the Bill of Quantities, or herein, all items shall be deemed to be inclusive of, but not limited to the following:
 - a Labour and all cost in connection therewith.
 - b Materials, goods, equipment and all costs in connection therewith (e.g. conveyance; delivery; unloading; storing; returning, packing; dewatering; handling; hoisting; lowering; shoring and protection of all existing and new excavation; formworks; etc.)
 - c Setting out of works.
 - d Cost of all laboratory and field tests stipulated in these Specifications.
 - e Use of Plant.
 - f Waste of Materials.
 - g Establishment charges, overhead charges & profit.
 - h All other expenses, royalties, charges and taxes specified in Conditions of Contract.
- ii Quantities of excavation, filling, embankments, etc. shall be calculated from level taken by the Contractor and agreed by the Engineer before commencement of the work.



iii Excavation

- a) The quantities given for excavating and subsequent disposal, shall be deemed to be the bulk before excavating and no allowance shall be made for any subsequent variation in bulk or for any extra space required to accommodate planking and strutting.
- b) The unit price for excavation shall be deemed to include the following also:
 - Excavating below water-level and excavating in rock
 - Getting out excavated materials by any means necessary and subsequent disposal of excavated material to any lift and lead.
 - Keeping excavations free from water, from any source whatsoever, and providing pumps and other equipment, power attendance for pumping and standing time.
 - Shoring, which shall mean providing everything requisite to uphold the sides of existing and any other excavation by whatever means are necessary.
 - Placing and compacting of backfilling in the excavations to the required degree and elevations as stipulated in the Drawings and as directed by the Engineer.
- c) Excavation and its measurements for foundation/ trenches shall be to the exact dimensions shown on the drawings multiplied by vertical depth of excavation.
- d) The area, shall be that of the lean concrete layer under all footings and shall not include any extra excavation required for shoring, formwork etc. No payment shall be made for any excavation beyond that defined above, or for any unauthorized width and depth.

iv Embankment

- a) Quantities for embankment shall be deemed to be the net volume of the embankment after being placed and compacted to the required degree and elevation as stipulated in the Drawings and as additionally directed by the Engineer.
- b) Treating the surface of the embankment, filling (e.g. leveling, grading to falls, grading to cambers) shall be deemed to be included in the unit price of embankment.
- c) Trimming the sides of embankment to slope shall be deemed to be included in the unit price of embankment.



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**1.
DESCRIPTION**

The work covered by this section of Specification consists of furnishing all labor, materials, equipment, services, miscellaneous and necessary items required to complete Termite Control and, related works as indicated on drawings, and specified herein, in strict accordance with this section of Specifications, subject to the terms and conditions of the Contract.

**2.
MATERIALS**

- i 'Agenda 25EC' by Jaffar Brothers / "Miraj" by IBS or equivalent product approved by the Engineer, mixed in clean water for application in earth or fill as recommended by the Manufacturer.
- ii 'Wood Protek' (England) or equivalent product approved by the Engineer, on exposed wooden surfaces.
- iii 'Solignum' or equivalent product approved by the Engineer, on concealed/covered wooden surfaces.

**3.
METHOD OF
APPLICATION**

Spray, Shower or flood the water mixed 'Agenda 25EC' / "Miraj" solution @ 5 liters per sq. meter to all applications to, on or in earth or fill. 'Wood protek' can be applied to wood with brush or spray. Wooden elements intended to be treated must be bark free, dry and not painted, varnished, polished or stained. After application of 'Wood Protek' let the surface dry-out for at least 12 hours. Spraying to wood shall be done by hand compression with an approximate pressure of 20 psi (1.4 kg/sq.cm).

**4.
WORKMANSHIP**

The treatment operation shall be carried out as follows:-

- i After excavation and soil compaction for foundation trenches and pits is complete in each and every respect, and passed for concreting work, but before laying of concrete or stone soling, Pesticides shall be penetrated to a depth of 1 ins (25 mm) minimum in porous earth or fill material at bottom and 2 ins (50 mm) to 3 ins (75 mm) at sides of excavations.
- ii Stock piled excavated materials or materials brought from outside the site and to be used as backfill are to be treated as above. After backfilling to required grade the area is again to be sprayed.



- iii After grading, compaction and leveling of earth or sand fill and before laying of any soling or lean concrete, all such areas are to be sprayed with 'Agenda 25EC' / "Miraj" or equivalent product approved by the Engineer penetrating a minimum of 1 ins (25 mm) into the earth or fill.
- iv Pesticide solution shall be applied inside the building lines and for a distance of 10 feet (3m) outside all building with specified pressure.
- v All rough wood work for the entire project is to be pesticide treated. All to be concealed/covered wooden elements such as internal frames, cores etc. shall be anti-termite treated with 'Solignum' or approved equivalent (not colorless) whereas all exposed wooden surfaces such as wooden ply shutters/frames, handrails etc. shall be treated with 'wood protek' (England) or approved equivalent colorless termite control chemical. The aforesaid pesticides shall be applied in accordance with the manufacturer's instructions. Pesticide shall be sprayed on all surfaces of all the wooden work viz, door frames blocking, furring, planks, boards etc., before installation. Spraying is to be done at the Site, after delivery and before installation. No spraying shall be necessary after field sawing, planning, joining or installation of such material. All spraying will be done within one week of working of the materials.

5.
LOCATION AND
SCHEDULING

- i Saturation of earth or fill material is to be done by adequate personnel and in such a manner as to in no way disrupt the progress of the work.
- ii Care shall be exercised to ensure that no mark or damage occurs to the finished building as a result of the work under this section, and Contractor shall verify and ensure that no material used herein will impede the growth of grass or plants in areas where spraying is done.

6.
STANDARDS

All methods of termite protections used herein be in accordance with best standard practices of National Pest Control Association, USA and the British Wood Preserving Association.

7.
GUARANTEE

The Contractor is to guarantee that the building shall be free from termites (white ants), wood bores and other pests or rodents which cause damage to wood or other organic materials for 10 years from the date of acceptance of the building. The Contractor will submit a bond to this affect to the Employer.

In the event of any damage caused within the guaranteed period, the Contractor shall replace at his own cost such damaged materials, finishes affected and suitably preserve and treat the entire premises with the best method known to the trade to prevent the spreading of termites.

8.
SAMPLES AND TESTS

All material and samples shall be subject to testing in accordance with the relevant standards specified herein or recommended by approved supplier and shall be rejected if found below these standards. Rejected materials shall be removed from the site immediately.

9.
MEASUREMENT AND PAYMENT

- i Unless otherwise specifically stated in the Bill of Quantities or herein, all the works involved within the scope of this section of Specifications shall be deemed to be inclusive of but not limited to the following:
 - a) CONTRACTORS establishment charges, overhead charges, profit, interest.
 - b) All other expenses, charges, taxes specified in the Conditions of CONTRACT.
 - c) Labor and all costs in connection therewith.
 - d) Use of plant, equipment and machinery and all costs in connection therewith, e.g. mobilization, demobilization, transporting, fuel, energy charges, grease, oil, installing, operating, storing, watching, returning, replacing, handling, maintaining, idle stand parking, removing, damaged, destroyed, salvaged.
- ii Material and goods, e.g. marketing, selecting, conveyance, loading, unloading, storing, watching, returning, handling, hoisting, lowering, cutting, joining, fixing, wastage, destroyed, damaged, salvaged.
 - a) The cost of all the works involved within the scope of this section of Specifications as per all the relevant Drawings are covered within the quoted unit rate of the item of the Bill of Quantities. **The scope of work**



includes treatment to all horizontal and vertical surfaces below grade and under floors. However, the measurement shall be made on the basis of excavated footprint of the building at Ground floor only and the unit rate shall cover all surfaces to be treated (horizontal and vertical).

- b) No separate payment will be made for Termite Control treatment on wood work covered under this section of Specifications, and all cost in connection therewith shall be deemed to have been included in the unit rates of the relevant items.

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**1.
SCOPE**

The work to be done under this section of Specifications consists of furnishing all plant, labour, equipment, appliances and materials for performing all operations required in connection with the construction of stone soling, in strict accordance with this section of Specifications & Drawings and/or as directed by the Engineer, subject to the terms and conditions of the Contract.

**2.
STONE**

Stone to be used shall comprise of strong, hard, durable stone of the approved size free from impurities, quarry sap, dust, dirt and solubility characteristics. The stone shall be obtained from approved quarries and shall be sound free from luminations and weak cleavages.

**3.
CONSTRUCTION**

Preparation of sub-grade:

Sub-grade shall be formed of suitable materials free of clods, sod, roots, stumps, brush or other objectionable material. Sub-grade material shall be placed in successive layers not exceeding 6" (150mm) in thickness loose measure, and each layer shall be thoroughly compacted to the satisfaction of the Engineer to levels and grades shown on the drawings.

Compaction shall be done by approved methods compatible with the soil /material to be compacted.

**4.
STONE BALLAST/
SOLING**

- i The stone ballast shall be well graded and broken hard stone of 2" (50mm) in maximum size obtained from an approved quarry.
- ii The well compacted soling stone shall be approximately 6" (150mm) in size from an approved quarry.

Laying:

The stone shall be laid and packed to even grades and well rolled using a 10-ton roller to a consolidated thickness as shown on the Drawings.

The whole of the surface of the compacted stone soling will be blinded with murum or any other approved material, after the interstices have been filled with smaller size stones, so as to effectively fill in the voids and crevices, watered, if necessary and again thoroughly rolled with the same roller to produce a smooth and even surface free from irregularities and true to line and level.



Care is to be taken to avoid any damage to existing structures, mains or pipes while rolling operation is in progress. In places inaccessible for a roller, compaction shall be done by hand tampers weighing not less than 20 lb. (9 kg) or power rammers, or motorized compacting machines as directed by the Engineer.

5

**MEASUREMENT
AND
PAYMENT**

- i Unless otherwise specifically stated in the Bill of Quantities or herein, all the work involved within the scope of this section of Specifications shall be deemed to be inclusive of but not limited to the following:
 - a Contractor's establishment charges, overhead charges, profit, interest.
 - b All other expenses, charges, taxes specified in conditions of Contract.
 - c Labour and all costs in connection therewith.
 - d) Use of plant, equipment and machinery and all costs in connection therewith e.g. mobilization, demobilization transporting, fuel, energy charges, grease, oil, installing, operating, storing, watching, returning, replacing, handling, maintaining, idle stand, parking, removing, damaged, destroyed, salvage.
 - e) Material and goods e.g. marketing, selecting, conveyance, loading, unloading, storing, watching, returning, handling, hoisting, lowering, cutting, joining, fixing, wastage, destroyed, damaged, salvaged.
- ii The cost of all the works involved within the scope of this Specifications as per all the drawings and conditions of Contract are covered only within the quoted rate of items of the B.O.Q.
- iii Unless due to change of Technical Specifications or change in the Drawings, no payment for separate items shall be made.
- iv The measurement for payment of stone soling as specified in the Specifications and B.O.Q will be made on the basis of Cft (CM) of compacted stone soling conforming to the drawings or as directed by the Engineer.



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**1.
SCOPE**

The work covered by this section of Specifications consists of furnishing all plant, labor, equipment, appliances and materials, and in performing all operation in connection with the supply and installation of plain and reinforced concrete work, complete in strict accordance with this section of the Specifications and the applicable drawings, subject to the conditions of the CONTRACT.

**2.
GENERAL**

- a. Full co-operation shall be given to other trades to install embedded items.
- b. Suitable templates or instructions, or both will be provided for setting items not placed in the forms. Embedded items shall have been inspected, and tests for concrete and other material or for mechanical operations shall have been completed and approved, before concrete is placed.
- c. For special concrete finishes and for special methods of construction (e.g. slip forms), formwork shop drawings shall be designed and prepared by the CONTRACTOR at his own cost. Approval of shop drawings as well as that of actual samples of finished concrete shall be obtained before WORK is commenced.
- d. CONTRACTOR shall also prepare BAR BENDING SCHEDULE, and get the same approved by the ENGINEER, prior to commencement of work.
- e. Approximate equivalent conversion of F.P.S. and S.I. units are indicated in the text. Engineers decision on any specific conversion shall be final and binding on all parties.

**3.
RELATED SPECIFICATIONS**

Latest editions of the following British, ASTM and ACI Standards are relevant to these Specifications where indicated:- (Equivalent Pakistan Standards are also applicable.)

a. British Standards:

B.S. 12-78	Portland Cement, Ordinary and Rapid Hardening (in lieu of C-150).
B.S. 410	Test Sieves.
B.S. 693	General Requirements for Oxyacetylene Welding of Mild Steel



B.S. 822-1201	Concrete aggregates from Natural Sources.
B.S. 1141	Cold Worked Steel Bars for the reinforcement of Concrete. General Requirements for the Metal - Arc Welding of MildSteel.
B.S. 1881	Methods of Testing Concrete.
B.S. 3148	Tests for Water for Making Concrete.
B.S. 4027	Sulfate-Resisting Portland Cement.
B.S. 4449	Hot Rolled Steel Bars for the Reinforcement of Concrete.
B.S. 4461	Cold Worked Steel Bars for the Reinforcement of Concrete.
B.S. 4466	Bending Dimensions and Scheduling of Bars for the Reinforcement of Concrete.

b. ASTM Standards:

A 615	Deformed Billet-Steel Bars for Concrete Reinforcement.
C 33-78	Standard Specification for Concrete Aggregates.
C 39-72	Compressive Strength of Cylindrical concrete Specimens.
C 42-77	Standard Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
C 94-78	Standard Specification for Ready Mixed Concrete.
C 138-71 T	Tentative Method of Test, for Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete.
C143-78	Standard Method of Test for Slump of Portland Cement Concrete.
C 150-72	Standard Specification for Portland Cement.
C 171-69	Standard Specification for Sheet Materials for Curing Concrete.
C 172-71	Standard Method of Sampling fresh Concrete.
C 173-71	Standard Method of Test for Air Content of freshly Mixed Concrete by the Volumetric Method.



C 208-72	Standard Specification for Insulating Board (Cellulosic Fiber) Structural and Decorative.
C 231-72T	Tentative Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
C 260-77	Standard Specifications for Air Entraining Admixtures
C309	Standard Specification for Liquid Membrane-Forming Compounds for curing Concrete.
C 494-71	Standard Specification for Chemical Admixtures for Concrete.
E 329-70	Recommended practice for Inspection & Testing Agencies for Concrete & Steel as Used in Construction.
- c ACI Standards:**
- | | |
|---------|--|
| ACI 318 | Building Code Requirements for Reinforced Concrete |
|---------|--|
- e In addition, the latest editions of other Pakistan and British Standards, American Concrete Institute Standards, American Society for Testing and Materials Standards and other Standards as may be specified by the ENGINEER for special Materials and Construction are also relevant.**

4. MATERIALS

4.1 Aggregates (Except for light-weight concrete):

- a. The sources of supply of all fine and coarse aggregates shall be subject to the approval of ENGINEER.
- b. All fine and coarse aggregates shall be clean and free from clay, loam, silt, and other deleterious matter. If required, ENGINEER reserves the right to have them washed by the CONTRACTOR at no additional expenses. Coarse and fine aggregates shall be delivered and stored separately at SITE. Aggregates shall not be stored on muddy ground or where they are likely to become dirty or contaminated.
- c. Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of ASTM C-33.
- d. Coarse aggregate shall be gravel or broken stone or hard, durable material free from laminated structure and conforming to ASTM C-33 graded as follows for use in mass concrete such as in foundations:



TOTAL PASSING

PERCENT BY WEIGHT

2" B.S Sieve (50.00 mm)	100
1-1/2" Sieve (38.00 mm)	95 - 100
3/4" Sieve (19.00 mm)	35 - 70
3/8" Sieve (9.50 mm)	10 - 30
No. 4 Sieve (4.75 mm)	0 - 5

Coarse aggregate for all cast-in-place concrete other than mass concrete and thick fair faced cast-in-place concrete shall be graded with the following limits:-

TOTAL PASSING

PERCENT BY WEIGHT

1" Sieve (25.00 mm)	100
3/4" Sieve (19.00 mm)	90-100
3/8" Sieve (9.50 mm)	20- 55
No. 4 Sieve (4.75 mm)	0- 10

Coarse aggregate for thin fair faced cast-in-place concrete shall be graded as follows:-

TOTAL PASSING

PERCENT BY WEIGHT

1/2" Sieve (12.50 mm)	100
3/8" Sieve (9.50 mm)	85-100
No. 4 Sieve (4.75 mm)	10- 30

- e. The nominal maximum size of aggregate for precast fair faced concrete shall be smallest of the following:
 - i One-fifth of the narrowest dimensions between sides of forms.
 - ii One-third of the depth of slabs.
 - iii Three-fourth of the minimum clear distance between reinforcing bars or between bars and form.
 - iv 1/2" (12 mm).
- f. The nominal maximum size of the aggregate for normal weight precast concrete shall be smallest of the following:-
 - i One-fifth of narrowest dimension between forms.
 - ii One-third of depth of slab.
 - iii Three-fourth of clear distance between bars.
 - iv 1" (25mm)
- g. The aggregate shall be stockpiled for a period before use so as to drain nearly to constant moisture content (as long as SITE and other conditions permit, preferably for at least a day). The grading of the coarse and fine aggregate shall be tested at least once for every 50 tons (or 750 C. ft) supplied to ensure that the

grading is uniform and the same as that of the samples used in the preliminary tests.

**4.2
Cement:**

- a. Cement shall conform to ASTM C - 150.
- b. Only one brand of each type of cement shall be used for concrete in any individual member of the structure.
- c. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed. There shall be sufficient cement at SITE to ensure that each section of WORK is completed without interruption. If the cement is supplied by THE OWNER, the CONTRACTOR shall inform ENGINEER of his requirement much before its use in construction.
- d. Cement reclaimed from cleaning of bags or from leaky containers shall not be used.
- e. CONTRACTOR shall provide and erect, at his own cost, in a suitable place, dry, well ventilated, and water proof shed of sufficient capacity to store the cement.
- f. The cement shall be used as soon as possible after delivery, and cement which ENGINEER considers has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise shall be rejected and removed immediately from the SITE at CONTRACTOR's expense. Any cement in containers, damaged so as to allow the contents to spill or access of the atmosphere to the cement prior to opening at the time of concrete mixing shall be rejected and removed immediately from the SITE at CONTRACTOR's expense.
- g. The mixing together of different types of cement shall not be permitted.

**4.3
Water:**

Clean and clear water which does not have sweet, saline or brackish taste to be used for mixing and curing of concrete. Where doubt exists, the strength of mortar sample made with questionable water is compared with mortar sample produced with acceptable water (like distilled water). The questionable water may be accepted if the sample yield concrete strength of at least 90% of the other sample made with acceptable water.

Water contaminants under no circumstance shall be greater than following limits:-

Oil ----- 0.00 ppm.
Chlorides ----- 1000 ppm.
Sulfates ----- 1000 ppm.
Turbidity ----- 2000 ppm.



Acids----- 10,000 ppm.

Potassium and NaOH 0.5 to 1.0% by weight of cement.

Sea water shall not be used for any reinforced concrete works or where concrete is later required to be plastered, painted or otherwise decorated.

4.4 Reinforcement:

- a. Reinforcement for concrete shall conform to the respective British, ASTM or other standards as specified in the Drawings and CONTRACT Documents or as may be specified by ENGINEER.
- b. Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements of ASTM A615 for deformed steel bars and shall have minimum characteristic stress of 60 ksi, (414 N/mm²). with minimum elongation of 12%.
- c. Reinforcement shall be obtained only from the manufacturer approved by the ENGINEER. If and when required CONTRACTOR shall provide all necessary facilities to ENGINEER for the selection of test pieces and shall cause these to be prepared and submitted where directed for tests at CONTRACTOR's cost.
- d. If the reinforcement is to be supplied by the OWNER, the CONTRACTOR shall inform ENGINEER of his requirements much before its use in construction.
- e. CONTRACTOR shall report immediately on receipt of any consignment, having any deviation in the standard weights of the reinforcing bars beyond those allowed in respective standards mentioned in clause (4.4.b) and (4.4.c) herein before.



5. CONCRETE MIX PROPORTIONS

5.1 General:

- a. The proportions of ingredients shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the WORK, but without permitting the materials to segregate or excessive free water to collect on the surface. Specific approval of the ENGINEER is required to waive limitations on mixture proportions.
- b. The proportions of ingredients shall be selected in accordance with Section 5.6 to produce the proper placeability, durability, strength and other required properties.

5.2 Strength:

The Specified compressive strength of the concrete cylinder, shall be 3000 psi, (21 N/mm sq) except where otherwise noted on Drawings. The equivalent cube strength shall be at least 25% higher than the specified cylinder strength. Strength requirements shall be based on the sampling and testing methods of ASTM C 39-72 (and BS 1881 for cube).

5.3 Durability:

Maximum permissible water-cement ratios for concrete in severe exposures to be as follows, unless lower water-cement ratio is required to meet specified strength limits:

Type of Structure	Structure continuously wet or frequently freezing and thawing ¹	Structure exposed to sea or sulfates
i. Thin sections & sections with less than 1" (25mm) cover over steel	0.45	0.40 ²
ii. All other Structures	0.50	0.45 ²

5.4 Slump:

¹Concrete should also be air-entrained.

²If S. R. Cement is used, permissible water-cement ratio may be increased by 0.05.

Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 4" (100 mm) or less. A tolerance of upto 1" (25 mm) above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete of lower than usual slump may be used provided it is properly placed and consolidated. The slump shall be determined by the "Test for Slump for Portland Cement Concrete" (ASTM C-143).

5.5 Admixtures:

If required or permitted, admixtures used shall be in accordance with the manufacturer's instructions except as otherwise specified herein.

5.6 Methods of Obtaining Mix Design:

For concrete of normal weight, mix proportions to provide the desired characteristics shall be developed using the methods/procedure covered by the latest edition of Recommended Practice for Selecting Proportions for Normal Weight Concrete ACI 211.1.

Trial mixtures having proportions and consistencies suitable for the WORK shall be made based on ACI 211.1, using at least three different water-cement ratios which will produce a range of strengths encompassing those required for the WORK. Trial mixes shall be designed to produce the specified slump. The temperature of concrete used in trial batches shall be reported.

For each water-cement ratio, compression test of cylinder/cube shall be made, cured, and tested in accordance with "ASTM C - 39 or BS 1881". From the results of these tests a curve shall be plotted showing the relationship between the water-cement ratio and compressive strength. From this curve, the water-cement ratio to be used in the concrete shall be selected to produce the required/specified design strength. The cement content and mix proportions to be used shall be such that this water-cement ratio is not exceeded when slump is the maximum permitted. Control in the field shall be based upon maintenance of proper cement content and slump.

6. PLANT AND WORKMANSHIP

6.1 Formwork:

- a. Forms shall be used, wherever necessary, to confine the concrete and shape it to the required dimensions. Forms shall have sufficient strength to with-stand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

Structurally adequate, form work shall also conform to the requirements of the special architectural finishes of the in-situ Plain and Reinforced Concrete specified/or shown on the Drawings. Shop drawings of such form shall be subject to the approval of the ENGINEER prior to its use. ENGINEER shall refuse concreting of any part which in his opinion may not yield specified finishes.

- b. Earth cuts shall not be used as forms for vertical surface or reinforced concrete work unless required or permitted.
- c. Mud centering shall not be permitted without the prior approval of the ENGINEER.
- d. Formwork shall be made of either timber, steel, plywood, proprietary building boards and such special material, as may be shown on the drawings or approved by the ENGINEER which gives the required finish to the surface of concrete. Wooden frame work shall be free from loose knots and shall be well seasoned. For the external concrete finishes 1/16" (1.5 mm) thick mild steel sheet forms shall be used. CONTRACTOR shall furnish shop drawings of such formwork prepared on the basis of architectural concept for the approval of the ENGINEER.
- e. Formwork shall conform to the shape, lines and dimensions as shown on the plans, and be so constructed as to remain sufficiently rigid during the placing and compacting of concrete, and shall be sufficiently tight to prevent loss of cement slurry. The design and engineering of the formwork, as well as its construction, shall be the responsibility of CONTRACTOR. Where necessary to maintain the specified tolerances, the formwork shall be **cambered** to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads.

CONTRACTOR shall establish and maintain in an undisturbed condition, and until final completion and acceptance of the WORK, sufficient control points and bench marks to be used for reference purpose to check tolerances.

- f. Requirements for facing materials are given in clause 8 "Finishing of formed Concrete". The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
- g. Where natural plywood form finish, grout cleaned finish, smooth rubbed finish, scrubbed finish, or sand floated finish is required, forms shall be smooth (faced with plywood, liner sheets, or prefabricated panels) and true to line, in order that the surfaces produced with required little dressing to arrive at true surfaces. Where any as-cast finish is required, no dressing shall be permitted in the finishing operation.
- h. Whereas cast surfaces, including natural plywood form finish, are specified, the panels of materials against which concrete is cast shall be arranged orderly with joints between panels planned in approved relations to opening, building corners, and other architectural features.



- i. Where panels for as-cast surfaces are separated by recessed or otherwise emphasized joints, the structural design of the forms shall provide for locating form ties within the joints so that patches of tie holes will not fall within the panel areas.
- j. Forms shall not be re-used if there is any evidence of surface wear and tear or defect which would impair the quality of the surface. Forms shall be thoroughly cleaned and properly coated before re-use.
- k. The formwork may be designed so that soffits of slabs and sides of beams, columns, and wall may be removed first leaving the forms to the soffits of beams and their supports in position.
- l. Positive means, wedges or jacks of accurate adjustment and proper removal of shores and struts shall be provided and all settlement shall be taken up during placing of concrete. Forms shall also be securely braced against lateral deflections.
- m. Where concreting of narrow members is required to be carried out within formwork of considerable depth, temporary openings in the sides of the formwork shall be provided where necessary to facilitate the placing and consolidation of the concrete. Small temporary openings shall be provided at the bottom of the formwork to columns, walls and deep beams to permit the cleaningout of debris and observations immediately before concrete is deposite.
- n. Form ties shall be constructed so that the ends or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than twice the diameter or twice the minimum dimension of the tie from the formed faces of concrete to be permanently exposed to view except that in no case shall this distance be less than 3/4" (19 mm) when the formed face of the concrete is not to be permanently exposed to view, form tie may be cut off flush with the formed surfaces. Through bolts shall be permitted provided that they are greased to allow for easy withdrawal and the holes subsequently made good. Through bolts are not to be used on water-retaining structures.
- o. At construction joints, contact surface of the form sheathing for flush surfaces exposed to view shall overlap the hardened concrete in the previous placement by not more than 1" (25 mm). The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint and to maintain a true surface.
- p. Runways or planks for moving labor and equipment shall be provided with struts or legs and shall be supported directly on the formwork or structural member without resting on the reinforcing steel.
- q. All surfaces of the embedded items shall be cleaned and any accumulated mortar or grout from previous concreting and of all other foreign material is removed before concrete is placed in them.



- r. Board forms having joints opened by shrinkage of the wood shall be swelled until closed by wetting before concrete is placed. Plywood and other woodsurface not subject to shrinkage shall be sealed against absorption of moisture from the concrete either by (1) a field applied, approved form oil or sealer, or (2) a factory applied non- absorptive liner. When forms are coated to prevent bond with concrete, it shall be done prior to placing of the reinforcing steel. Care shall be taken that such approved coating is kept out of contact with the reinforcement. Whereas cast finishes are required, materials, which will impart a stain to the concrete shall not be applied to the form surfaces. Where the finished surface is required to be painted, the material applied to form surface shall be compatible with the type of paint to be used.
- s. In normal circumstances generally where temperatures are above 68°F (20°C) where ordinary cement is used, forms may be struck after expiry of the following periods.
- | | | |
|--------|--|-------------------------|
| - | Walls, columns and vertical sides of beams | 48 hours or as directed |
| by the | | ENGINEER. |
| - | Slabs (Shores or props left under, removal and refixing of props not permitted). | 10 days |
| - | Beams soffits (Shores or props left under, removal and refixing of props not permitted). | 12 days |
| - | Removal of shores or props to slabs: | |
| 1. | Spanning upto 14 ft. (4 meters) | 10 days |
| 2. | Spanning over 14 ft. (4 meters) | 21 days |
| - | Removal of shores or props of beams: | |
| 1. | Spanning upto 20 ft. (6 meters) | 18 days |
| 2. | Spanning over 20 ft. (6 meters) | 25 days |



For rapid hardening cement 1/2 of the above period will be sufficient in all cases except vertical sides of slabs, beams and columns which should be retained for a minimum of 24 hours.

- t. Proper allowance shall be made for the decrease in rate of hardening of concrete in cold weather and the minimum periods must be increased when the mean daily temperature is below 68°F, (20°C).
- u. When repair of surface defects or finishing is required at an early age, forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.
- v. Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or the treatment required on such sloping surfaces shall be performed at once and followed by the specified curing.
- w. All formwork shall be removed without such shock or vibration as would damage the reinforced concrete.
- x. When reshoring or repropping is permitted or required, the operations shall be planned in advance and shall be subject to approval. While reshoring is underway no live load shall be permitted on the new construction. In no case during reshoring shall concrete in beams, slab, columns or any other structural member be subject to combined dead and construction loads in excess of the load permitted by ENGINEER for the developed concrete strength at the time of reshoring. Reshores shall be placed simultaneously with stripping operations are but in no case later than the end of working day on which stripping occurs.

Reshores shall be tightened to carry their required loads without over stressing the concrete. Reshores shall remain in place at least until representative tests of the concrete being supported have reached the strength/time specified in 6.1.s.

- y. Floors supporting props or shores under newly placed concrete shall have their original supporting props or shores left in place or shall be reshored. The reshoring system shall have a capacity sufficient to resist the anticipated loads and in all cases have a capacity equal to at least one half of capacity of the shoring system above. The reshores shall be located directly under a shore position above unless other locations are permitted.

The reshoring or re-propping shall extend over a sufficient number of storeys to distribute the weight of newly placed concrete, forms, and construction live loads in such a manner that the design superimposed load of the floors supporting shores or props are not exceeded.

No loads, other than those permitted by the ENGINEER in connection with the actual work in hand, shall be allowed on suspended floors until 28 days after concreting where ordinary Portland cement is used and 14 days when rapid hardening Portland cement is used.



- z. It is required to give forms for reinforced concrete an upward camber to ensure that the beams or slabs including cantilever slabs do not have a sag when they have taken up their deflection. Camber, unless indicated otherwise on drawings, should be about 1/240 for supported beams and slabs and 1/180 for cantilevers.

6.2 Reinforcement:

- a. All metal for reinforcement shall be free from loose mill scale, loose rust, mud, oil, grease, or other harmful matter immediately before the concrete is placed.
- b. Reinforcement is to be accurately placed as shown in the Drawings, and secured against displacement by using 18-20 gauge black annealed wire ties or suitable slips at intersections and supported from the formwork by using concrete, metal or plastic chairs and spacers or hangers of an approved pattern. Where concrete blocks are used for ensuring the cover they shall be made of mortar not leaner than 1 part of cement to 2 parts of sand. Where the concrete surface will be exposed to the weather in the finished structure the portions of all accessories in contact with the formwork shall be galvanized or shall be made of plastic.
- c. Bars used for concrete reinforcement shall be fabricated in accordance with the dimensions shown in the Bending Schedule.
- d. The cutting tolerance for all bars shall be +/-1" (+/- 25 mm).
- e. Where an overall or an internal dimension of a bent bar is specified in the schedule, the bending tolerance, unless otherwise stated, shall be as in Table 1.

TABLE 1--BENDING TOLERANCES

DIMENSIONS OF BENT BARS						TOLERANCE	
Over		Upto and Including		Plus		Minus	
Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)
--	--	36	900	1/8	3	1/4	6.0
36	900	72	1800	1/4	6.0	1/2	12.0
72	1800	--	--	1/2	12.0	1	25.0

- f. Bars shall be placed to the following tolerances:



- i. Concrete cover to formed surface:
+/- 1/4" (6.0 mm)
- ii. Minimum spacing between bars:
+/- 1/4" (6.0 mm)
- iii. Top bars in slabs and beams:
 - * Members 8" (200 mm) deep or less:
+/- 1/4" (6.0 mm)
 - * Members more than 8" (200 mm) but not over 24" (600 mm) deep:
+/- 1/2" (12.0 mm)
 - * Members more than 24" (600 mm) deep:
+/- 1" (25 mm)
- iv. Crosswise of member:
spaced evenly
within 1" (25 mm)
- v. Lengthwise of members:
+/- 2" (50 mm)
- g. Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, resulting arrangement of bars shall be subject to approval of the ENGINEER.
- h. Vertical bars in column shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all columns dowels.
- i. Reinforcement shall not be bent or straightened in a manner that will injure the material. No bars shall be bent twice in the same place, nor shall they be straightened after bending.

Unless permitted by the ENGINEER, reinforcement shall not be bent after being partially embedded in hardened concrete. Bars which depend for their strength on cold working shall not be heated for any reason (except for welding) Reinforcement larger than 1-1/2" (38.0 mm) in dia may be bent by the use of heat at (not exceeding 1550 °F). Bars bent shall not be cooled by quenching.
- j. No splice of reinforcement shall be made except as shown on the working Drawings.



- k. Welding shall be permitted for bars only under suitable conditions and with suitable safeguards in accordance with B.S 693. 1856, or AWS D 12.1, provided the type of reinforcement bars have the required welding properties. Tack welding may be used to fix in position bars that cross each other, only with prior approval of the ENGINEER.
- l. Exposed reinforcement intended for bonding with future extensions is to be effectively protected from corrosion. Protection is also to be provided to reinforcement partly built into concrete exposed part to be built into later concrete.
- m. No concreting is to be carried out until the reinforcement has been checked and approved by the ENGINEER.

6.3 Batching:

- a. All cement, including cement supplied in bulk, shall be batched by weight. A bag of cement, unless marked otherwise, may be taken as 112 lbs (50 kg) or as directed by the ENGINEER
- b. Aggregate shall be batched by weight, due allowance being made for water content. Aggregate may be batched by volume only with the prior permission of ENGINEER. The apparatus for weight batching may be an integral part of the mixer or a separate unit of a type approved by ENGINEER.. It shall be accurate within 2% and shall be checked for accuracy at least once a week.
- c. Where the batching plant is of the type in which cement and aggregate are weighed in the same compartment, the cement shall be introduced into the compartment between two sizes of aggregate.
- d. Where volumetric batching of aggregate is permitted gauge boxes shall be provided for measuring the coarse and the fine aggregate. These shall be **deep and narrow rather than shallow and wide**. Tests for the bulking of sand shall be made at intervals and the necessary quantity of sand added.
- e. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue to flow for a period which may extend to the end of the first 25 percent of the specified mixing time.

6.4 Mixing:

- a. The concrete shall be mixed in an approved batch mixer conforming to the requirement of B.S 1305. It shall be fitted with the manufacturer's plate stating the rated capacity and the recommended number of revolutions per minute and



shall be operated in accordance therewith. It shall be equipped with a suitable charging mechanism and an accurate water measuring device.

- b. Mixing shall continue for the period recommended by the mixer manufacturer or until apparently the mix is uniform in color, whichever period is longer. If it is desired to use a mixing period less than 1-1/2 minute ENGINEER's approval shall be obtained in writing.
- c. Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three quarters of the required mixing time shall take place after the last of the mixing water has been added.
- d. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10% of their original height.
- e. Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be retempered, but shall be discarded.

6.5 Transport:

- a. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by means which will prevent segregation or loss or addition to ingredients. It shall be deposited as nearly as practicable in its final position so as to avoid rehandling or flowing. All skips vehicles, or containers used for transporting the concrete shall be thoroughly cleaned.
- b. During hot or cold weather, concrete shall be transported in deep containers to minimize the loss of water/heat.

6.6 Placing:

- a. Before placing of concrete, formwork shall have been completed, water shall have been removed, reinforcement shall have been secured in place, expansion joint material, anchors, and other embedded items shall have been kept in position, and the entire preparation shall have been approved.

No concrete is to be placed into the foundation trenches until the ground to receive the same has been examined and approved by ENGINEER for this purpose.

- c. The actual sequence of construction proposed by CONTRACTOR shall be subject to ENGINEER's approval before construction starts on any part of the structure, and this sequence shall not be varied without ENGINEER's prior approval.



- d. The concrete shall be placed after it has been mixed as soon as is practicable. Once the concrete has left the mixer no more water shall be added, although the concrete may be mixed or agitated to help maintain workability. The concrete shall not be used if, through any cause, the workability of the mix at the time of placing is too low for it to be compacted fully and to an acceptable finish by whatever means are available.

The time between mixing and placing should be reduced if the mix is richer or the initial workability of the mix is lower than normal, if a rapid hardening cement or an accelerator is used, or if the work is carried out at a high temperature or exposed to a drying atmosphere. CONTRACTOR shall ensure that the delay between mixing and placing does not exceed 30 minutes under any circumstances. Any concrete which does not satisfy this requirement shall not be used.

- e. The concrete shall be deposited as nearly as possible in its final position to avoid rehandling. In no circumstances may concrete be made to flow along the forms by the use of vibrators. Concreting shall be carried out on as a continuous operation using methods which shall prevent separation or loss of ingredients.
- f. The free fall of concrete shall not be allowed to exceed eight feet and where it is necessary for the concrete to be lowered more than this amount, it is not to be dropped into its final position, but it is to be placed through pipe, the lower end of which shall be kept in, or close to the freshly deposited concrete. The dia. of the pipe shall be not less than 4 times the maximum size of aggregate.
- g. For mass concrete, concrete shall be placed in layers approximately 18" (450 mm) thick. Vibrator heads shall extend into the previously placed layer.
- h. The workmen carrying concrete to the SITE, and all other workmen moving about before the concrete is placed shall move only along runways or planks placed over the forms.
- i. Prior to the laying of concrete on load bearing masonry walls, bearing plates and at other points, as may be directed by ENGINEER, the surface will be brought to a true, hard smooth, level using a cement sand mortar in the ratio of 1 volume of cement to 3 volumes of sand. Two layers of building paper weighing 1.3 oz/sq. ft (400 g/m²) will then be laid flat to separate the concrete from the surface on which it is to be laid.

6.7

Construction Joints:

- a. Concreting shall be carried out continuously upto construction joints, the position and arrangement of which shall be pre-determined with the approval of the ENGINEER.
- b. Joints not shown on the Drawings shall be so made and located as to least impair the strength of the structure and shall need prior approval of ENGINEER. In general, they shall be located near the middle of the spans of slabs and beams unless a secondary beam intersects a main beam at this point, in which case the joint in the main beam shall be offset to a distance equal to twice the width of the secondary beam. Joints in walls and columns shall be at the underside of floors



slab or beams, and at the top of footings. Beams, brackets, columns, capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

- c. All reinforcing steel shall be continued across joints. Key and inclined dowels shall be provided as directed by ENGINEER. Longitudinal keys at least 1- 1/2" (40 mm.) deep shall be provided in all joints in walls and between walls and slab or footings.
- d. When the work is to be resumed on a surface which has hardened, such surface shall be roughened in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.
- e. The hardened concrete of construction joints and of joints between footings and walls or columns, between walls or columns and beams or floors they support, joints in un-exposed walls and all others not mentioned below shall be dampened (but not saturated) immediately prior to placing of fresh concrete.
- f. The hardened concrete of joints in exposed work, joints in the middle of beams, and slabs and joints in work designed to contain liquids shall be dampened (but not saturated) and

then thoroughly covered with a coat of cement grout of similar proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surface and at least 1/2" (12.0 mm) thick on horizontal surface. The fresh concrete shall be placed before the grout has attained its initial set.

- g. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brush. Care being taken to avoid dislodging of particles of aggregate. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 6" (150 mm) in thickness, and shall be well rammed against old work, particular attention being paid to corners and close spots.
- h. Stop ends for movement joints or construction joints shall be made by splitting them along the lines of reinforcement or the concrete. Stop ends made of expanded metal or similar material may only be left permanently in the concrete with prior written approval of ENGINEER. Where such stop ends are used, no metal may be left permanently in the concrete closer to the surface of the concrete than the specified cover to the reinforcement. Wood strips inserted for architectural treatment shall be kerfed to permit swelling without pressure on the concrete.



6.8

Embedded Items:

- a. The material, design and location of waterstops in joints shall be as indicated in the Drawings. Each piece of premolded water stop shall be of maximum practicable length in order that the number of end joints will be held to a minimum.

Joints at intersections and at end of pieces shall be made in the manner most appropriate to the material being used. Joints shall develop effective

watertightness fully equal to that of the continuous water-stop material, and shall permanently develop not less than 50% of the mechanical strength of the parent section, and shall permanently retain their flexibility.

- b. Electric conduits and other pipes which are planned to be embedded shall not, with their fittings, displace more than four percent of the area of the cross section of a column on which stress is calculated or which is required for fire protection. Sleeves, conduits, or other pipes passing through floors, walls, or beams shall be of such size or in such location so as not to impair unduly the strength of the construction. Such sleeves, conduits in compression in the displaced concrete, provided that they are not exposed to rusting or other deterioration, are of uncoated or galvanized iron or steel not thinner than standard steel pipe, have a nominal inside diameter not over 2" (50 mm) and are spaced at centers not less than thrice their diameter. Except when plans of conduits and pipes are approved by ENGINEER embedded pipes or conduits other than those merely passing through, shall not be larger in outside diameter than one-third the thickness of the slab, walls, or beam in which they are embedded nor shall be spaced closer than three diameters on center, nor so located as to impair unduly the strength of the construction. Sleeve pipes, or conduits within the limitations of this section may be embedded in concrete with the approval of ENGINEER, provided they are not considered to replace the displaced concrete.

- c. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.

All Contractors whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to introduce and/or furnish embedded items before the concrete is placed.

- d. Expansion joint material, waterstops and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.



6.9

Consolidation:

- a. All concrete shall be consolidated by vibration, so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of form, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall have a minimum frequency of 800 vibrations per minute and sufficient amplitude to consolidate the concrete effectively.

Vibrators shall be inserted and withdrawn at points approximately 18" apart (450 mm). At each insertion, the duration shall be sufficient to cause consolidation, generally from 5 to 15 sec. A spare vibrator shall be kept on the SITE during all concreting operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process supplemented if necessary by spading to work the coarse aggregate back from the formed surface.
- b. If there is any tendency for the mix to segregate during consolidation, particularly if this produces excessive laitance, the mix proportions shall be modified to affect an improvement in the quality of the concrete to the satisfaction of ENGINEER and in conformity with the provisions of Clause 5.
- c. Vibrators shall not be allowed to contact the formwork for exposed concrete surface.
- d. Mechanical vibrators shall be of a type suited in the opinion of ENGINEER to the particular conditions.
- e. Over-vibration or vibration of very wet mix is harmful and should be avoided.

6.10

Curing and Protection:

- a. Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relative constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval of ENGINEER.
- b. For concrete surfaces not in contact with forms, one of the following procedures shall be applied immediately after completion and finishing:
 - Ponding or continuous sprinkling.
 - Application of absorptive mats or fabric kept continuously wet.
 - Application of water proof sheet materials approved by ENGINEER.
 - Application of other moisture retaining covering as approved.
 - Application of curing compound conforming to ASTM C 309. The compound shall be applied in accordance with the recommendations of the



manufacturer immediately after any sheen which develops after finishing has disappeared from the concrete surface. It shall not be used on any surface against which additional concrete or other materials to be bonded unless it is proved that the curing compound will not prevent bond, or unless positive measures are taken to remove it completely from area to receive bonded applications.

- c. Moisture loss from surface placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping forms wet until they can be safely removed. After form removal, the concrete shall be cured until the end of the limit prescribed in Clause 6.10.d by one of the methods of Clause 6.10.b.
- d. Curing in accordance with clause 6.10.a & 6.10.b shall be continued for at least 14 days in the case of all concrete except concrete with Rapid hardening Portland cement for which the period shall be at least 7 days.

Alternatively, if tests are made of cylinders/cubes kept adjacent to the structure and cured by the same methods, moisture retention measures, unless stated otherwise on drawings, may be terminated when the average compressive strength has reached 70 percent of the minimum specified works strength. If one of the first four curing procedures of clause 6.10.b is used initially, it may be replaced by one of the other procedures of that Clause any time provided the concrete is not permitted to become surface dry during the transition.

- e. When the mean daily outdoor temperature is less than 41-degree F (5 C) then temperature of the concrete shall be maintained between 50-68°F (10°C-20°C) for the required curing period of Clause 6.10.d. When necessary arrangements for heating, covering, insulation or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless approved precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.
- f. When necessary, provision for windbreak, shading for spraying, sprinkling, ponding or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.
- g. Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5°F (3°C) in any one hour or 50°F (28°C) in any 24-hour period.
- h. During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials or methods by application of curing procedures, and by rain or running water, self-supporting structures shall not be loaded in such a way as to over stress the concrete.



6.11

Works in Extreme Weather:

- a. Unless adequate protection is provided and approval is obtained concrete shall not be placed during rain. Rain water shall not be allowed to increase the mixing water nor to damage the surface finish.
- b. When the temperature of the surrounding air is expected to be below 40 degrees F (4.4 C) during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed shall be no lower than 55 degrees F (13 - C) for sections less than 12" (300 mm) in any dimension nor 50°F (10°C) for any other sections.

When necessary, concrete materials should be heated before mixing and carefully protected after placing; in general, heating of mixing water alone to about 140°F (60°C) may be sufficient for this purpose. Dependence should not be placed on salt or other chemicals for the prevention of freezing. No frozen material or materials, containing ice shall be used. All concrete damaged by frost shall be removed. It is recommended that concrete exposed to the action of freezing weather should have entrained air and the water content of the mix should not exceed 5.5 gallons (25 liters) per bag of cement. If water or aggregate is heated above 100°F (38°C) the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 100°F (38°C).

- c. During hot weather, the temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and should not exceed 90°F (32.°C). For massive concrete this temperature should not exceed 70°F (21.°C). When the temperature of the concrete exceeds 90°F (32°C), precautionary measures approved by ENGINEER shall be put into effect. When the temperature of the steel is greater than 122°F (50°C) steel forms and reinforcement shall be sprayed with water just prior to placing the concrete. The ingredients shall be cooled before mixing, or flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

Other precautions recommended by ACI standard 305R-91 shall also be adopted.

7.

TEST FOR CONCRETE QUALITY

7.1

General:

CONTRACTOR shall provide samples of concrete for testing at ENGINEER's direction. Proper facilities shall be provided for making and curing the test specimens in accordance with the specifications. A competent person shall be employed by CONTRACTOR whose first duty shall be to supervise all stages in the preparation and placing of the



concrete. All test specimens shall be made and SITE tests carried out under his direct supervision and at CONTRACTOR's cost.

7.2 Samples:

Conduct strength tests on at least one test sample per 50 cubic yards of concrete (38 cu meters) with a minimum of one sample per concrete pour. Each test sample shall consist of no less than

three concrete test cylinders/cubes made from a single sample of concrete from a randomly selected batch of concrete, taken at point of discharge from mixer or truck, cured under standard conditions. One cylinder/cube from each sample shall be tested at age 3 days and two at age 28 days unless otherwise directed by the ENGINEER.

7.3 Adequacy of Mix:

In case of Concrete mix, the appropriate strength requirement shall be considered to be satisfied if none of the strengths of the specimen is below the specified strength or if the average strength of the three specimens is not less than the specified strength and the difference between the greatest and least strengths is not more than 20% of that average.

When the results of tests show that the strength of any concrete is below the minimum specified, ENGINEER may give instructions for the whole or part of the work concerned to be removed and be replaced at the expense of CONTRACTOR. CONTRACTOR shall bear the cost of any other part of his, or any other CONTRACTOR's work, which has to be removed and replaced as a result of the defective concrete. If any concrete is held to have failed, ENGINEER may order the proportions of that class of concrete to be changed in order to provide the specified strength.

8. FINISHING OF FORMED CONCRETE

8.1 General:

- a. After removal of forms the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the Drawing or as specified in Clause 8.5.
- b. When finishing is required to match a small sample furnished to CONTRACTOR, the sample finish shall be reproduced on an area at least 100 square feet in an inconspicuous location designated by ENGINEER before proceeding with the finish in the specified location.



8.2

As-Cast Finishes:

a. Rough Form Finish:

No selected form facing materials shall be specified for rough form finish surfaces. Tie holes and defects shall be patched, Unless if required to be retained if so directed by ENGINEER. Fins exceeding 1/4" (6 mm) in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the forms.

b. Smooth Form Finish:

The form facing material shall produce a smooth hard uniform texture on the concrete.

It may be plywood, tempered concrete-form grade hardboard, metal, plasticpaper, or other approved material capable of producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn edge, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All fins shall be completely removed.

8.3

Architectural Finishes:

a. Textured Finishes:

Textured form liners may be of formed plastic sheet, wood, sheet metal, or other material designated in Drawings. Liner panels shall be secured in forms by cementing or stapling, but not by methods which will permit impressions of nail heads, screw heads washers, or the like to be imparted to the surface of the concrete, unless shown otherwise on the Drawings. Edges of textured panels shall be sealed to each other or to dividing strips, if specified or shown, to prevent bleeding of grout. The sealant used shall be non-staining to the surface.

b. Applied Finishes:

When finishes of plaster or similar trowelled materials are to be applied, the surface of the concrete shall be prepared to ensure permanent adhesion of the finish. If the concrete is less than 24 hours old, it can be roughened with a heavy wire brush or scouring tool. If the concrete is older the surface may be roughenedmechanically or by etching with dilute hydrochloric acid. After roughening, the surface shall be washed free of all dust, acid, chemical retarder, and other foreignmaterial before the final finish is applied.



8.4

Rubbed Finishes:

The following finishes shall be produced on concrete with a smooth form finish. Where smooth rubbed finish is to be applied, the forms shall have been removed and necessary patching completed as soon after the placement of the concrete as possible without compromising any structural requirements.

a. Smooth Rubbed Finish:

Smooth rubbed finish shall be produced on newly hardened concrete not later than a day following form removal.

Surfaces shall be wetted and rubbed with carborundum brick or other abrasive until uniform color and texture are produced. No cement grout shall be used other than the cement paste drawn from the concrete itself by the rubbing process.

b. Grout Cleaned Finish:

No cleaning operations shall be undertaken until all contiguous surfaces to be cleaned are completed and accessible. Cleaning as the work progresses shall not be permitted.

Mix 1 part Portland Cement and 1-1/2 part fine sand with sufficient water to produce a grout having the consistency of thick paint. White Portland Cement shall be substituted for a part of the grey Portland Cement in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch. Wet the surface of the concrete sufficiently to prevent absorption of water from the grout and apply the grout uniformly with a brush or a spray gun. Immediately after applying the grout, scrub surface vigorously with a cork float or stone and fill all air bubbles and holes. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, sack or other means. After the surface whitens from drying (about thirty minutes at normal temperature) rub vigorously with clean burlap. The finish shall be kept damp for at least 36 hours after final rubbing.

c. Cork Floated Finish:

1. Remove forms at an early stage, within 2 to 3 days of placement where



possible.

2. Remove ties, and all burrs and fins.
3. Mix 1 part Portland cement and 1 part fine sand with sufficient water to produce a stiff mortar.
4. Dampen surface.
5. Apply mortar with firm rubber float or with trowel, filling all surface voids.
6. Apply a small amount of water with a fog spray to prevent too rapid drying of compressed mortar.
7. Apply a small amount of water with a fog sprayer.
8. Produce the final texture with a cork float using a swirling motion.

8.5

Unspecified Finishes:

If the finish is not designated in the Drawings, the following finishes shall be used as applicable:

a. **Rough Form Finish:**

For all concrete surface not exposed to public view and / or are specified to have subsequent finishing.

b. **Smooth Form Finish:**

For all concrete surfaces exposed to public view and or are not required to have subsequent finishing.

8.6

Related Unformed Surfaces:

Tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the formed surfaces. Final treatment on form surfaces shall continue uniformly across the unformed surfaces.

9.

REPAIR OF SURFACE DEFECTS:

9.1



General:

- a. Any concrete failing to meet the specified strength or not formed as shown on Drawings, concrete with surface beyond tolerances or with defective surfaces which cannot be properly repaired or patched in the opinion of ENGINEER shall be removed and replaced at CONTRACTORS's expenses. ENGINEER may reject any defective concrete and order it to be cut out in part or in whole and replaced at the CONTRACTOR's expense. Only in case of minor surface defects, ENGINEER may approve a surface treatment in accordance with the Clause. 9.2
- b. All ties and bolt holes and all repairable defective areas shall be patched immediately after the removal of forms.

9.2

Repair of Defective Areas:

- a. All honeycombed and other defective concrete shall be removed down to sound concrete. The area to be patched and area at least 6" (150 mm) wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand or an approved bonding agent shall then be well brushed/ applied into the surface.
- b. The patching mixture shall be made of the same material and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2- 1/2 parts sand by damp loose volume. White Portland cement shall be substituted for a part of the grey Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.
- c. The quantity of mixing water shall be not more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
- d. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the

premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface to permit initial shrinkage; it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be covered by approved curing compound, except as specified in Clause 9.2 g. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.

- e. Where as-cast finishes are specified, the quantity of patched area shall be strictly limited. The combined total of patched areas in as-cast concrete surfaces shall not exceed 2 square ft. in each 1000 square feet (2 sq. m in each 1000 sq.m) of as-cast surface. This is in addition to form tie patches, if the project design permits to fall within as-cast areas.



- f. Any patches in as-cast architectural concrete shall be indistinguishable from surrounding surfaces. The mix formula for patching mortar shall be determined by trial to obtain a good color match with the concrete when both patch and concrete are cured and dry. After initial set, surface of patches shall be dressed manually to obtain the same texture as surrounding surfaces.
- g. Patches in architectural concrete surfaces shall be cured for 7 days. Patches shall be protected from premature drying to the same extent as the body of the concrete.

9.3

Tie and Bolt Holes:

After being cleaned and thoroughly dampened, the tie and bolt holes shall be filled solid with patching mortar.

9.4

Proprietary Materials:

If permitted or required by ENGINEER proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures. Such compounds shall be used in accordance with the manufacturer's recommendation with prior approval of ENGINEER.

10.

CONCRETE CONSTRUCTION TOLERANCE

Where tolerances are not stated in the Specifications or Drawing for any individual structure or feature, maximum permissible deviations from established lines, grades and dimensions shall conform to the following. The CONTRACTOR is expected to set and maintain concrete forms so as to ensure completed work within the tolerance limits. These allowable tolerances shall not relieve CONTRACTOR of his responsibility for correct fitting of indicated materials. These tolerances are not cumulative.

10.1

Variation from the plumb (or as specified for sloped walls).

- a. In the lines and surfaces of columns, piers and walls.
 - * In any 10 ft (3 m) of length or height: 1/4" (6 mm)
 - * In any storey or 20 feet (6 meters) Max: 3/8" (10 mm)
 - * Maximum for the entire length or height: 3/4" (20 mm)



- b. For exposed corner columns, control joint grooves and other conspicuous lines.
- * In any bay or 20 feet (6 meters) maximum: 1/4" (6 mm)
 - * Maximum for the entire length or height: 1/2"(12.0 mm)

10.2

Variation from the levels or the grades indicated on Drawings:

- a. In floors, ceilings, beam soffits, and in arrises.
- * In any 10 feet (3 meters) of length: 1/4" (6 mm)
 - * In any bay or 20 feet (6 meters) feet maximum: 3/8" (10 mm)
 - * Maximum for the entire length: 3/4"(20 mm)
- b. For exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
- * In any bay or 20 feet(6m) maximum: 1/4" (6 mm)
 - * Maximum for the entire length: 1/2"(12.0 mm)

10.3

Variation of the entire building lines from established position in plan and related position of columns, walls and partitions.

- a. In any bay or 20 feet (6 m) maximum: 1/2" (12.0 mm)
- * Maximum for the entire length: 1" (25 mm)

10.4

Variation of the size and locations of sleeves, floors openings and wall openings:
1/4" (6 m)

10.5

Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.



Minus:	1/4" (6 mm)
Plus:	1/2" (12.0 mm)

10.6 Footings:

- a. Variations in dimensions in plan.
 - * Minus: 1/2"(12.0 mm)
 - * Plus (plus variation applied to concrete only, not to bars dowels): 2" (50 mm)
- b. Misplacement or eccentricity of concrete.
 - * 2 percent of the footing width in the direction of misplacement but not more than 2"(50 mm)
- c. Reduction in thickness
 - * Minus 5 percent of specified thickness.

10.7 Variation in Steps

- a. Rise: 1/8" (3 mm)
Tread: 1/4" (6 mm)
- b. In consecutive steps
 - Rise: 1/16" (1.0 mm)
 - Tread: 1/ 8" (3 mm)

10.8 Tolerance for Precast Concrete:

Forms must be true to size and dimensions of concrete members shown on the plans and be so constructed that the dimensions of the finished product will be within the following limits at the time of placement of these units in the structure, unless otherwise noted on ENGINEER's Drawings.

- a. Overall dimensions of members per 10 ft (3 mm): +/- 1/16" (1.0 mm)
- b. Cross-sectional dimensions
 - Section less than 3"(75 mm): +/- 1/16" (1.0 mm)
 - Section over 3" (75 mm) less



than 18" (450 mm): +/- 1/ 8" (3 mm)

Section over 18" (450 mm): +/- 1/ 4" (6 mm)

- c. Deviations from straight lines in long sections. Not more than 1/8 inch per 10 ft (3mm / 3 m).
- d. Deviation from specified camber +/- 1/16" (1.5 mm) per 10 ft (3m) of span. Maximum differential between adjacent units in erected position 1/4 inch (6 mm).

10.9

Tolerance for Pavements:

- a. Ramps
 - * Departure from established alignment +/- 1/2 inch (12.0 mm).
 - * Departure from established longitudinal +/- 1/4" (6 mm) grade on any line.
 - * Departure from transverse template contour except at transverse joints +/- 1/8 inch (+/- 3 mm).
 - * Departure from transverse template control at transverse joints +/- 1/4" (+/- 6 mm) in width of one traffic lane.

10.10

Pavements for Parking Areas:

Twice values listed for ramp pavements.

11.

ACCEPTANCE OF STRUCTURE

11.1

General:

- a. Completed concrete work which meets all applicable requirements will be accepted subject to the other terms of the CONTRACT Documents.
- b. Completed concrete work which fails to meet one or more requirements and which has been repaired to bring it into compliance will be accepted subject to the other terms of the CONTRACT Documents.
- c. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Specifications or in the CONTRACT Documents. In this event, modifications complies with the requirements.



11.2

Dimensional Tolerances:

- a. Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of Section 10 considered potentially deficient in strength and subject to the provisions of Section 11.4.
- b. Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of Section 10 may be rejected and the excess material shall be subject to removal. If removal of the excess material is permitted, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance. Permission is required if excess material is to be removed in accordance with this Section.

11.3

Appearance:

- a. Architectural concrete with surface defects exceeding the specified limitations shall be removed in accordance with this Section.
- b. Concrete members cast in the wrong location may be rejected if the strength, appearance or function of the structure is adversely effected or misplaced items interfere with other construction.
- c. Inaccurately formed concrete surfaces exceeding the limits of Section 6 & of Section 10 and which are exposed to view, may be rejected and shall be repaired or removed and replaced if required.
- d. Other concrete exposed to view with defects which adversely affect the appearance of the specified finish may be repaired only by approved methods.
- e. Concrete not exposed to view, but of defective appearance, may be accepted at the discretion of the ENGINEER.

11.4

Strength of Structure:

- a. The strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control the strength of the structure, including but not necessarily limited to the following conditions:
 - Concrete strength requirements not considered to be satisfied in accordance with Section 7.
 - Reinforcing steel size, quantity, strength, position or arrangement at variance with the requirements of Section 4.4 & 6.2 of the CONTRACT Documents.



- Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.
 - Curing less than that specified.
 - Inadequate protection of concrete from extreme temperature during the early stages of hardening and strength development.
 - Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
 - Poor workmanship likely to result insufficient strength.
- b. Structural analysis and/or additional testing may be required when the strength of the structure is considered potentially deficient.
- c. Core tests may be required when the strength of the structure is considered potentially deficient.
- d. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with ACI Standard 318.
- e. Concrete work judged inadequate by structural analysis or by results of a load test shall be reinforced with additional construction, if so directed by ENGINEER or shall be replaced, at the CONTRACTOR's expense.
- f. The CONTRACTOR shall pay all costs incurred in providing the additional testing and/or analysis required by this Section.
- g. THE OWNER will pay all costs of additional testing and/or analysis which is made at his request and which is not required by specifications, or the CONTRACT Documents.

12. METHODS OF MEASUREMENT OF CONCRETE WORKS

12.1 General:

- a. Unless otherwise specifically stated in the Bill of Quantities, or herein, all items shall be deemed to be inclusive of, but not limited to, the following:
- i. Labor/plant and all costs in connection therewith.



- ii. Materials, goods and all costs in connection therewith, e.g. conveyance, delivery, unloading, storing, returning, packing, handling, hoisting, lowering.
 - iii. All fixtures and all costs in connection therewith for precast works.
 - iv. Fitting and fixing materials and goods in position.
 - v. Waste of materials, and Square cutting.
 - vi. Mixing, transporting, hoisting, placing in from at any level, compacting through vibration & curing etc. complete including the cost of formwork & its removal (but excluding cost of reinforcement).
 - vii. Establishment charges, overhead charges and profit.
 - viii. All other expenses, charges and taxes specified in Conditions of CONTRACT.
- b. Works shall be measured net as fixed in position as per drawings and instructions of ENGINEER. Each measurement shall be taken to the nearest 1/2" (12.0 mm). This rule shall not apply to any dimensions stated in the descriptions.

12.2
Concrete:

- a. Concrete shall be measured as executed but no deduction shall be made for the following:
- Volume of any steel embedded in the concrete.
 - Volume occupied by water pipes, conduits etc., not exceeding 4 square inch (2500 sq. mm) each in cross-sectional area.
 - Voids not exceeding 1 square foot in work given in square feet and 0.1 sq M in work given in Sq Meters. If any void exceeds above limit total void shall be deducted.
 - Voids not exceeding 1 cubic foot in work given in cubic feet, 0.03 cubic meter in work given in cubic meter. If any void exceeds above limits, unit total void shall be deducted.
 - b. Voids, which are not to be deducted as per Section 12.2.a above, refer only to openings or vents which are wholly within the boundaries of measured areas. Openings or vents which are at the boundaries of measured areas shall always be subject to deduction irrespective of size.
 - c. Junctions between straight and curved works shall in all cases be deemed to be included with the work in which they occur.



- d. Concrete work shall be classified and measured separately as follows unless otherwise described elsewhere:-
- Buildings, foundation beams, foundation slabs, footings, bases of columns, machine foundations, mass concrete etc., in cubic feet (Cubic Meter).
 - Floor slabs on ground with floor beams in cubic feet (Cubic Meter).
 - Walls in foundations, plinth and superstructure in cubic feet (Cubic Meter) stating thickness.
 - Columns, piers, pilasters, pillars etc., in cubic feet (Cubic meter).
 - Lintels, beams and brackets in cubic feet (Cubic Meter).
 - Suspended floors, roofs and stair landings in square feet (sq. Meter) stating thickness.
 - Stairs (excluding landing) in cubic feet (Cubic Meter).
 - Railings in cubic feet (Cubic Meter), square feet (Sq. Meter), or linear feet (Meter) stating description.
 - Parapets, purdees and the like in cubic feet (Cubic Meter) stating thickness.
 - Jali, blocks in square feet (Sq. Meter) stating thickness & description.
 - Precast concrete items shall each be enumerated except if otherwise shown in the Bill of Quantities, separately stating the description.
- e. Measurement of walls shall be taken between attached columns, piers or pilasters. The thickness of attached columns, piers or pilasters shall be taken as the combined thickness of the wall and the columns, piers or pilasters. Attached or isolated columns, piers, pilasters and the like (except where caused by openings) having a length on plan not exceeding four times the thickness shall be classified as columns. Those having a length over four times the thickness and caused by openings in walls shall be classified as walls.
- Columns shall be measured from the top of footings/beams or floor surfaces to the under side of beams or slabs as the case may be. Where the width of the beams is less than the width of columns, the extra width at the junction shall be included in the beam.
- The depth of the beams shall be measured from bottom of the slab to the bottom of the beams, except in case of inverted beams where it shall be measured from top of slab to the top of beam. The cross section below or above the slab.

12.3

Formwork:

- a. Formwork (if separate and extra payment is specifically stated in the Bill of Quantities) shall be measured in square feet (Sq. M) as the actual surface of the finished structure which required to be supported during the deposition of the concrete, including the upper surfaces to the work sloping more than 15 degree from the horizontal. No allowance shall be made for overlaps and passing at angles and no deduction shall be made for the following:-
 - Voids not exceeding ten square feet (1 Sq. m).
 - Intersections of main beams with walls or columns.
 - Intersections of secondary beams with main beams.
- b. Formwork shall be deemed to be inclusive of, but not limited to items detailed in section 12.1 and the following:-
 - Batten, struts, reversed cut strings, bolting, oiling, wedging, easing, striking, removing and making good exposed faces of concrete after removal of formwork. Also yokes, wales sheathing, jack rods, jacks, working platforms and finishers, scaffolds, etc.
- c. Forming chamfers not exceeding 2" (50mm) wide and forming splayed internal angles not exceeding 1/2" (12.0 mm) wide shall not be paid for extra.
- d. Temporary stop ends for constructed joints shall not be measured and paid for.
- e. Classification of formwork (if separate and extra payment is specifically stated in the Bill of Quantities) shall be as follows:-
 - To horizontal or sloping soffits of suspended slabs, floors, roofs, staircases, landings and the like.
 - To sloping upper surfaces of suspended slabs, floors, roofs and the like where more than 15 degree from horizontal.
 - To vertical or battering sides of foundations, foundation beams and slabs, ground beams, machine foundations and the like.
 - To vertical or battering sides of walls, solid balustrades and the like.
 - To vertical or battering sides.
 - To vertical or battering sides of stanchion casings, columns, piers, plasters and the like.



- To sides and soffits of openings in walls, recesses in walls, projecting panels on walls and the like.
 - To sides and soffits of horizontal or sloping beam casings, beams, brackets, lintels, staircase, strings and the like.
 - To sloping upper surfaces of beam casings, beams, brackets, lintels, staircase-strings and the like where more than 15 degrees from horizontal.
 - To edges of beds, roads, footpaths, paving and the like.
 - To edges of suspended slabs, floors, roofs, landing and the like.
 - To risers of steps and staircases.
 - To sides of kerbs, upstands and the like.
- f. Formwork to throats, grooves, chases, rebates, chamfers over 2" wide (50 mm) splayed internal angles over 1/2" wide (12.5 mm) moldings and the like shall each be measured separately in linear feet stating the size.

12.4

Rate for Reinforcement:

- a. The rate tendered for any type of reinforcement by the CONTRACTOR shall also be inclusive of the cost of binding wire wastages, and the cost of concrete, metal or plastic chairs and spacers or hangers, etc.
- b. All reinforcement shall be provided in length shown in Drawings and as per Specifications.

Should the CONTRACTOR provide lengths of reinforcement which are greater than shown on the Drawings no payment of extra length shall be made. Overlaps, unless clearly shown in working Drawings, shall not be allowed and measured.

- c. The CONTRACTOR shall be paid for reinforcement by weight computed from Table-2 and from linear measurements of reinforcements actually used at SITE as per the Drawings, Specifications and instructions of ENGINEER. No payment shall be made for steel chairs or wastage. CONTRACTOR shall not claim for the difference in the actual weights of bars and their standard weights given in Table -2.



TABLE-2:

Nominal Bar Diameter (Inches) ³		Bar Number	Weight lbs/ft
1/4"	-		0.167
3/8"	# 3		0.376
1/2"	# 4		0.668
5/8"	# 5		1.043
3/4"	# 6		1.502
7/8"	# 7		2.044
1"	# 8		2.670
1-1/8"	# 9		3.400
1-1/4"	#10		4.303
1-3/8"	#11		5.313
1-3/4"	#14		7.650
2-1/4"	#18		13.600

(mm)	(kg/m)
8	0.395
10	0.616
12	0.887
16	1.576
20	2.463
22	2.980
25	3.849
28	4.828
32	6.306
36	7.981

³To the nearest 1/8



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**1.
GENERAL**

**1.1
DESCRIPTION**

1. Work included:

Precast concrete units required for this Work are indicated on the Drawings. Included are provision and installation of items to both interior and exterior conditions such as, but not limited to, copings, sills, jallies, gargoyles and lintels, window units, architectural facades, panels, slabs units, facades, panels, slabs etc.

2. Related work:

- a) Precast concrete flag paving and steps for external work are described under Section 2780 Unit paving.
- b) Precast concrete drain trench units, curbs, curb gutters, posts, water spout etc. are described under Section 2510 Concrete Walks, Roadways Curbs and Gutters.
- c) Tiles for roofing are described under Section 7500 Membrane Roofing.

**1.2.
QUALITY
ASSURANCE**

1. Qualifications of workmen:

- a) For the forming, casting and placing of precast concrete units, use only skilled masons who are thoroughly experienced with the materials and methods specified and thoroughly familiar with the design requirements.
- b) In acceptance or rejection of precast concrete units, no allowance will be made for lack of skill on the part of workmen.
- c) Provide one skilled supervisor who shall be present at all times during execution of the Work of this Section and who shall personally direct the execution of this portion of the Work.

**1.3.
SUBMITTALS**

1. Samples:

- a) Within 120 days after award of Contract, and before any materials for this Section are delivered to the Job Site, submit one set of Shop Drawings and samples of the proposed units to the Engineer for approval in accordance with these Specifications.

- b) Shop Drawings must indicate general arrangement, construction and anchorages.

**1.4.
PRODUCT
HANDLING**

1. Protection:

Protect concrete materials before, during, and after installation and protect the installed Work and materials of other trades.

**2.
PRODUCTS
2.1.
MATERIALS**

1. Concrete:

- a) Concrete shall conform to pertinent requirements of Section 3300: Cast-in-Place Concrete.
- b) Mixes for exposed items such as jallies, copings, sills window units, architectural facades and panels and gargoyles slabs etc. shall be according to structural specification.
- c) Concealed items such as lintels shall be according to structural specifications.
- d) Works crushing strength of units shall be as specified in the structural specifications.

2. Formwork:

Formwork for precast concrete units to conform with Section 3300 of these Specifications and Structural Drawings, however all formwork will be of steel.

3. Reinforcing:

Reinforcing for precast concrete units to conform with Section 3300 of these Specifications, unless otherwise indicated on Shop Drawings.

4. Mortar:

Material for setting precast units in masonry shall be of similar mix described in Section 4200 Unit Masonry.

5. Pigmentation of Units:

Mineral pigment compatible with cement for precast concrete units shall conform to B.S. 1014. Colours shall be resistant to alkalis, lime, heat and light. Colour to be approved by Engineer.

6. Jointing:

Sealants and backing materials required for jointing shall be approved by Engineer.
Refer also to section 7900 Joint Sealants.

2.2.

OTHER MATERIALS

1. Materials and methods not specifically described but required for proper fabrication and installation of precast concrete units, shall be as provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.

EXECUTION

3.1.

**SURFACE
CONDITIONS**

1. Inspection:

- a) Prior to installation of precast units described in this Section, carefully inspect installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
- b) Verify that unit masonry may be completed in accordance with pertinent codes and regulations and the original design.

2. Discrepancies:

- a) In the event of discrepancy, immediately notify the Engineer.
- b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.

FABRICATION

1. Design and cast units to permit handling and installation and to bear weights and stresses to be encountered in completed building.
2. Thoroughly mix pigment with cement in proportions not exceeding 5% by weight of cement or to manufacturer's specifications, both to prior approval of Engineer.
3. Refer to details for shapes and jointing.
4. Ensure a minimum cover of concrete over reinforcement as indicated on Drawings, or as specified in the structural specifications.
5. Cure precast concrete units as per specifications.



3.3
INSTALLATION

1. Ensure that units are not cracked, chipped or stained before, during, or after installation.
2. Install units in accordance with Drawings. Ensure a sound, durable, stable installation suitable to receive following work.
3. Seal joints between parapet copings and flashing copings at roofs with sealants, using recommended procedures and backing materials.
4.
 - a) Units unless specified elsewhere shall be jointed with mortar materials.
 - b) Continuous exposed units shall have mortar tinted to match precast concrete.
5. Precast window units, architectural facades and panels will be lifted in place by a tower crane. The method of lifting of these units will be submitted to the Engineer for approval.
6. Shop drawings for anchorage of precast window units, architectural facades and panels will be submitted for approval to the engineer. Proper and durable anchorage of these units will be the total responsibility of contractor.

3.4.
CLEANING

1. General:
 - a) Do not allow the accumulation of scraps and debris arising from the work of this Section. Maintain the area in a neat and orderly condition at all times. In the event of spilling or splashing material on to other surfaces, immediately remove spilled or splashed material and traces of residue to the approval of the Engineer.
 - b) Clean surfaces of precast concrete units.
 - c) Upon completion of work of this Section, promptly remove from the Job Site broken units, debris arising from the work of this Section, tools and equipment, leaving all areas in a neat and orderly condition to the approval of the Engineer.

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**1.
GENERAL**

**1.1
DESCRIPTION**

1. Work included:

Supply and install masonry accessory materials not specifically described in other Sections of these specifications but required for the construction of masonry unit walls indicated on the Drawings.

2. Items:

Steel dowels indicated as being steel bars similar to plain or deformed types, normally used for the reinforcement of concrete.

**1.2.
SUBMITTALS**

1. Within 120 days after award of Contract, and before any material is delivered to the Job Site, submit to the Engineer complete samples of masonry constituent/ accessories proposed to be furnished and installed.

**1.3.
PRODUCT
HANDLING**

1. Protection:

Protect these materials before, during, and after installation and protect the installed work and materials of other trades.

**2.
PRODUCTS**

1. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to the Employer.

**2.1.
MATERIALS**

1. Where masonry accessories are required, and no material or thickness is indicated on the Drawings, furnish and install the highest quality.
2. Masonry accessories:



-
- a) Control joint filler: Preformed rubber, neoprene or polyvinyl chloride materials of size and shape indicated on Drawings. Refer to Section 7900 Joint Sealants.
 - b) Steel dowels for tying masonry shall be 3/8 in. dia. (9mm) deformed reinforcing bar, coated with liquid galvanizing, in accordance with Section 3300 Cast-in-Place Concrete.
 - c) Wall ties: mild steel wire 1/2 in. by 1/2 in. (12mm x 12mm) mesh 3 ins (75mm) wide, galvanized to B.S. 729 after fabrication or galvanized butterfly type.
 - d) Rope made of jute for weep-hole vents.
 - e) Wall base Flashing: See Division 7.
 - f) Anchors:
 - i) Plate type: minimum 1/8 in. (3mm) galvanized steel, of shapes and sizes to suit purpose.
 - ii) Wire type: 1/4 in. (6mm) galvanized wire of shapes and sizes shown.
 - iii) Anchor bolts: including nuts, washers, studs, ferrules, and related items, of galvanized steel or brass, as detailed.

2.2.
OTHER MATERIALS

1. Materials and methods not specifically described but required for proper installation of items in this Section shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.
EXECUTION
3.1.
INSTALLATION

1. Build-in anchors, plugs, lintels, ties, frames, inserts and other equipment or materials to be embedded in masonry work, as indicated on Drawing or specifications in section 4200.



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1.
GENERAL

1.1
DESCRIPTION

1. Work included:

Unit masonry required for this Work is indicated on the Drawings and includes the provision and installation of Concrete blocks, Clay bricks, brick work, coping units and related material both inside and outside the building.

1.2.
QUALITY
ASSURANCE

1. Qualifications of workmen:

- a) For the actual cutting and placing of masonry units, use only skilled masons who are thoroughly experienced with the materials and methods specified and thoroughly familiar with the design requirements.
- b) In acceptance or rejection of installed masonry units, no allowance will be made for lack of skill on the part of workmen.
- c) Provide one skilled mason who shall be present at all times during execution of the work of this Section and who shall personally direct the execution of this portion of the Work.

1.3.
SUBMITTALS

1. Samples and Mock-ups:

- a) Within 120 days after award of Contract, and before any masonry materials are delivered to the Job Site, submit six samples of the proposed masonry units and colour samples of mortar to the Engineer for his approval in accordance with these Specifications.
- b) At Engineer's or Consultant's direction, construct mock-ups required as part of this Contract:
 - i) Construct built-in lighting niches of various types for review of maintenance, appearance and light dispersal.
 - ii) Construct other special light fixtures in block or brick forms for review.



- iii) Construct external and internal facade/facing of building with all edges, details niches etc. as shown on drawings and instructed by Engineer.

**1.4.
PRODUCT
HANDLING**

1. Protection and Storage:

- a) Protect masonry materials before, during, and after installation and protect installed work and materials of other trades.
- b) Masonry units and packaged material shall be placed on planks raised from the ground, covered with a waterproof tarpaulin and kept well ventilated until time of use. No material shall be allowed to become wet. Use only quantities of blocks/bricks required for immediate use. Do not stock pile units on the structure. Sand or loose material shall be stored so that it will not be contaminated from dirt or other extraneous material from the ground.

2. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to the Employer.

**2.
PRODUCTS
2.1.
CONCRETE BLOCKS**

- 1. Block sizes shall be 16 ins. by 8 ins by 4 ins, 6 ins and 8 ins. (400x200 mm by 100, 150, and 200 mm) thickness including a 3/8 in. (10mm) allowance for jointing. Physical requirements of blocks shall comply with B.S. 6073.
- 2. Solid concrete blocks have a minimum crushing strength of 1,200 psi. per average of 3 units tested, or 1,000 psi. per individual unit tested, based on gross area.
- 3. Hollow concrete block units wherever specified shall have cores with cross sectional area atleast equal to the percent of gross area of block given below:
 - 8 ins (200 mm) 38 percent
 - 6 ins (150 mm) 30 percent
 - 4 in. (100 mm) 30 percent
- 4. Minimum shell wall thickness 1-1/4 in. (31 mm)
- 5. Permissible tolerance in size of block shall be 1/8 in. (3 mm) each way.



6. Block Making:

- a) Blocks shall be machine moulded.
- b) Blocks shall be continuously water cured for a minimum of 10 days and covered between sprinkling operations with a 4 mm. thick polyethylene sheet or hessian cloth. After the curing period blocks shall be air dried. Blocks shall not be installed until completely dry.
- c) Cured concrete blocks shall be stored off the ground so as to allow air circulation.
- d) Blocks cast on different days shall be stacked separately and shall be labelled showing the date on which they were cast.
- e) Properties of blocks not specified here shall conform to BS 6073.

7.

- a) The Contractor shall provide test certificates proving the average minimum crushing strength of the blocks prior to the commencement of the construction. Further test certificates shall be provided as required by the Engineer to ensure that all batches of blocks have the minimum crushed strength specified. The Block strengths are to be determined in accordance with BS 2028.
- b) The test shall be carried out by a laboratory approved by the Engineer. Evidence shall be produced that the block manufacturer has an efficient method of quality control. The Engineer will require to periodically test samples of blocks, & the Contractor shall make any necessary arrangements. The method of sampling for all tests shall be in accordance with BS 2028.
- c) All properties of specifications of blocks not explained in these specifications or BS 2028, shall comply with the requirements of P.S. 419, as directed by the Engineer.

8. ABSORPTION RATE

The Contractor shall at his own cost, satisfy the Engineer that the absorption rate of the block when determined in accordance with BS 3921 does not exceed 20g/mm²/min. or that the Contractor is able to adjust it so that it does not exceed this value on site.

9. SOLUBLE SALT CONTENT

For exposed Blockwork, the contents, by weight percent of soluble sulphate, calcium, magnesium potassium and sodium radicals, shall not exceed respectively 0.30, 0.10, 0.03, and 0.03, percent when ascertained in accordance with BS 3921 at the cost of the Contractor.



2.2.
FACE BRICKS

1. a) Clay bricks to be of first quality, and comply with pertinent data of B.S. 3921.
- b) Brick sizes shall be generally 9 ins by 4-1/2 ins by 3 ins. (225 x 113 x 75mm). A small size of 9 ins by 2-1/4 ins by 1-1/2 ins (225 x 56 x 38mm) shall be used where shown on Drawings. Non Standard sizes and shapes shall be as shown on Drawings. Dimensions include a 3/8 in. (9 mm) allowance for jointing.
- i) Bricks shall be sound, hard and well burnt with uniform size, shape and colour, homogeneous in texture and free from flaws and cracks.
- ii) A fracture surface should show a uniform compact structure free from holes, lumps or grit.
- iii) Arises should be square, straight and sharply defined.
- iv) Brick dimensions shall not vary more than 1/8 in. (3 mm) from standard size.
- v) Bricks shall give a metallic ring when struck with a small hammer or another brick.
- vi) Surface should be hard enough to prevent scratching by a finger nail.
- vii) Bricks should not break when struck against another brick or dropped flat from a height of 3 to 4 ft. (900mm to 1200mm) on a solid surface.
- viii) Bricks shall not absorb water more than 1/16th of their own weight when dry.
- ix) Non-standard shapes shall be of same texture, colour etc. as described for standard units.

2.3.
MASONRY BRICKS

1. All bricks shall be of first class quality made from good brick earth, free from saline deposits and shall be sand moulded. They shall be thoroughly burnt with outbeing vitrified shall be regular, uniform in shape and size with sharp and square edges parallel faces and of deep red or copper colour. First class bricks shall be homogenous in texture and emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and modules of lime. First class brick is an oven dried condition shall not absorb more than 1.5 of its weight of water when immersed one hour in water of 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class brick shall be not less than 8.5 N/mm² (1200 psi) for an individual brick.

2. All bricks shall be manufactured by the Trench Kiln Method or other standard methods approved by the Engineer. The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter. Salts shall not exceed 0.3 percent and calcium carbonate shall not exceed 2.0 percent.
3. The mould used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently large than the size of the bricks being manufactured to allow for shrinkage in drying and burning. Over-size irregular and worn moulds shall be destroyed. Each finished brick for brick masonry shall be 225mm by 114mm by 75mm in size and weight between 3.2 to 4.2 kilograms. All bricks shall have a "frog" 5mm deep on one face.

2.4. GLASS BLOCKS

1. Glass blocks used for decorative purposes are described under section 4270 of the specifications.

2.5. MORTAR

1. Mortar for unit masonry shall achieve a compressive strength of 1500 psi in 28 days, and consist of:
 - a) Portland Cement to BS 12-78.
 - b) Aggregate: damp loose sand to BS 1200, Table 10 graded 3/16 in. down.
 - c) Water: clean and clear water which does not have sweet, saline or brackish taste to be used for mixing and curing of concrete. Conform to B.S. 3148 is essential.
 - d) Mortar colorings: finely ground, first quality, sun-proof, lime-proof, high purity mineral pigment with a specific gravity similar to cement, conforming to B.S. 1014.
 - e) Additives where used, shall be proprietary products used in the proportions and manner recommended by the manufacturer. The additives, shall in no way adversely affect the mortar strength or contain chemicals which may be harmful to other buildings materials. To add gypsum to cement is strictly forbidden.

2.6. REINFORCEMENT STEEL

1. Reinforcement steel required for masonry units shall be as described in Section 4050 Basic Masonry Materials and Methods.

2.7.



GROUT

1. Grout shall consist of Portland cement, sand, pea gravel and adequate water to produce a concrete of approximately 10 inches (250 mm) slump, and shall have a ultimate compressive strength of 1500 psi in 28 days.

**2.8.
CONCRETE**

1. Concrete for infill between top of masonry walls and underside of structure shall be 1:3:6 mix by volume of 2000 psi compressive strength in accordance with Section 3300 Cast-in-Place Concrete.

**2.9.
ADMIXTURES**

1. Admixtures may be used only with the written approval of the Engineer.

**2.10.
WALL TIES**

1. Wall ties as described in Section 4050 Basic Masonry Materials and Methods.

**2.11.
INSULATION**

Insulation to be inserted into the cavities or applied to faces of brick work or block work shall be correctly executed in accordance with the manufacturer's instructions. Where foam insulation is to be inserted into cavities, holes and openings shall be sealed prior to injection to prevent seepage of the foam.

Loose fill insulation shall be poured into cavities from the top of each wall section completed, where required, and shall be allowed to form its natural density, and shall not be tamped.

Where insulation boards are specified, proper anchorage to walls is essential. Refer to Section 7200: Building Insulation of these specifications, type and installation procedures.

**2.12.
SCAFFOLDING**

Contractor shall provide safe scaffolding of adequate strength for use of workmen at all levels and heights at his own expense. Scaffolding which is unsafe in the opinion of the Engineer shall not be used until it has been strengthened and made safe for use of workmen. Cost of scaffolding etc., shall be included by the Contractor in the unit rate for masonry items.

Damage to masonry from scaffolding or from any other subject shall be repaired by the Contractor at his own cost.



2.13.
OTHER MATERIALS

1. Materials and methods not specifically described but required for proper installation of unit masonry, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

2.14.
TESTING

The Contractor will submit samples of all materials such as bricks, blocks, metal wall ties, rawal plugs etc. along with their technical data, catalogue cuts, testing results etc. etc. for the approval of the Engineer who may require to get the material tested by an independent Testing Laboratory to be approved by the Engineer. Blocks and Bricks will be required to be tested as and when delivered to the site. All testing will be carried out at the Contractor's cost. Periodical testing of Blocks will be in accordance to BS 2028. Blocks and bricks will be tested for compressive strength, efflorescence, dimensions, water absorption, manufacturing process, density, surface texture, moisture movement, cement, aggregate and water.

3.
EXECUTION
3.1.
SURFACE
CONDITIONS

1. Inspection:
 - a) Prior to work of this Section, carefully inspect installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
 - b) Verify that unit masonry can be completed in accordance with pertinent codes and regulations and the original design.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify the Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been completely resolved.
3. Environmental Conditions:

During hot weather protect masonry construction from direct exposure to wind and sun when erected in an ambient air temperature above 32 C (90 F) in the shade with a relative humidity less than 50%.



3.2.
COORDINATION

1. Carefully coordinate with other trades to ensure proper and adequate interface with them and the work of this Section.

3.3.
MIXING MORTAR

1. General:
 - a) Use a mechanical mixer of one sack minimum capacity. Hand mixing will be permitted provided quantities of materials and water are accurately controlled, and that method of mixing is approved by Engineer.
 - b) Mix mortar at least three minutes after materials have been added.
 - c) Mix only as much mortar as can be used in one hour after water has been first mixed into the batch.
2. Retempering:

Do not retemper mortar.
3. Mortar Mixes:
 - a) Mix proportions by volume:
 - i) Interior and Exterior work
1:4 (cement sand)
 - b) Use cement mortar for parapets and stacks.

3.4.
INSTALLATION

1. General:
 - a) All masonry laid plumb, true to line, with level and accurately spaced courses and reveals, with corner plumb and true, and with each course breaking joints with the course below. Bond shall be kept plumb throughout. Units with greater than 12 percent absorption shall be wetted before laying.
 - b) Concrete blocks for wall construction at jambs to openings and at piers to be grouted.
 - c) Block walls of 8 ins (200 mm) thickness exceeding 24 feet (7.3 meters) length shall be supported at intermediate points, not exceeding 12 feet, (3.6 meters) with two 12 ins by 12 ins (300mm x 300mm) masonry piers bonded to wall. Install a continuous vertical mortar joint between piers.
 - d) Gaps of less than 8 ins (200mm) between tops of masonry and underside of

structure shall be completed with cut masonry units or built flush with concrete.

- e) The methods and equipment used for transporting the masonry units and mortar shall be such as will not damage the units nor delay the use of mixed mortar. Units shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work.

2. Laying up:

- a) Place units in mortar with full trowelled bed and head joints.
- b) Align all vertical cells to maintain a clear, unobstructed system of flues, or shafts. Clean out as work proceeds.
- c) Mortar work to be in accordance with B.S. CP 121 section 4.4.
- d) When laying fresh units to set or partially set masonry, clean surfaces of those previously installed and remove loose mortar prior to laying fresh units.
- e) The masonry work shall be carried up in uniform manner and no portion shall be carried out more than one meter above the adjoining one at any time. All masonry shall be kept strictly true and square and the whole properly bonded together and levelled around each floor.
- f) Block shall be laid with mortar joints as shown on the drawings or as directed by the Engineer. Both bed and vertical joints shall be 6mm in thickness completely filled with cement mortar as specified herein, and each block shall be added firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the block masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and re-pointed.
- g) The exterior faces of the walls shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the block work has been laid and finishing the joint with a pointing tool. Horizontal joints shall be struck to form a weathered joint and vertical joints shall be struck with a V notch.

Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints.

3. Built-in Work:

- a) Work required to be "built-in" and/or incorporated in any masonry construction as work progresses, includes all anchors, expansion joint shields, barrier fins, loose lintels, bearing plates, structural steel bucks, door and window frames, access doors and frames, wall plugs and flashingetc.

-
- b) Avoid cutting and patching unless directed by Engineer.
 - c) Set hold-fasts, anchors and other items required by this and other parts of these Specifications.
 - d) Solidly grout spaces around items and backs of metal door frames.
 - e) Build-in pipe chases as required by Other Contractors. Cutting of masonry after laying shall be only as directed by Engineer.
 - f) Build-in short lengths of drain pipe, to walls, outside of buildings for surface water drainage transfer as described in Section 2700: Concrete Walks Roadways, Curbs and Gutters.
 - g) Masonry bases or concrete masonry units under equipment, except those built on rough slabs; and other accessories; unless specifically indicated otherwise on the Drawings, the spaces around all built-in equipment unless provided by others i.e. mechanical trades, shall be filled in solid with appropriate masonry material and/or concrete so indicated on Drawings, also all unit steel door bucks shall be filled in solidly with masonry and cement mortar.
4. Dowels and wall ties:
- a) Install projecting reinforcing bar dowel anchors into beams, columns and slabs and grout into masonry. Bars to be drilled and grouted into structural members, as specified in the structural specification/drawings.
 - b) Embed wall ties 3 ins. (75mm) into each bearing of double skin walls, at 18 ins. (450 mm) centres vertically and 24 ins. (600 mm) horizontally, staggered pattern.
5. Dampproofing:
- Damp proof courses shall be laid on an even mortar bed, free from projections which may puncture the materials. Where the damp-proof course is to be stepped only flexible membranes shall be used. Damp-proof course unless otherwise specified shall consist of Class 'C' (3000 psi) Cement Concrete 2ins (50mm) thick, mixed with approved quality water proofing compound as per manufacturers specifications and shall be laid at required level as per drawings and instructions of the Engineer. The D.P.C. shall be tamped, consolidated, leveled and edges and corners made to the requirements of drawings and shall include finishing and curing. The cost of D.P.C will be assumed to be part of cost for unit Masonry.
- Install vertical damp-proof membrane and horizontal damp-proof course as described in Section 7100, Dampproofing & Water Proofing.
6. Joints and weep holes:
- i) Joints for blockwork shall be flush.
 - ii) Install weep holes as shown on Drawings.
-

7. Tolerances:

Unit masonry shall be erected plumb and true to line and level with a maximum variation of 1/8 in. (3mm) in 10 ft. (3 m).

**3.5.
GROUTING**

1. Timing:

- i) Do not grout until masonry has cured at least 24 hours.
- ii) Consolidate grout at time of pouring by puddling and filling cells of masonry, and then reconsolidating later by puddling before the plasticity is lost.

**3.6.
CURING AND
REPAIRS**

1. All unit masonry shall be watered cured and shall be kept wet for at least seven days, by an approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the requirements of these Specifications for water used in the manufacturer of masonry units.
2. If, after the completion of any masonry work, the units are not in alignment or level, or does not, conform to the lines and grades shown on the drawings or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.

**3.7.
CLEANING &
PROTECTION**

1. Inspection:

Upon completion of the Work of this Section, make a thorough inspection of installed unit masonry and verify that units and joints have been installed in accordance with the provisions of this section; make necessary adjustments.

2. Protection:

- a) Protect sills, ledges and surrounding work from mortar drippings or other damage during masonry construction. Remove misplaced mortar or grout immediately.
- b) Wrap wood mullions and other built-in wood items with 4 mm. Polythene sheeting and remove at completion of work.
- c) Cover tops of uncompleted walls with non-staining waterproof coverings when work is not in progress.

3. Cleaning:

- a) Clean surfaces of unit masonry as required for proper application of the specified finishes.
- b) Cut out and re-point defective joints.
- c) Upon completion of Work to this Section, promptly remove from the Job Site mortar droppings, broken units debris arising from the work of this Section, and tools and equipment, leaving all areas in a neat and orderly condition to the approval of the Engineer.

4.
MEASUREMENT
AND PAYMENT
4.1
GENERAL

Except otherwise specified herein or elsewhere in the Contract Document, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost there of shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

1. Chiselling of masonry, wherever required.
2. Providing and fixing all joint reinforcing bars and dovetail anchors.
3. Providing and filling class 'D' concrete in the cavity of hollow block masonry.
4. Providing and laying damp proof courses, horizontal and vertical water proofing/damp-proofing insulation where directed.
5. Providing and installing expansion joint in masonry, units.

4.2.
SOLID BLOCK
MASONRY

1. Measurement:

In case of different thickness of slab/beams/columns in different areas or rooms or for any other reasons, whatsoever, if chiselling of masonry is required, the Contractor shall do so at his own cost. Where for any reason whatsoever, the height of the wall is short of ceiling height, the actual height shall be made good with class 'C' (3000) nominal mix concrete. This concrete shall neither be measured nor be paid under item of concrete but will be paid for under the item of wall masonry. Similarly, where the lintel heights are such that the contractor has to chisel the masonry or provide cast-in-place concrete to make up the height of the course, no payment will be made for chiselling, but where such cast-in-place concrete is provided, payment for the same will be made at the unit rate of masonry.

Measurement for acceptable completed works of solid block masonry will be made on the basis of number of Sq.ft (sq. meter) provided and installed in position as

shown on the drawings or as directed by the Engineer. Each measurement shall be taken to the nearest 1/2 in. (10mm.). All openings and lintel left in the masonry wall will be deducted.

2. Payment:

Payment will be made for acceptable measured quantity of solid block masonry work on basis of unit rate per sq. meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

4.3.
HOLLOW BLOCK MASONRY

1. Measurement:

Measurement for acceptable completed works of hollow block masonry wall will be made on the basis of number of sq. metre provided and installed in position as shown on the Drawings or as directed by the Engineer. Each measurement shall be made to the nearest 10mm. All openings left in the masonry will be deducted. Solid block masonry around openings and lintel shall not be measured separately. It shall be included in the measurement of hollow block masonry for payment.

2. Payment

Payment will be made for acceptable measured quantity of hollow block masonry works on the basis of unit rate per sq. meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the item.

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1
GENERAL

1.1
DESCRIPTION

1. Work included:

- a) Supply and install miscellaneous iron and steel items and those not specifically described in other Sections of these Specifications but required for a complete and operable facility, as implied or shown on Drawings.
- b) Work included in this Section is generally pertaining to concealed or semi-concealed metal items required to frame, support or retain various elements, described in other Sections of these Specifications, such as steel angles for supports and framing, anchor plates, straps, ties, bolts and anchoring devices.
- c) Examine other Sections of these Specifications and all Drawings for relating work of this Section, and of other trades.

1.2
QUALITY
ASSURANCE

1. Qualifications of welders:

Use only certified welders and shielded arc or spot process for welding performed in connection with the Work of this Section.

1.3
SUBMITTALS

1. Shop Drawings:

- a) Within 120 days after award of Contract, and before any miscellaneous metal is delivered to the Job Site, submit Shop Drawings to the Engineer for approval in accordance with these Specifications.
- b) Show locations, markings, quantities, materials, sizes, and shapes and indicate methods of connecting, anchoring, fastening, bracing, and attaching to the work of other trades.

2. Proof of compliance:

Upon completion of this portion of the Work, and as condition of its acceptance, deliver to the Engineer a letter signed by the contractor that miscellaneous metal was furnished and installed in complete accordance with this Section of these Specifications.

1.4
PRODUCT
HANDLING

1. Protection:

Protect miscellaneous metal before, during, and after installation and protect the installed work and materials of other trades.

2. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to the Employer.



2
PRODUCTS
2.1
STEEL

1. Steel shall be mild steel, new, free from rust, and conform to BS 4360.

2.2
BOLTS AND NUTS

1. Bolts and nuts shall be new, free from rust, and conform to B.S. 4395.

2.3
WELDING
ELECTRODES

1. Arc and spot-welding electrodes used shall be only those specifically recommended for the purpose.
2. Oxy-acetylene welding shall comply with BS 693 and 2937. Welding shall be continuous except where tack welding is permitted and exposed welds shall be ground smooth. Arc welding and electrodes for metal shall conform to BS. 639 and 5135.

2.4
SHOP PAINT &
GALVANISING

1. Hot dipped galvanizing conforming to BS 729 (Part 1). These items may be fabricated in sections. Joint welding after galvanizing is permitted only if area around joints is liquid galvanized.
2. One coat of zinc rich primer.

2.5
DOWELS &
ANCHORS

1. Steel, galvanized as per Article 2.4.

2.6
OTHER
MATERIALS

1. Materials and methods not specifically described but required for proper fabrication and installation of miscellaneous metal, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.



3
EXECUTION
3.1
SURFACE
CONDITIONS

1. Inspection:

- a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where fabrication and installation of the Work of this Section may properly commence.
- b) Make measurements in the field to ensure proper and adequate fit of miscellaneous metal items.
- c) Verify that miscellaneous metal may be fabricated and installed in strict accordance with the original design and the approved Shop Drawings.

2. Discrepancies:

- a) In the event of discrepancy, immediately notify the Engineer.
- b) Do not proceed with fabrication or installation in areas of discrepancy until they have been fully resolved.

3.2
FABRICATION

1. Compliance:

- a) Fabricate miscellaneous metal in strict accordance with approved Shop Drawings.
- b) Build work square, true, straight and accurate to size, with joints closely fitted and properly secured.
- c) Fabricate item from steel unless otherwise noted.
- d) Use self-tapping shake-proof countersunk flat headed screws on items required to be assembled by screws or as indicated.

2. Prefabrication:

Shop prefabricated items complete and ready for installation.

3. Welding:

- a) Preparation shall be in accordance with B.S.C.P. 3012.
- b) Unless otherwise indicated on Drawings, weld shop connections.
- c) Make joints and intersections of metal tightly fitting and securely fastened.
- d) Make work square, plumb, straight, and true.
- e) Exposed welds to be continuous for length of each joint, and are to be filed or ground smooth and flush.

4. Holes:

- a) Drill or punch holes required for the attachment of work of other trades and for bolted connections.
- b) Burned holes are not acceptable.



3.3
**SHOP
PAINTING**

1. Preparation:
 - a) Thoroughly clean metal as described in Section 9900 of Painting.
 - b) Provide required protection for metal to be encased in concrete to prevent accumulation of deleterious foreign material.
2. Painting:
 - a) Apply one shop coat of primer to metal item, with exception of stainless steel, aluminum, and those to be galvanized or encased in concrete.
 - b) Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7⁰ C.
 - c) Shop Paint all steel except:
 - i Steel to be encased in concrete;
 - ii Surfaces to be welded;
 - iii Contact surfaces to be high strength bolted; and
 - iv Steelwork which will be concealed by interior finish.
 - d) Steel items (including bolts etc.) exposed to the atmosphere inside and outside of construction shall be hot dipped galvanized.

3.4
PAINTING

1. Fabricated ferrous items shall receive a priming coat of paint. Surfaces which cannot be reached for painting after erection shall receive two coats of paint before installation.
2. Clean surfaces to be field welded; do not paint. Conform to B.S.C.P. 3012.

3.5
ERECTION

1. *Coordination:*

Coordinate installation schedule with the schedules of other trades to ensure orderly and timely progress of the total Work.
2. *Compliance:*

Erect and install miscellaneous metal in strict accordance with the Drawings, and the approved Shop Drawings, aligning straight, plumb, and level within a tolerance of one quarter of one percent.
3. *Anchoring:*
 - a) Supply anchorages and other miscellaneous metal, not specified in other Divisions, or shown on Drawings, but required to complete the work.
 - b) Provide suitable and acceptable means of anchorage, such as dowels, anchor clips, bar anchors, expansion bolts, etc.
4. *Touching up:*
 - a) After the erection and installation is complete, touch- up shop priming coats



damaged during transportation and erection, using the priming paint specified for shop priming.

- b) Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection.
- c) Touch-up galvanized surfaces with zinc primer where burned by field welding.

3.6

**MISCELLANEOUS
WORK**

1. Miscellaneous Work: Supply other metallic items such as steel angles around openings, angles and plates, joint covers etc., which are specified on Drawings and not specified in other Divisions.



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1.
GENERAL

1.1
DESCRIPTION

1. Work included:
 - a) Supply and install miscellaneous iron and steel items and those not specifically described in other Sections of these Specifications but required for a complete and operable facility, as implied or shown on Drawings.
 - b) Work included in this Section is generally pertaining to concealed or semi-concealed metal items required to frame, support or retain various elements, described in other Sections of these Specifications, such as steel angles for supports and framing, anchor plates, straps, ties, bolts and anchoring devices.
 - c) Examine other Sections of these Specifications and all Drawings for relating work of this Section, and of other trades.

1.2.
QUALITY ASSURANCE

1. Qualifications of welders:

Use only certified welders and shielded arc or spot process for welding performed in connection with the Work of this Section.

1.3.
SUBMITTALS

1. Shop Drawings:
 - a) Within 120 days after award of Contract, and before any miscellaneous metal is delivered to the Job Site, submit Shop Drawings to the Engineer for approval in accordance with these Specifications.
 - b) Show locations, markings, quantities, materials, sizes, and shapes and indicate methods of connecting, anchoring, fastening, bracing, and attaching to the work of other trades.
2. Proof of compliance:

Upon completion of this portion of the Work, and as condition of its acceptance, deliver to the Engineer a letter signed by the contractor that miscellaneous metal was furnished and installed in complete accordance with this Section of these Specifications.



**1.4.
PRODUCT
HANDLING**

1. Protection:

Protect miscellaneous metal before, during, and after installation and protect the installed work and materials of other trades.

2. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to the Employer.

**2.
PRODUCTS
2.1.
STEEL**

1. Steel shall be mild steel, new, free from rust, and conform to BS 4360.

**2.2.
BOLTS AND NUTS**

1. Bolts and nuts shall be new, free from rust, and conform to B.S. 4395.

**2.3.
WELDING
ELECTRODES**

1. Arc and spot-welding electrodes used shall be only those specifically recommended for the purpose.
2. Oxy-acetylene welding shall comply with BS 693 and 2937. Welding shall be continuous except where tack welding is permitted and exposed welds shall be ground smooth. Arc welding and electrodes for metal shall conform to BS. 639 and 5135.

**2.4.
SHOP PAINT &
GALVANIZING**

1. Hot dipped galvanizing conforming to BS 729 (Part 1). These items may be fabricated in sections. Joint welding after galvanizing is permitted only if area around joints is liquid galvanized.
2. One coat of zinc rich primer.



2.5.
DOWELS & ANCHORS

1. Steel, galvanized as per Article 2.4.

2.6.
OTHER MATERIALS

1. Materials and methods not specifically described but required for proper fabrication and installation of miscellaneous metal, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.
EXECUTION
3.1.
SURFACE
CONDITIONS

1. Inspection:
 - a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where fabrication and installation of the Work of this Section may properly commence.
 - b) Make measurements in the field to ensure proper and adequate fit of miscellaneous metal items.
 - c) Verify that miscellaneous metal may be fabricated and installed in strict accordance with the original design and the approved Shop Drawings.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify the Engineer.
 - b) Do not proceed with fabrication or installation in areas of discrepancy until they have been fully resolved.

3.2.
FABRICATION

1. Compliance:
 - a) Fabricate miscellaneous metal in strict accordance with approved Shop Drawings.
 - b) Build work square, true, straight and accurate to size, with joints closely fitted and properly secured.
 - c) Fabricate item from steel unless otherwise noted.



- d) Use self-tapping shake-proof countersunk flat headed screws on items required to be assembled by screws or as indicated.
- 2. Prefabrication:

Shop prefabricated items complete and ready for installation.
- 3. Welding:
 - a) Preparation shall be in accordance with B.S.C.P. 3012.
 - b) Unless otherwise indicated on Drawings, weld shop connections.
 - c) Make joints and intersections of metal tightly fitting and securely fastened.
 - d) Make work square, plumb, straight, and true.
 - e) Exposed welds to be continuous for length of each joint, and are to be filed or ground smooth and flush.
- 4. Holes:
 - a) Drill or punch holes required for the attachment of work of other trades and for bolted connections.
 - b) Burned holes are not acceptable.

3.3. ***SHOPPAINTING***

- 1. Preparation:
 - a) Thoroughly clean metal as described in Section on Painting.
 - b) Provide required protection for metal to be encased in concrete to prevent accumulation of deleterious foreign material.
- 2. Painting:
 - a) Apply one shop coat of primer to metal item, with exception of stainless steel, aluminum, and those to be galvanized or encased in concrete.
 - b) Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 70 C.
 - c) Shop Paint all steel except:
 - i Steel to be encased in concrete;
 - ii Surfaces to be welded;



- iii Contact surfaces to be high strength bolted; and
- iv Steelwork which will be concealed by interior finish.
- d) Steel items (including bolts etc.) exposed to the atmosphere inside and outside of construction shall be hot dipped galvanized.

3.4. PAINTING

1. Fabricated ferrous items shall receive a priming coat of paint. Surfaces which cannot be reached for painting after erection shall receive two coats of paint before installation.
2. Clean surfaces to be field welded; do not paint. Conform to B.S.C.P. 3012.

3.5. ERECTION

1. Coordination:

Coordinate installation schedule with the schedules of other trades to ensure orderly and timely progress of the total Work.
2. Compliance:

Erect and install miscellaneous metal in strict accordance with the Drawings, and the approved Shop Drawings, aligning straight, plumb, and level within a tolerance of one quarter of one percent.
3. Anchoring:
 - a) Supply anchorages and other miscellaneous metal, not specified in other Divisions, or shown on Drawings, but required to complete the work.
 - b) Provide suitable and acceptable means of anchorage, such as dowels, anchor clips, bar anchors, expansion bolts, etc.
4. Touching up:
 - a) After the erection and installation is complete, touch- up shop priming coats damaged during transportation and erection, using the priming paint specified for shop priming.
 - b) Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection.
 - c) Touch-up galvanized surfaces with zinc primer where burned by field welding.



3.6.
MISCELLANEOUS WORK

1. Miscellaneous Work: Supply other metallic items such as steel angles around openings, angles and plates, joint covers etc., which are specified on Drawings and not specified in other Divisions.

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1.
GENERAL

1.1
DESCRIPTION

1. Work included:

Supply and installation of wood trim, ceiling slats and panels, architraves, stair handrails, valences, counter fascias, shaft panels, trim, skirtings, palmets, ornamental paneling, carving and facing, jali work, suspending ceilings, wood flooring and other items not specifically described but necessary to complete the work of this and other section of these specifications.

1.2.
QUALITY ASSURANCE

1. Qualifications of workmen:

For cutting and fitting of trim and finish material, use only skilled finishing carpenters who are thoroughly trained and experienced for the work required, completely familiar with the requirements of this work.

2. Rejection:

In the acceptance or rejection of finish carpentry, no allowance will be made for lack of skill on the part of workmen. Any rejected item shall be removed from the site of works, at Engineers discretion.

Submit data for each product and process specified as work of this section and incorporated into items of architectural woodwork during fabrication, finishing, and installation or submit Mock-Ups for each and every item for Engineer's approval.

1.3.
SUBMITTALS

1. Samples:

Within 120 days after award of contract and before any material is delivered to the job Site submit three samples of proposed material to the Engineer for his approval.

Samples shall include characteristic data described in this section.

Submit Wood Preservative Treatment Data and chemical treatment manufacturer's data and instruction for application.



**1.4.
PRODUCT
HANDLING**

1. Protection:

Protect the materials of this section before, during, and after installation and protect installed work and materials of other trades.

2. Replacement:

In the event of damage, immediately make repairs and replacements to approval, at no additional cost to the Employer.

**2.
PRODUCTS
2.1.
TIMBER**

1. Wood shall be first quality and conform to the applicable requirements and B.S. 1186.

- a) Use Ash wood as shown on the Drawings or as approved by Engineer, free from defects that impair its strength and durability. Knots if any, in Ash only, shall not be over 1/2 in (12mm.) Wood to be well seasoned in an approved manner.
- b) Moisture content shall not exceed 12% by weight for interior use and 17% for exterior use.
- c) Unless otherwise noted on Drawings or described in other sections of these specifications use Ash wood for transparent finish. Back-up or exposed members requiring planed finish shall be Ash.

**2.2.
PRESERVATIVE
TREATMENT**

1. Preservative treatment:

Following basic fabrication liberally apply preservative in flood coats to all surfaces requiring treatment to ensure maximum absorptions. Use a coarse, low pressure spray wherever possible. Allow each coat to soak in, but not too dry before applying further coats. The preservative shall be an organic solvent type, with a water-repellent component. This treatment should be provided after seasoning. Materials should be cut and machined before treatment wherever possible. Where material is cut, drilled or machined after treatment, the areas so cut, drilled or machined, should be treated by brush or spray application of the same preservative. Treated timber shall be able to receive glue, paint, putty, neoprene or PVC gaskets and standard sealants with no adverse effects to either materials.



2. Manufacturer: Subject to compliance with requirements provide products of:-

Solignum Limited, U.K.

Wood Protek, England or approved equivalent

Discard treated lumber which does not comply with requirements of referenced woodworking standard. Do not use twisted, warped, bowed, discolored, or otherwise damaged or defective lumber.

2.3.
BLOCK
BOARD

1.
 - a) Plywood blockboard (batten board) for paint finish shall be of best quality to B.S. 344 and as approved by Engineer. b) Bonding shall be with urea resin adhesive to BS 1203, 1204. Use WBP (weather- proof and boil-proof) for exterior use and MR (moisture resistant) for interior use.
 - b) Grade 2/2
 - c) Face veneer: commercial ply or Ash wood as indicated on Drawings.
 - d) Edge treatment: solid Ash wood band
 - e) Thickness as shown on Drawings.
2.
 - a) Plywood blockboard or transparent finish shall be of best quality to B.S. 3444 and as approved by Engineer.
 - b) Bonding shall be with urea resin adhesive as described for paint finish blockboard.
 - c) Grade 1/1
 - d) Face veneer: Ash wood or approved equivalent as indicated on Drawings.
 - e) Thickness 1 1/2 ins. (38mm) minimum
 - f) Edge treatment: solid Ash wood band to match face veneer type.
3. Face grading of plywood blockboard:
 - a) Grading is described front face and rear face respectively.
 - b) Grades are as follows:
 - i) Grade 1 veneer shall be of one or two pieces of firm smoothly cut veneer. When of two pieces, the joint shall be approximately at the center of the board. Veneer shall be free from knots, worm and



beetle holes, splits, dots, glue stains, filling or inlaying of any kind or other defects. No end joints are permissible.

- ii) Grade 2 veneer shall present a solid surface free from open defects. Veneers when jointed need not necessarily be matched for colour or be of equal width. A few sound knots are permitted with occasional minor discoloration and slight glue stains, isolated pin holes not along the plane of the veneer. Occasional splits not wider than (0.8 mm) and not longer than one-tenth of the length of the panel or slightly opened joints may be filled with a suitable filler. This grade shall admit neatly made repairs consisting of inserts of the same species as the veneer which present solid level hard surfaces and are bonded with an adhesive equivalent to that for bonding the veneers. No end joints are permissible. Standard hardboard shall be type 'S' in accordance with B.S. 1142 part 2.

**2.4.
CUSTOM FALSE
CEILING**

1. Comply with the following requirements:-
Type of Construction : Wood framing with particle board panels.
Framing Partial wood or as shown on drawing.
2. Plywood for painted finish : Any species, Density not less than 35 lbs/cft.(at 12% moisture content) of minimum 3 ply or of thickness as indicated in drawings.
Face Pattern: Plain
Backing Veneer Species Same as face species or any hardwood compatible with face species.
3. Particle Board for Painted Finish: Minimum density 40 lbs/cu.ft. blockboard/chipboard with any species ply veneer of density not less 35 lbs/cft. (at 12% moisture contents) veneered to both faces.
Face Pattern: Plain
4. Paint: Synthetic Enamel Paint refer Section-9900 "Painting and polishing.

2.5.
FINISH FASTENINGS

- a) Nails for Interior Trim Round lost head to and Finish: B.S. 1202
- b) Nails for External Work: Steel to B.S. 1202 Galvanized to B.S.729
- c) Screws for External Work: Brass raised counter-sunk to B.S.1210
- d) Screws for Interior Work: Brass flat head to B.S. 1210

2.6.
ADHESIVES

- 1. For joining members shall be a urea resin or an approved equal to BS 1203,1204. Use WBP (weather- proof and boil-proof) for exterior members and MR (moisture-resistant) for interior work. Interior members placed in damp or humid areas shall be joined with WBP type.
- 2. Alternatively use 'Calatac WD-30' PUA adhesive by I.C.I. OR for Granolith by HOECHST for all conditions or approved equivalent

2.7.
OTHER MATERIALS

- 1. Materials and methods not specifically described but required for proper fabrication and installation of finished carpentry, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.



3.
EXECUTION
3.1.
SURFACE
CONDITIONS

Inspection:

- a) Prior to work of this section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
- b) Verify that finished carpentry may be completed in strict accordance with the original design to the approval of Engineer.
- c) Condition woodwork to average prevailing humidity, condition installation areas prior to installing.

2. Discrepancies:

- a) In the event of discrepancy, immediately notify the Engineer.
- b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.
WORKMANSHIP

1. Carpentry shall be in accordance with B.S. 1186 "Quality of timber and workmanship in joinery". Entire responsibility for seasoning of wood, prevention of warping, cracking or other defects found in finished material will rest with contractor.
2. Wooden members found warped, bent, cracked or defective, during construction period or in duration of maintenance period, shall be rejected by Engineer and be replaced by contractor at his own cost and risk.
3. Finished carpentry to have joints true, tight, and well nailed with members assembled in accordance with the Drawings.
4. Moulding and ornamental work shall be worked from full size details prepared by the contractor from Architectural Drawings. Shapes shall be worked from solid pieces unless otherwise noted or approved by Engineer.
5. Jointing:
 - a) Install items straight, true, level, plumb, and firmly anchored in place. Where blocking or backing is required, coordinate with other trades to ensure placement of backing and blocking in a timely manner.



- b) Nail trim with finish nails of proper dimension to hold the member firmly in place without splitting the wood.
- c) Nail exterior with galvanized nails, making joints to exclude water, setting them in waterproof glue or caulking described in these specifications.
- d) On exposed finish work, set nails for putty.
- e) Do not drive, all wood screws except that they may be started by driving and then screwed home.

3.3.
INSTALLATION OF
OTHER ITEMS

1. Install other items in strict accordance with the Drawings, anchoring firmly in place at the prescribed location, straight, plumb, level, and anchored for long life under hard use.

3.4.
FINISHING

1. Sandpaper finished wood surfaces thoroughly as required to produce a uniformly smooth surface, always sanding in the direction of the grain. Do not sand wood which is designed to be left rough. No coarse-grained sandpaper mark, hammer mark, or other imperfection will be accepted.

3.5.
CLEANING UP

1. General:

Keep the premises in a neat, safe, and orderly condition at all times during execution of this portion of the work. Prevent accumulation of sawdust, cut-ends, and debris.
2. Sweeping:
 - a) At the end of each working day, or more often if necessary, thoroughly sweep surfaces where refuse from this portion of the work has settled.
 - b) Remove the refuse to the area of the job site set aside for storage.
 - c) Upon completion of this portion of the work, thoroughly broom clean surfaces.



4.
***METHOD OF
MEASUREMENT***

Generally

Timber which is sawn (that is, not milled) and timber which is finished (that is, milled) shall each be so described.

Descriptions of timber members shall state whether the sizes are basic (that is, before machining) or finished (that is, milled, within permitted deviations).

Boarding and Flooring

Unless otherwise stated, boarding and flooring shall be measured by area, without addition for joints or laps, classified as follows:

- a) Floors, which shall include landings
- b) Walls, which shall include returns, reveals of openings or recesses and attached and unattached columns
- c) Ceilings, which shall include attached and unattached beams and soffits of staircases
- d) Roofs, which shall include tops and cheeks of dormers and sides and bottoms of gutters, stating whether flat, sloping or vertical; firing pieces and bearers shall be understood to be included.

Eaves and verge boards, which shall include fascias, barge boards or the like, shall be measured by length.

Fillets and rolls shall be measured by length.

Grounds and battens

Open-spaced grounds and battens shall be measured by area, taken overall.

Individual grounds and battens shall be measured by length.

Framework

Framework shall be measured by area, taken overall; alternatively, it may be measured by length.

Finishings and fittings

Finish such as cover fillets architraves or the like; beads, stops or the like; edgings, window boards, backboards, nosings or the like shall be understood to be included in the rates quoted in bill of quantities. However, skirting shall be measured by length.



Unless otherwise stated, fittings shall be measured by length, classified as follows:

- a) Work tops, which shall include seats or the like
- b) Handrails or balustrades.

Shelving shall be measured by area.

Composite items

Unless otherwise stated, composite items (which shall mean items which might be fabricated off-site whether or not they are fabricated off-site) shall be enumerated; all metal work or the like shall be understood to be Included.

Any associated work (for example, decorations) shall be measured in accordance with the relevant sections of this document.

Ironmongery

Units or sets of ironmongery shall be Included.



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PART 1
GENERAL:

11 1 DESCRIPTION:

1. Work included:

Supply and installation of Fiber glass Reinforced Plastic grating and other items not specifically described but necessary to complete the work of this and other section of these specifications.

1. 2 QUALITY ASSURANCE:

1. Qualifications of workmen:

For cutting and fitting finish material, use only skilled finishing carpenters who are thoroughly trained and experienced for the work required, completely familiar with the requirements of this work.

2 Rejection:

In the acceptance or rejection of finish, no allowance will be made for lack of skill on the part of workmen. Any rejected item shall be removed from the site of works, at Engineers discretion.

Submit data for each product and process specified as work of this section and incorporated into items of architectural wood work during fabrication, finishing, and installation or submit Mock-Ups for each and every item for Engineer's approval.

1. 3 SUBMITTALS:

1. Samples:

Within 120 days after award of contract and before any material is delivered to the Job Site submit three samples of proposed material to the Engineer for his approval.

Samples shall include characteristic data described in this section.

Submit manufacturer's data and instruction for application.

1. 4 PRODUCT HANDLING:

1. Protection:

Protect the materials of this section before, during, and after installation and protect installed work and materials of other trades.

2 Replacement:

In the event of damage, immediately make repairs and replacements to approval, at

no additional cost to the owner.

PART 2 PRODUCTS:

2.1 GENERAL

- A. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
- B. Fiberglass reinforcement shall be bi-directional roving's in sufficient quantities as needed by the application and/or physical properties required.
- C. Resin shall be {Isophthalic Polyester, Polyester or Modified Acrylic - choose one), with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.
- D. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.
- E. All products shall have a tested flame spread rating of 25 or less per ASTM E-84 Tunnel Test. Plate shall not burn past the 25 mm reference mark and will be classified HB per ASTM D635.

2.2 GRATING:

- A. Properties are;

Standard Panel Size 998mm x 2038mm

Weight Per kg/Sq.M 23.5 Kg/Sq.M

Open Area 72%

Mesh Size 50mm x 50mm

x 50mm Bar Thickness (Top/Bottom) 8 / 6

Non-Slip Surface

Or as define in drawing, BOQ or as per manufacturers specification.

2.3 MANUFACTURER:

- 1. Manufacturer: Subject to compliance with requirements provide products of approved manufacturer mention in BOQ & drawing.-

PART 3

EXECUTION:

3.1 SURFACE CONDITIONS:

1. Inspection:
 - a. Prior to work of this section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
 - b. Verify that finished item may be completed in strict accordance with the original design to the approval of Engineer.
 - c. Condition wood work to average prevailing humidity, condition installation areas prior to installing.
2. Discrepancies:
 - a. In the event of discrepancy, immediately notify the Engineer.
 - b. Do to proceed with installation in areas of discrepancy until they have beenfully resolved.

3.2 INSTALLATION:

- A. Contractor shall install grating in accordance with manufacturer's assembly drawings. Lock grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

3.3 CLEANING UP:

1. General:

Keep the premises in a neat, safe, and orderly condition at all times during execution of this portion of the work. Prevent accumulation of sawdust, cut-ends, and debris.
2. Sweeping:
 - a. At the end of each working day, or more often if necessary, thoroughlysweep surfaces where refuse from this portion of the work has settled.
 - b. Remove the refuse to the area of the job site set aside for storage.
 - c. Upon completion of this portion of the work, thoroughly

broom cleansurfaces.

4. METHOD OF MEASUREMENT

Grating shall be measured by area, without addition for joints or laps.

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1.
GENERAL

1.1
DESCRIPTION

1. Work included:

Under this Section includes the supply and installation of waterproofing tank lining, vertical damp-proof membranes and damp-proof courses as indicated on Drawings and as follows:

a) Vertical damp-proofing:

To the exterior faces of concrete walls to water tank, swimming pools, concrete planters, pool machine rooms, lift pits, exterior walls below grade at basements and to outer faces of inner skins to external walls.

b) Horizontal damp-proof course:

To base of exterior wall above grade, over lintels, at parapets to exterior wall and under copings but not limited to same.

c) Waterproof membrane:

To areas like SOG, retaining walls, roof/attic slab, terraces, planters and gutters underground water reservoirs, swimming pool and where floor drains are indicated on Mechanical or Architectural Drawings or as directed by Engineer.

d) Swimming pool membrane:

To interior faces of outer concrete walls and slabs of swimming and wading pools.

1.2.
QUALITY ASSURANCE

1. Qualifications of installers:

- a) The installer shall be currently approved by the manufacturer of the selected membrane or surface waterproof coating material.
- b) For installation of membranes and application of surface waterproof coatings use only competent and skilled tradesmen completely familiar with the products, and the manufacturer's current recommended methods.

2. Manufacturer's certification:

Prior to start of installation of the Work to this Section, engage at the Job Site, a representative of the manufacturer of the damp/waterproofing membrane or surface waterproof coating material and the tank liner to inspect and certify that:



- a) Surfaces to which the waterproofing/dam-proofing is to be applied are in a condition suitable for this application.
- b) Materials to be installed comply with the requirements of this Section of these Specifications.
- c) Materials to be installed are in complete accordance with the manufacturer's current recommendations.

1.3 SUBMITTALS

1. Within 90 days after the award of Contract and before any material is delivered to the Job Site submit to Engineer, for approval in accordance with these Specifications, complete design data for inner water tank liner and pool membrane. Describe and illustrate details of application including jointing, special junctions with adjacent materials, mixing, curing and special preparatory measures.

2. Manufacturer's certification:

Upon completion of this portion of the Work, and as a condition of its acceptance, deliver to the Engineer 2 copies of the certification described in Article 1.2.2, each copy signed by an officer of the firm manufacturing the waterproofing/damp-proofing materials.

3. Guarantee:

Upon completion of this portion of the Work, and as a condition of its acceptance, deliver to the Engineer a written guarantee signed by the Contractor and endorsed by the waterproofing/damp-proofing and tank liner materials manufacturers guaranteeing that the installed materials will remain intact and free from leaks for a period of at least 10 years following date of installation.

1.4. PRODUCT HANDLING

1. Protection:

Protect waterproof/damp-proof materials before, during and after installation and protect the installed work and materials of other trades.

2. Repair:

In the event of damage immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.



**2.
PRODUCTS**

**2.1.
DAMP-PROOF
MEMBRANE**

1. a) Damp-proofing and Waterproofing Asphalt Primer: priming oil shall be made by the manufacturer of the bitumen compound.
- b) Bitumen: “ Hycarb AHS “ by National Petrocarbon Ltd., Karachi.
- c) Bituthene 3000 or Master pren or Equivalent.
- d) Bruch bond of Fospak or Brushcrete of FEB.

**2.2.
HORIZONTAL DAMP-
PROOF COURSE**

1. Same material as article 2.1 of this Section.

**2.3.
INTERNAL TANK FINISH
PODIUM ETC**

1. Cement Plaster (if required). Use Acrylic reinforced cementitious, flexible coating. Acceptable products are:

Cementitious waterproofing system from Sika./BASF, or Aquafin or Fospak or approved equivalent by the Engineer.

**2.4.
WATERPROOF
MEMBRANE**

Torch applied waterproof membrane over lean concrete and over pile caps external surfaces of retaining wall and Underground water tank walls. Acceptable Products are:

Fospak
Sika
Aquafin.
Hi-Grip by Pak Hy –Oils Ltd
or as approved by the Engineer.

**2.5.
POOL MEMBRANE**

1. Same material as Article 2.4 of this Section.



**3.
EXECUTION**

**3.1.
PREPARATION**

1. Concrete shall have full 28-day cure prior to application of membrane or surface coating.
2. Concrete and masonry surfaces shall be free of roughness, voids and projections. Voids shall be grouted in accordance with Section 3300 on Cast-in-Place Concrete or substrate plastered in accordance with Section 9200 on plaster work, at Contractor's own cost.
3. Remove laitance, loose aggregate, form release agents or other surface treatments as well as dust, oil, grease or other contaminants which would affect complete bonding of membrane or surface coatings to concrete and/or masonry surfaces.
4. Do not apply material to wet surfaces, unless directed otherwise. Ensure areas adjacent to surfaces of application are kept dry. Dewater in accordance with Section 2140: Dewatering.
5. Do not apply bitumen when its temperature is above 205⁰ C (401 ⁰F). It shall be kept from being heated in excess of 245⁰ C (473 ⁰F), or as recommended by the manufacturer.
6. Apply waterproofing/damp-proofing membrane on primed surfaces only in accordance with Manufacturer's specifications.

**3.2.
DAMP-PROOF
MEMBRANE**

1. Install damp-proof membranes as follows:
 - a) Prime surface with a uniform coating of asphalt primer at the rate of 5 litres (1.1 gals) per 10 sq. meters (12 sq.yds), or as recommend by the manufacturer.
 - b) Apply vertical Damp-proofing to a thickness of 90 mil. or 1/16 in. with 6 ins lap at joints where end of previous application is dry. Apply 2 coat fillets at internal angles and overlaps at horizontal damp-proof courses. This work to be protected or covered after deemed complete by Engineer.
 - c) Embed and joint insulation boards tightly butted and with staggered joints into final layer of bitumen. For this process bitumen shall not exceed 266 F (130° C).

3.3.
***HORIZONTAL DAMP-
PROOF COURSE***

1. Install damp-proof courses as follows:
 - a) Ensure full grouting and projecting reinforcement is complete before primer is applied.
 - b) Primer coat as Article 3.2.
 - c) Uniform layer of P.B.4 to a total thickness of 120 mil. or 1/8 in. applied in 3 coats. Apply 2 coat fillets at internal angles, and at base angles.
 - d) Set DPC 1/2 in. back from outer face of wall to allow for pointing, and extend 6 ins minimum up or over vertical adjacent surface.

3.4.
***TANK FINISH
PODIUM ETC.***

1. This surface coating shall be installed directly to the unfinished concrete floor, walls and ceilings or on the plastered surfaces (if required). Prepare in accordance with Article 3.1. Apply cement plaster (if required) as described in Section 9200: Plaster works. Use material as specified in Article 2.3. or as approved by the Engineer in accordance with the Manufacturer's specifications.

3.5.
***WATERPROOF
MEMBRANE***

- a) All concrete and metal surfaces such as drains, pipes, etc. shall be cleaned of oil rust, scale and other foreign matter. Rough area and honeycombed concrete must be repaired prior to installation at contractor's own cost.
- b) Substrates to receive membrane shall be smooth and perfectly dry prior to application of membrane.
- c) At joints (and cracks) structural specifications to be followed.
- d) Apply the membrane as specified in Article 2.4. in accordance with the Manufacturer's specifications.



3.6.
POOL MEMBRANE

1. Install pool membrane as follows:
 - a) This membrane shall be installed directly over inner of outer pool wall. Preparation shall be in accordance with Article 3.1.
 - b) Same as Article 3.5.1a of this Section.
 - c) Same as Article 3.5.1b of this Section.
 - d) Same as Article 3.5.1c of this Section.
 - e) Same as Article 3.5.1d of this Section.

3.7.
***CLEANING &
PROTECTION***

1. Upon completion of Work to this Section, promptly clean shed surfaces of debris, stains and equipment, leaving areas in a neat and orderly condition to approval of Engineer.



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1.
GENERAL

1.1
DESCRIPTION

1. Work included:
 - a) Work under this Section includes the supply and installation of all materials under the finished concrete roof deck, slab, terraces/planter, as indicated on the drawings but subject to the restrictions described in item 1.2.
 - b) The metal seam roof is referred to in this Section of these Specification as uninsulated roofs.
2. Work not included:

Sheet metal flashings around curbs to mechanical equipment and over pads to same.
Refer to Mechanical Works Contract.

1.2.
QUALITY ASSURANCE

1. Restrictions of Specification:

Use only the methods and materials described in this Section of these Specifications to fulfil the requirements of this contract.
2. Qualifications of installers:
 - a) The roofing installer shall be currently approved by the manufacturer of the selected roofing.
 - b) For installation of membrane roofing, use only competent and skilled roofers completely familiar with the products, and the manufacturer's current recommended methods of installation.
3. Manufacturer's Certification:

Prior to start of installation of the Work of this Section, engage at the Job Site, a representative of the manufacturer of the membrane roofing, to inspect and certify that:

 - a) Surfaces to which the membrane roofing is to be applied are in a condition suitable for this application.
 - b) Materials to be installed comply with the requirements of this Section of these Specifications.



- c) Materials to be installed are in complete accordance with the manufacturer's current recommendations.

**1.3.
SUBMITTALS**

1. Manufacturer's certification:

Upon completion of this portion of the Work, and as a condition of its acceptance, deliver to the Engineer 2 copies of the certification described in this Section, each copy signed by an officer of the firm manufacturing the membrane roofing system.

2. Guarantee:

Upon completion of this portion of the Work, and as a condition of its acceptance, deliver to the Engineer a written guarantee signed by the Installer and endorsed by the membrane roofing manufacturer guaranteeing that the installed membrane roofing will remain intact and free from leaks for a period of at least seven years following date of installation.

3. Samples:

Submit samples of roofing material for quality of the product for approval complete with manufacturer's specification data.

**1.4.
PRODUCT
HANDLING**

1. Protection:

Protect roofing materials before, during, and after installation and protect installed work and materials of other trades

2. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

3. Shipping and Storage:

Roofing material shall be packed in hay and shipped in crates adequately to prevent shifting. Once on the site, they shall be stored on wood sleepers near the point of intended use. Roofing membranes shall be in their original packing and stored in a dry place till the time of installation.



2.
PRODUCTS
2.1.
MATERIALS

1. Roof Coating:
 - a) Coating to roofs over slab, and terraces/planters shall be cold brushed applied material Aquafin 2K / M by Shomburg or Sika Seal 105 by Sika Group or approved equivalent applied as per manufacturer's recommendations.
2. Sand and Cement to requirements of Section for Cast in Place Concrete.
3. Mortar materials and colour for cement tiles shall be same specified by the Engineer.
4. Insulation: Moulded polystyrene board, as described in Section 7200 for Insulation.
5. Roofing Tiles:
 - a) Locally made Pre-cast roof tiles 24"x24"x2" (600mm x 600mm x 50mm) minimum. thick of durable quality suitable for roof application. Colour to match approved sample.
 - b) Ingredients: Cement tiles shall consist of cement, fine sand and water all in measured amounts.
 - c) Moulding: Tiles shall be shaped by inserting into moulds. Irregular surfaces shall be finished by hand tooling, provided such tooling has no visible effects after firing.
 - d) Defects: Deformed items shall be discarded. Rough surfaces may be ground smooth with written agreement of the Engineer. Tolerances upto 1/16" (1.56mm) total variation in any dimension will be allowed.
 - e) Colour: To match approved sample. Discoloration will be a basis of rejection for any cement tile.
 - f) Formula: A written description of the process for making approved cement tiles shall be given to the Engineer.
6. Concrete and mix design for upstand curbs at attic perimeters and around roof penetration shall be the same as pertinent data of Section on Cast-in-place Concrete. Use ordinary Portland cement.



2.2.

OTHER MATERIALS

1. Materials and methods not specifically described but required for proper installation, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.

EXECUTION

3.1.

**SURFACE
CONDITIONS**

1. Inspection:
 - a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify the Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.

LAYING SEQUENCE

1. General roof areas:
 - i) Sand and cement sloping screed.
 - ii) Roof Coating: Same as 2.1 above
 - iii) Insulation: Moulded polystyrene of 32 kg/M³ density rapped in 6 Mil. Polythene sheet.
 - vi) Loose Pre-cast concrete tiles

3.3.

**ROOF MEMBRANE
TYPE ECOGUM 4P
TORCH-ON-MEMBRANE**

1. Membrane materials shall be applied to surfaces as per the Manufacturer's instructions.
 - a) All concrete and metal surfaces such as drains, pipes etc. shall be clean of oil, rust, scale and other foreign matter. Rough area and honeycombed concrete must be repaired prior to installation.
 - b) At joints (and cracks) structural specifications to be followed.



- c) Institute all required procedures for protection of completed membrane during installation of membrane and throughout remainder of Construction period. Do not allow any type of traffic on unprotected membrane.

3.4. INSULATION

1. Lay boards staggered and with easily butted joints unbonded to roof membrane. Entire surface of roof area shall be flush with edges aligned.
2. Do necessary cutting around protrusions and upstands.
3.
 - a) Prevent disfigurement and damage to insulation boards from point loads during installation and afford same protection while subsequent materials are placed on top.
 - b) Damaged or dented boards shall be replaced with new ones.
 - c) Do not leave boards exposed to sunlight or uncovered at the end of the day.

3.5. SCREEDING

1. Mix to consist of one part Portland cement to three (2) parts Sand and six (4) parts Coarse aggregate to Engineers approval.
2. Wet sand and cement sloping screed before installing mortar mix.
3. Spread and place mortar mix to conform with slopes indicated on Drawings, minimum thickness of 3" (75mm). Apply in alternate bays not exceeding 250 sq.ft. (232.23 sq. m.). Form canted fillets at upstands
4. Screeding and tamping shall be done immediately after spreading to achieve prescribed slopes.
5. Mix shall then be smoothed and consolidated to a uniform close textured surface with a wood float, to remove high and low spots exceeding 1/4 in. (6 mm) in 10 ft. (3 m). Avoid excessive floating.
6. Showing signs of laitance will be subject to rejection by the Engineer. These faulty areas shall be replaced at no additional cost to the Employer.
7. Screed layer shall be cured for a minimum of 7 days after finishing as described in Section for Cast-in-place concrete.
8. Allow sufficient time for material to thoroughly harden and ensure surface is dry before allowing other work to be carried out.

3.6.
ROOF FINISH

1. Lay cement roof tiles, where indicated over mortar mix.
 - a) Loosely laid tiles with joints butted and aligned in both directions but not coincidental with those of the insulation. Set out tiles to roof areas so that dimensions remaining at perimeter walls, to receive half size.
 - b) Cut tiles square to face to a tolerance of 1/8 in (3mm). Cutting shall be kept to a minimum.
 - c) Mortar shall be a mix of one (1) part cement to four (4) parts sand.
 - d) Apply sufficient mortar at joints.
 - e) Ensure alignment is correct with adjacent tiles and evidence of movement or rocking is eliminated.
2. Following setting of flags and tiles poured, concrete edging/upstands shall be installed reinforced with expanded metal lath, lapped and secured under precast copings. Ensure that lathing is well supported and set back 1/2 in. (12mm) from finished face of concrete. Profile of edging upstand shall be as shown on Drawings including canted fillet.

3.7.
ROOF SCUPPERS

1. At general roof areas and uninsulated roof areas with roof scupper outlets apply expanded metal pebble stops and pebbles as shown on Drawings.
 - a) Expanded metal pebble stops shall be shaped and liberally coated with bitumen prior to installation.
 - b) Embed pebble stops into a coating of hot bitumen, over ply roofing felt, extending bitumen 6 ins (150mm) beyond area to be covered by metal. Ensure no sharp edges are protruding through surface of roofing.
 - d) After completion of general roof finishes lay pebbles into areas designated for same as shown on Drawings.

3.8.
TOLERANCES

1. Deviations exceeding 1/4 in. in 10 ft (6mm in 3 Meter) applied in all directions will not be accepted.

3.9.
CLEANING

1. Upon completion of the work of this Section immediately remove debris, excess materials and smears that may remain.



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1.
GENERAL

1.1
DESCRIPTION

1. Work included:

The purpose of caulking in this Work is to provide a positive barrier against penetration of air and moisture at joints between items where caulking is essential to continued integrity of the barrier. Caulking will normally be performed under the work of various Sections of these Specifications but shall be performed in strict accordance with the provisions of this Section. Following locations shall require cacking

- a) Periphery of wood and metal frames in exterior and interior walls including doors and windows.
- b) Joints between cement plaster and dissimilar materials.
- c) Joints between concrete or masonry and dissimilar materials.
- d) Joints between glass and glazing beads to exterior windows.
- e) Internal angles as follows:
 - i) Wall and floor finish joints with bathtubs.
 - ii) Wall and floor finish joints with WC's and squat toilets
 - iii) Wall to wall and floor to wall junctions in showers.
- f) Concrete road joints.
- g) Other locations as directed by Engineer.

1.2.
QUALITY ASSURANCE

1. Qualification of applicators:

Installation of caulking shall be performed only by workmen thoroughly skilled and specially trained in the techniques of caulking, and who are completely familiar with the published recommendations of the manufacturer of the caulking material being used.

2. Rejection of installed caulking:

Indication of lack of skill on the part of caulking installers shall be sufficient grounds for the Engineer to reject installed caulking and to require its immediate removal and complete recaulking at no additional cost to the Employer.



**1.3.
SUBMITTALS**

1. Samples submit manufacturers technical data for product required :

Within 120 days after award of the contract and before any sealants are delivered to the Job Site submit 3 ins (75 mm) strips of each specified type in available colours for selections by Engineer, applied to pieces of hardboard, concrete, and aluminum. Supply also a small sample in a sealed container.

1. Protection:

- a) Deliver materials with each container bearing an unbroken seal and manufacturer's label.
- b) Protect caulking materials before, during, and after installation and protect installed work and materials of other trades.

2. Replacements:

In the event of damage, immediately make repairs and replacements necessary to the approval of Engineer, at no additional cost to the Employer.

3. Storage:

- a) Store caulking materials and equipment under conditions recommended by its manufacturer.
- b) Do not use materials stored for a period of time exceeding the maximum recommended shelf-life of the material.

**2.
PRODUCTS
2.1.
CAULKING
MATERIALS**

1. Caulking Sealants: These shall be non-sagging type, non-staining, neutral or other colour approved by Engineer where exposed to view, and shall be as follows or specifically approved type by Engineer:

Type 1

Silicone low modulus one part, 'NITOSEAL 125 by FOSROC or other approved equivalent to periphery of wood and metal frames in exterior walls including windows, doors, etc. Also, to precast concrete unit jointing, vertical exterior expansion joints, but not limited to same.

Type 2

Acrylic emulsion based one part, 'NITOSEAL 100/105 by FOSROC or other approved equivalent for joints around window and door frames, brickwork and blockwork.



Type 3

Silicone elastomeric one-part, mildew resistant, moisture curing to showers, toilets and bathtubs or other approved equivalent. Use NITOSEAL 130 by FOSROC, or equivalent.

Type 4

Polyurethane multi part, 'NITOSEAL 225/240 by FOSROC or other approved equivalent to interior masonry expansion joints, joints between interior framed units and their openings, behind door frames to refrigerated refuse room and where sealant is required to receive paint.

Type 5

Liquid Polysulphide Polymer, two part, 'THIOFLEX 600 by FOSROC, or other approved equivalent, for structural expansion and others relief joints.

2. Joint backing:

Where indicated on Drawings and/or directed by Engineer use closed cell foam rod polyethylene, expanded polyurethane neoprene or butyl rubber round solid rod joint backing, in joints over 1/8 in.(3 mm), circular in section, capable of being installed under at least 25% compression or equal as approved in advance by Engineer.

3. Bond breaker:

Polyethylene tape or Pressure sensitive plastic tape or masking tape placed between sealant and joint backing which will not bond to sealant, where required.

**2.2.
CAULKING
EQUIPMENT**

1. Caulking equipment to be as recommended by the manufacturer of the caulking material being installed.

**2.3.
OTHER MATERIALS**

1. Materials and methods not specifically described but required for proper installation of items in this Section, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

**3.
EXECUTION
3.1.
SURFACE
CONDITIONS**

1. Inspection:

- a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.



- b) Verify that caulking may be installed in accordance with the manufacturer's recommendations.
2. Discrepancies:
- a) In the event of discrepancy, immediately notify the Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2. PREPARATION

1. Remove dust, paint, loose mortar and other foreign matter. Dry joint surfaces.
2. Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sandblasting.
3. Remove oil, grease and other coatings from non-ferrous metals with solutions to Engineer's approval.
4. Prepare concrete, masonry, glazed and vitreous surfaces to sealant manufacturer's instructions.
5. Examine joint sizes and correct to achieve depth ratio $\frac{1}{2}$ of joint width.
6. Install joint backing to achieve correct joint depth. Where joints exceed 1/8 in. (3 mm) width use rod type backing.
7. Where necessary to prevent staining, mask adjacent surfaces with tape prior to priming, if required, and caulking.
8. Apply bond breaker tape where required to manufacturer's instructions.
9. Prime sides of joints to manufacturer's instructions immediately prior to caulking, where required.

3.3. BACK-UP MATERIALS

1. Verify the compatibility of joint backing material with caulking before installation.

3.4. APPLICATION

1. Carefully study the Drawings, furnishing and installing proper caulking at each point where called for and at other points where caulking is essential in maintaining the continued integrity of the watertight barrier.



2. Install caulking in strict accordance with the manufacturer's recommendations, taking care to produce beads of proper width and depth, to tool as recommended by the manufacturer, and to immediately remove all surplus caulking.
3. Apply sealants, primers, if required, joint backing and/or bond breakers to manufacturer's instructions. Apply sealant using a gun with proper size nozzle. Use sufficient pressures to fill voids and joints solid. Superficial pointing with skin bead is not acceptable.
4. Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities. Neatly tool to within 1/16 in. (2 mm) of the surface.
5. Apply sealant to around perimeter joints between exterior windows/door frames to adjacent building components, to control joints in masonry walls, interior corners to showers, around all edges of bathtubs, WC. fixtures and elsewhere indicated on Drawings. Apply sealant to glazing conditions as described in Section 8.5 of these Specifications.

**3.5.
CLEANING**

1. Clean adjacent surfaces immediately and leave work neat and clean. Remove excess and droppings, using recommended cleaners as work progresses. Remove masking tape after tooling of joints.

**4.
METHOD OF
MEASUREMENT**

Joint Sealers to be measured by length.



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PART 1 GENERAL

1.1 Description

1. Work included:

Building insulation required for this Work includes, but is not necessarily limited to:

- a) All External Walls.
- b) Building Roof.
- c) Refrigerated Refuse room walls, ceiling and door.
- d) or specified in drawing

1.2 Product Handling

1. Protection:

- a) Deliver materials to the Job Site and store in a safe dry place with all labels intact and legible at time of installation.
- b) Protect building insulation materials before, during, and after installation and protect the installed work and materials of other trades.
- c) Do not leave insulation exposed to sunlight. Keep covered with clear or light colored waterproof material. Apply finish material soon after installation of the insulation. Brush off any sunlight degraded surface material prior to adhering insulation.

2. Replacements and acceptability:

Panels chipped, cracked or squashed shall be rejected. In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

PART 2

MATERIAL

2.1 Insulation

1. Type 1

- a) Self-extinguishing extruded closed cell high density Polystyrene Board of Diamond Jumbolon or approved equivalent polystyrene molded bead board minimum density 2lbs. per cu.ft (32-35 kg/m) density, for roofs, terraces/planters, external walls, cavity walls and Rammed earth walls etc. according to the drawings / details.

2.2 Fastening

1. Flexible faced insulations shall be fastened with staples.

2.3 Adhesive & Tapes

1. Polystyrene Type Insulations:
Bedding and jointing material as described in other Sections of these Specifications.
2. Flexible Faced Insulations:
Foil tape for joints and punctures as recommended by insulation manufacturer.
3. Rigid Mineral-Fibred Boards:
Bedding and jointing adhesive as recommended by insulation manufacturer.

2.4 Other Materials

1. Materials and methods not specifically described but required for proper installation of building insulation, shall be provided by Contractor subject to prior approval of the Engineer at no additional cost to Employer.

PART 3

EXECUTION

3.1 Surface Conditions

1. Inspection:
 - a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
 - b) Verify that building insulation may be installed in accordance with the original design and the manufacturer's recommendations.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify the Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2 Installation

1. Roof:
Refer to Section 7560 Membrane Roofing.
2. Refrigerated Refuse Room:
Refer to Section on Refrigerated Refuse Room.
3. Insulation facing flanges shall be stapled to framing material and foil taped to form complete seal. Tape any punctured facing material.

4. Refrigerated Refuse Room Doors:

Cut, bed and joint insulation boards within doors in adhesive.

3.3 Inspection

1. Upon completion of the installation, visually inspect each area and verify that insulation is complete and properly installed.

4.0 METHOD OF MEASUREMENT

Refer Section 7100: Damp proofing & Waterproofing

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PART 1 GENERAL

1.1 Description

Needle Punched non-woven manufactured

- From 100% Virgin Polypropylene staple fibres
- Weight: 500 gsm, 5.9 meter wide, 80 meter long
- Thickness: 4.1 mm (under 2 kPa)

Tensile Strength – MD	EN ISO 10319	39 kN/m
Tensile Strength - XD	EN ISO 10319	39 kN/m
Elongation at break – MD	EN ISO 10319	70 %
Elongation at break – XD	EN ISO 10319	75 %
CBR Puncture Resistance	EN ISO 12236	6300 N
Dynamic Cone Drop	EN ISO 13433	6 mm
Permeability	EN ISO 11058	40 m/s. 10 ⁻³
Waterflow normal to the plane	EN ISO 11058	40 l/m ² .s
Characteristic Opening Size	EN ISO 12956	60 µm

The geotextile fabric shall be UV stabilized and inert to chemicals commonly encountered in soil and water.

1.2 DURABILITY

- Predicted to be durable for a minimum of 25 years in all natural soils
- Natural UV light: Retained Strength of > 80% after 50 MJ/m² exposures.
- Moisture: Does not absorb moisture
- Rot, Mildew: Unaffected
- Natural occurring acids and alkali: Unaffected
- Oxydation Resistance EN ISO 13438: Retained Strength >90% at (110±1) °C after 14 days exposure.
- Chemical Resistance EN 14030: Excellent
- Microbiological Resistance EN 12225: Excellent

Geotextile rolls shall be furnished with suitable wrapping for protection and each roll shall be labeled and identified for field identification as well as for inventory and quality control purposes.

The surface to receive the geotextile fabric shall be prepared to a relatively smooth condition, free of obtrusions, depressions, and debris. Geotextile installation shall proceed in the direction of construction. Longitudinal joints in the fabric shall have a minimum overlap of 30cm, sewn or otherwise specified by the Engineer. In the event construction machinery is used to place the fabric, the working platform for the machinery shall be the soil and not the previously laid geotextile.

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PART 1 GENERAL

1.1 Description

- Fiber Bonding: Thermally Bonded
- Polymer: 100% Polypropylene, continuous filament and UV Stabilised
- Fiber diameter: 40 - 50 micron
- Roll Size: 4.5-meter width, 100-meter length = 450 Sqm Roll
- Durability: 100 years in all-natural soils
- According to Quality system ISO 9001, ISO 14001
- Oxidation Resistance EN ISO 13438: 100% retained strength
- Chemical Resistance EN 14030: 100% retained strength
- Microbiological Resistance EN 12225: 100% retained strength

Property	Standards	Value
Area Weight (g/m ²)	EN ISO 9864	190
Thickness under 2kN/m ² (mm)	EN ISO 9863-I	0.57
Thickness under 200kN/m ² (mm)	EN ISO 9863-I	0.48
Mechanical Properties		
Energy Absorption (kJ/m ²)	EN ISO 10319	5.8
Tensile strength (kN/m)	ASTM D4595	13.1
Elongation (%)	ASTM D4595	52
Tensile Strength at 5% (kN/m)	ASTM D4595	5.7
Puncture strength (N)	ASTM D6241	1850
Tear strength (N)	ASTM D4533	400
Puncture US Road (N)	ASTM D4833	370
Dynamic Cone Puncture (mm)	EN ISO 13433	22
Hydraulic Properties		
Opening Size O ₉₀ Wet (μm)	EN ISO 12956	80
Opening Size O ₉₅ Dry (μm)	ASTM D4751	100
US Sieve	ASTM D4751	140
Permittivity (1/s)	ASTM D4491	0.65
Permeability (V _{H50}) (10 ⁻³ mm/s)	EN ISO 11058	35
Flow rate at 10cm WH (l/(m ² .s)	BS 6906-3	60
Permeability at 20 kN/m ² (10 ⁻⁴ m/s)	DIN 60500-4	1.9
Permeability at 200 kN/m ² (10 ⁻⁴ m/s)	DIN 60500-4	1.4

1.2 Execution

Geotextile rolls shall be furnished with suitable wrapping for protection and each roll shall be labelled and identified for field identification as well as for inventory and quality control purposes.

The surface to receive the geotextile fabric shall be prepared to a relatively smooth condition, free of obtrusions, depressions, and debris. Geotextile installation shall proceed in the direction of construction. Longitudinal joints in the fabric shall have a minimum overlap of 30cm, sewn or otherwise specified by the Engineer. In the event construction machinery is used to place the fabric, the working platform for the machinery shall be the soil and not the previously laid geotextile.

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I. GENERAL

1.1. DESCRIPTION.....2



PART 1 GENERAL

1.1 Description

Fibrillated Polypropylene Fibre for concrete reinforcing: Concrete shall be treated with Fibrillated Polypropylene synthetic reinforcing Fibres when indicated on the drawings or as otherwise specified by the Architect/Consultant in accordance with the fibre manufacturer's recommendations.

- a. Synthetic reinforcing fibres shall be manufactured from virgin polypropylene.
- b. The recommended dosage is 2.7 kg per cubic meter (4.5 lb per cubic yard) of concrete.
- c. The Fibrillated Polypropylene Fibres shall be of 50mm length.
- d. Fibre supplier shall provide Fibrillated polypropylene fibre in pre-portioned packet for each batch of concrete mix.
- e. Fibre supplier shall provide technical assistance, if required.
- f. All fibres must meet or exceed the standards and specifications set forth in ACI 544, Fibre Reinforced Concrete. The fibre should be manufactured from 100% virgin homopolymer to meet ASTM C-1116.
- g. Listed below are the minimum properties of the polypropylene fibres for use. All fibres must meet or exceed the characteristics described in ACI-544, IR, table 4.1, Fibre Reinforced Concrete.
 1. Tensile Strength of granule: 6000 psi
 2. Tensile Strength of Polypropylene fibre: 60,000 psi
 3. Elongation at break: 12%
 4. Fibre: 100% Fibrillated Polypropylene
 5. Lengths: 50 mm
 6. Absorption: Nil
 7. Specific gravity: 0.9
 8. Ignition point: 593 °C
 9. Melting point: 160-170 °C
 10. Heat & UV stabilization: Long term
 11. Thermal conductivity: Low
 12. Electrical conductivity: Low
 13. Color: Transparent
 14. Salt resistance: High
 15. Acid resistance: High
 16. Alkali resistance: 100% (alkali proof)

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1. GENERAL

1.1. DESCRIPTION.....2

1.2. DURABILITY.....2



PART 1 GENERAL

1.1 Description

Needle Punched non-woven manufactured

- From 100% Virgin Polypropylene staple fibres
- Weight: 150 gsm, 5.9 meter wide, 100 meter long
- Thickness: 1.9 mm (under 2 kPa)

Tensile Strength – MD	EN ISO 10319	11.5 kN/m
Tensile Strength - XD	EN ISO 10319	11.5 kN/m
Elongation at break – MD	EN ISO 10319	65 %
Elongation at break – XD	EN ISO 10319	70 %
CBR Puncture Resistance	EN ISO 12236	1850 N
Dynamic Cone Drop	EN ISO 13433	22 mm
Permeability	EN ISO 11058	95 m/s. 10 ⁻³
Waterflow normal to the plane	EN ISO 11058	95 l/m ² .s
Characteristic Opening Size	EN ISO 12956	110 µm

The geotextile fabric shall be UV stabilized and inert to chemicals commonly encountered in soil and water.

1.2 Durability

- Predicted to be durable for a minimum of 25 years in all natural soils
- Natural UV light: Retained Strength of > 80% after 50 MJ/m² exposures.
- Moisture: Does not absorb moisture
- Rot, Mildew: Unaffected
- Natural occurring acids and alkali: Unaffected
- Oxidation Resistance EN ISO 13438: Retained Strength >90% at (110±1) °C after 14 days exposure.
- Chemical Resistance EN 14030: Excellent
- Microbiological Resistance EN 12225: Excellent

Geotextile rolls shall be furnished with suitable wrapping for protection and each roll shall be labeled and identified for field identification as well as for inventory and quality control purposes.

The surface to receive the geotextile fabric shall be prepared to a relatively smooth condition, free of obtrusions, depressions, and debris. Geotextile installation shall proceed in the direction of construction. Longitudinal joints in the fabric shall have a minimum overlap of 30cm, sewn or otherwise specified by the Engineer. In the event construction machinery is used to place the

fabric, the working platform for the machinery shall be the soil and not the previously laid geotextile.

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PART 1 GENERAL

1.1 Description

1 Work Included

Work of this Section includes all labor, materials, equipment and services necessary for fabrication, supply and installation of Composite Aluminum Metal Panels and all related ancillaries for cladding of exterior and interior building walls, columns, soffits, etc. as shown on the drawings and as specified herein and required.

1.2 Submittals

Submit the following in accordance with Specification Sections.

- A. Product data including manufacturer's product specification, standard details, and certified product test results, installation guidelines, and general recommendations, as applicable to materials and finishes for total panel system.
- B. Samples for initial selection purposes in form of manufacturer's color charts or chips showing full range of colors, finishes, and patterns available for composite metal panels with factory-applied finishes.
- C. Samples for verification purposes of composite metal panels. Provide 4" x 10" sample composite panels in thickness specified for assembly approval. Include clips, anchors, supports, fasteners, closures and other panel accessories.
- D. Submit two (2) draw-down samples of each color and finish selected on a 4" x 8" aluminum substrate for color approval only.
- E. Submit Shop Drawings indicating thickness and dimension of parts; fastening and anchoring methods; detail and location of joints, including joints necessary to accommodate thermal movement.

1.3 Quality Assurance

- A. Composite panel manufacturer shall have a minimum of ten years of continuous experience manufacturing the panel material.
- B. Fabricator/Installer - shall be approved by composite panel manufacturer and have not less than five years' experience having completed full Metal composite panel cladding system work similar in material, design and extent to that indicated for this project and with record of successful in-service performance.
- C. When possible, field measurements shall be taken prior to completion of shop fabrication.
- D. Maximum deviation from the vertical and horizontal alignment of erected panels shall be no more than 1/4" in 20'-0".
- E. Follow manufacturer's recommendations and guidelines for storage, handling, fabrication and field forming of panels.

- F. Fabricator/Installer shall be one and the same to ensure single-source responsibility.
- G. Prior to installing the full systems a mock up sample shall be installed exposing the individual layers and members of the system. Size of the mock shall be as determined by the Engineer.

1.4 System Performance Requirements

- A. Testing: Panels furnished under this Section shall have been tested in accordance with tests specified under this Article; provide certification by panel supplier showing compliance with requirements. Otherwise perform tests through an approved laboratory and provide certified tests results. Test results shall meet indicated standards.
- B. Deflections and Thermal Movements; Provide panel suppliers products and system that are capable of withstanding building movements and weather exposures, including wind loading of 40 lbs/ sq ft inward and 40 lbs/ sq ft outward, and which are capable of performing within the following limitations:
 - Structural Performance: Shall have been tested in accordance with ASTM E330-96 at design. Pressure of 40 lbs/ sq ft. No permanent deformation or failures of structural members shall occur.
- C. Leakage Resistance, Water, and Air: Provide the panel suppliers system that has been tested to demonstrate permanent resistance to leakage as follows:
 - Air Leakage: AT 1.57 psf, not more than 0.06 cfm/ft² of wall area when tested in accordance with ASTM E283-91.
 - Water Penetration: Water penetration in this specification is defined as the appearance of uncontrolled water in the wall. Provisions shall be made in the design to drain to the exterior face of the wall any leakage of water at joints and/or any condensation within the construction. No water infiltration under static pressure when tested in accordance with ASTM E331-93 at a differential of 10% of inward acting design load, 6.24 psf minimum after 15 minutes.

1.5 Delivery, Storage, And Handling

- A. Deliver panels and other components so they will not be damaged or deformed. Package composite wall panels for protection against transportation damage. Identify fabricated units and component panels per erection drawings.
- B. Handling: Exercise care in unloading, storing, and erecting panels to prevent bending, warping, twisting, and surface damage.
- C. Storage: Store composite panels in well-ventilated space out of direct sunlight. Protect panels from moisture and condensation with tarpaulins or other suitable weather tight covering installed to allow ventilation. Panels shall be sloped to insure positive drainage of any accumulated water. Do not store panels in closed containers or unventilated spaces where temperatures can exceed 120 degrees F. Do not store panels in contact with other materials that might cause straining, denting, or other surface damage.

PART 2

PRODUCT

2.1 Composite Metal Panels

- A. Raw material: The panel shall be composed of non toxic low density polyethylene core between two sheets of high strength aluminum alloy, with technology of continuous compositing, rub- resistant, acid

- resistant, and alkali resistant; having surface coating of PVDF manometer paint; with the following minimum specifications:
- a. Panel Thickness: 4 to 5 mm (as recommended by the manufacturer for the type of application)
 - b. Bond Integrity: When testing for bond integrity, simulating resistance to delaminating:
 - c. Bond Strength: 1,000 psi minimum in accordance with ASTM D1781-76. Shall have had no change in bond performance after eight (8) hours of submersion in boiling water and twenty-one (21) days immersion in 70 degree F water.
 - d. Peel Strength: 22.5 inch lbs./in. minimum in accordance with ASTM D1781-76.
 - e. Flame Spread: 0 when tested in accordance with ASTM E84.
 - f. Smoke Developed: 10 when tested in accordance with ASTM E84.
 - g. Surface Flammability: Passed when tested in accordance with ASTM E108-88 modified.
 - h. Finish/Color: to be selected from manufacturer's color guide/range and as approved by the Architect/Engineer.
- B. Substructure
- a. Background supporting structure: Galvanized steel frame.
 - b. Substructure: Fixing shall be aluminum
- C. Acceptable Manufacturers (Aluminium Composite Panel Cladding)
- 1. Alpolic
 - 2. Alubond
 - 3. Alucobond
 - 4. Reynobond
 - 5. i-Bond OR
 - 6. Any similar product approved by the Architect/Engineer

2.2 WARRANTY

Submit written warranty in form of acceptance to Engineer/ Owner, jointly signed by contractor and by subcontractor for the work, warranting against defective materials, products due to defective fabrication and installation, delaminating and finish will not crack, peel, corrode or dis-colour for period of 10 years from date of completion of the work.

2.3 FABRICATION OF PANELS

- A. Finish: Panels shall have minimum 70% fluoropolymer resin coating that meets or exceeds values expressed in AAMA 605.2 where relevant to coil coatings.
- C. Panel system to be "Rout and Return Wet Seal" System. Or as recommended by the manufacturers for type of application on the Project.
- D. Panels shall be shop fabricated to sizes and joint configurations indicated on the drawings.
- E. Where final dimensions cannot be established by field measurement before completion of panel

manufacturing, provide allowance for field adjustments as recommended by the fabricator. Panellines, breaks, and angles shall be sharp and true, with surfaces free from warp or buckle.

- F. Panels shall have a removable plastic film applied during production to remain on during shipping, fabrication and erection.

PART 3.

EXECUTION

A. Inspection

Examine the areas and conditions where exterior composite metal panels are to be installed and notify the Architect/Engineer of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the Contractor in a manner acceptable to the Architect/Engineer. Beginning of installation shall signify structure and adjacent conditions as being proper and acceptable.

Examine all structural steel before beginning installation to ensure that all supporting members are straight, level, plumb and true, in accordance with AISC minimum tolerances and satisfactory for panel installation.

B. Installation

Install profiles in accordance with drawings and the manufacturer's recommendations installed profiles to be straight and plumb and true to line and levels indicated. Flashing and trim shall be installed true and in proper alignment.

Sealant shall be installed where indicated, without skips and voids, to ensure weather tightness and integrity of the vapor barrier.

Execute work in such manner to achieve equal surface appearance. Do not interrupt work prior an area within the specified limitation is complete.

C. Cleaning and Protection

Provide final protection and maintain conditions that all exposed interior and exterior finishing system during construction is without damage or deterioration.

After installation is complete, all exposed interior and exterior surfaces of the metal panel system, including flashing and accessories, shall be cleaned of all dust, dirt, grease and other foreign material to the satisfaction of the Engineer. Surfaces and color of erected panel materials shall be uniform.

Coated finish surfaces shall be cleaned in accordance with the recommendations of the coating material manufacturer.

Minor scratches and abrasions in panel coating shall be touched up with air drying materials supplied by the panel manufacturer. Touch up material shall match the color, surface characteristics and durability of the original coating.

Replace damaged panels and other components of work that cannot be repaired by finish touchup or similar minor repair.

Protective film to be removed just prior to caulking, which is done just before completion of work.

ARTICLE INDEX

1. GENERAL.....1



8.1
GENERAL

METAL WORKS

1. Scope of Works

This section of the specification covers all steel and aluminum work (doors and windows), hardware, wire gauze/screens and ironmongery not covered under section 8 : Carpentry, Joinery and Ironmongery.

2. Materials

All materials shall conform with the relevant BS. Equivalent standards may be accepted with the approval of the Engineer. The manufacturer's test certificates shall be supplied to the Contractor before any steel can be accepted.

Structural steel (channels, angles, flats, bars and other rolled sections) shall conform to BS 15 "Mild Steel for General Structural purposes".

In addition, structural steel hot-rolled sections shall comply with the requirements of B.S. 4: Part 1; structural steel hot-rolled hollow sections and with B.S.4: Part 2. The maximum carbon contents shall be in accordance with B.S. 4360.

Steel sections for casement doors and windows shall be hot rolled low carbon steel on piece sections with flanges rolled integrally, flanges forming the weathering contacts at both inside and outside points of closure.

Galvanizing shall be hot dip as per BS 792 Part 1 "Hot Dip Galvanized Coating".

Bolts and nuts shall conform to BS 4190. Bolts shall be oil protected on the threaded parts.

Steel plates and sheets shall conform to BS 1449 "Steel plates sheets and strips".

Washers shall conform to BS 4320.

M.S. hold fasts and lugs shall be of approved size with split end for embedding except the lugs for aluminum doors, windows and glazing which shall be as supplied by the approved manufacturers of these items.

Steel pipes shall be black steel pipes medium quality conforming to BS 1387/57 of M/S KPM or approved equal make.

Wire gauze shall be 24 SWG. 12 x 12 meshes square inch, (300mm x 300mm) for openable panels of doors and windows where required.

Hardware ironmongery and fixtures shall be in quantity and of approved type and makes. These shall be of best quality, conforming in all respects to specifications.

Steel doors and windows shall conform to the approved construction details.

3. Samples

Samples of all materials shall be submitted by the Contractor for testing where so required by the Engineer at Contractor's cost and for approval. Only approved type of materials shall be used throughout the works and rejected materials shall be removed from the site of works immediately.

Samples to be supplied will include, but not be restricted to the following:

- a) All types of metal doors incl. Frames.

Samples of the above mentioned items shall be installed on site as directed by the Engineer. Approval shall be obtained and all subsequent works shall in strict accordance



with the installed samples, any work inferior to that will be removed and replaced at Contractor's cost.

4. Shop Drawings

Prepare shop drawings showing clear and complete details of each assembly, component and connection, together with all information relative to their fabrication, surface treatment and erection.

Submit one A1 size transparency of each drawing to the Consultant/Engineer 10 working days before the proposed date for commencement of fabrication, and obtain permission before fabricating.

The examination of shop drawings by the Consultant/Engineer shall not relieve the Contractor of the full and absolute responsibility for the information on the shop drawing.

5. Handling and Storage

Handle and store all works without overstress or deformation. Store all works clear of ground and in such a way that water does not lie on it. Supply bolts, nuts, and washers in grit-free containers and store in water tight premises. Do not use burred, damaged, corroded or otherwise unserviceable bolts.

Do not damage workshop applied finishes during delivery, off-loading, stacking and erection.

6. Workmanship

Verify dimensions and levels for all works on site; take field measurements of all openings before manufacturing.

Workmanship and finish shall be as described in relevant B.S. and C.P. unless otherwise specified.

Where work is exposed to view and forms part of the architectural treatment, give special attention to the finish. Shearing, flame cutting and clipping shall be done carefully and accurately, sharp corners and rough edges shall be faired by grinding or other approved means, and where noted on the drawings, welds shall be made smooth to approval.

7. Fabrication

Do not commence until permission to use the relevant shop drawing has been received site operations where necessary shall be done in positions of easy access. Site welds shall be located wherever possible in positions for down hand welding.

Do not weld short lengths together to make up required member lengths without first obtaining approval.

Fabricate steel beams with natural camber up.

Do not weld temporary attachments on flanges of beams, girders and the like without first obtaining permission. If such permission is granted remove temporary attachments when no longer needed and reinstate surface to a smooth finish.

All surfaces in contact and all surfaces inaccessible after assembly shall first be treated as described under Painting of Structural Steel.

8. Assembly

Shop Assembly



Assemble and connect components as shown on the drawings so that they withstand twisting, warping, bending or overstressing during transport and handling. Provide temporary braces where necessary to prevent damage.

Machined surfaces

Machined surfaces shall be accurately finished to dimensions and tolerances and have a surface finish as shown on the drawings.

Drilling and punching

Holes for bolts and rivets may be drilled or punched.

Do not flame cut holes.

Holes shall be 2 mm larger than the nominal diameter of the bolt or rivet unless otherwise specified and all burrs shall be removed.

Assembly and fixing

Accurately fit meeting faces together before bolting or welding. Keep edges of members free from gouges and burrs.

Drill holes and shop fix cleats, lugs, ties other fixings, necessary before applying protective coatings.

Dissimilar metals

Prevent direct contact between incompatible metals by suitable means. Including but not necessarily limited to separation layers, sleeves or gaskets of plastic film, bituminous felt, mastic, paint coatings, and the like. Separation materials shall not be visible on exposed surfaces.

Expansion and Contraction

Provide for thermal movement in joints and fastenings, particularly in sheet metals and thin sections, and in the installation of assemblies such as frames. Prevent detrimental effects including tearing, buckling, opening joint, undue stress and fatigue.

Roller shutter

Roller shutter shall be as per below detail :

Slates made of tough prime painted galvanized steel, bottom bar of M.S. angles guards rolled form steel and brackets rolled steel plates. Counter balance adjustable. Hood of 24 gauge galvanized steel. Curtain and hood finish will be galvanized per ASTM A 525 standards. Doors will be manual push up with slide bolts suitable for padlocks.

These shutters are to be installed behind the opening on brackets above and to each side of the opening. Headroom and side room are needed to accommodate over lap, brackets, rolled up curtain, guides and chain gear. Appropriate planetary gearing is to be incorporated. Removable mullions between two roller shutters shall not be used.

Steel doors and windows

Where required the Contractor shall supply, assembly and fix steel windows and doors as shown on the drawings. The steel windows and doors shall comply with B.S. 990 and shall be from an approved source and shop-primed with two coats of red lead oxide or other approved rust resisted primer. Steel windows and doors shall be supplied complete with approved locks, hooks, stays hinges and other necessary fittings. Steel door and windows shall be built-in and bedded concrete or brickwork as shown on the drawing.

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**1.
GENERAL**

**1.1
DESCRIPTION**

1. Work included:

Wooden doors and metal / wooden frames including sidelights required for this Work are indicated on the Drawings and Schedules.
2. Related Work:
 - a) Refer to Section Ornamental Metal for gate material.
 - b) Refer to Section Finished Carpentry for architraves and mouldings.
 - c) Refer to Section Sealants (Pointing Mastics) for caulking.
 - d) Refer to Section for installation of Finish Hardware and to Consultant's Hardware Schedule or ironmongery and weather stripping.
 - e) Refer to Section for Glass and Glazing.

**1.2.
QUALITY ASSURANCE**

1. Qualifications of fabricators and installers:

For fabrication and installation of doors and frames use only skilled carpenters and installers completely familiar with recommended methods of fabrication and installation and requirements of this Work.

**1.3.
SUBMITTALS**

1. Shop Drawings:

Within 120 days after award of Contract, and before any doors and frames are fabricated submit Mock-ups to Engineer for approval in accordance with these Specifications.
2. Upon completion of this portion of the Work, and as a condition of its acceptance, deliver to Engineer a letter signed by Contractor certifying that the materials delivered to the Works and fabricated items comply in all respects with provisions of this Section of these Specifications.

**1.4.
PRODUCT
HANDLING**

1. Protection:

Protect materials and fabricated items before, during, and after installation and protect installed work and materials of other trades.
2. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

**2.
PRODUCTS
2.1.
WOOD**

1. Timber shall be of first quality and conform to the applicable requirements and B.S. 1186.
 - a) Timber shall be **Ash** wood as shown on Drawings and schedules, free from defects that would affect its strength and durability. Knots shall not be over 1 ins (25mm) in their greatest dimension and be sound and tight. Timber to be well seasoned.
 - b) Moisture content shall not exceed 7% by weight for interior use and 12% for exterior use.

**2.2.
PRESERVATIVE
TREATMENT**

1. Timber shall be treated by dipping in pentachlorophenol conforming to B.S. 3842. Metal shall be painted with a primer coat.

**2.3.
SOLID CORE LEAVES**

1.
 - a) Flush doors shall be solid core type with **Ash** wood as specified on Drawings or schedules and conform to B.S. 459 (part 2) "Flush Doors" with Formica / veneer faces ready to receive transparent or paint finish.
 - b) Doors to be factory made and the product of an approved manufacturer. Glue used for bonding shall be first quality waterproof, specially manufactured for same. Door leaf shall be well seasoned core of solid block board with facing ply on eachside. Minimum thickness of ply facing to be 1/8 in. (3mm) Face Formica veneers, hot pressed bonded to core. Door leaf shall have well seasoned Ash wood border framing of 2-1/2 ins (63mm) on all sides, except for doors with panic exit devices which shall have 9 ins (225mm) edge bands. Door leaf thickness shall be as indicated on Schedule.
2. Face veneer species: Ash ply as shown on Door Schedule or Drawings.

2.4.
PANELLED LEAVES

1. a) Panelled doors shall comply to B.S. 459 (panelled, glazed and wood doors) and be of solid **Ash** wood as per Drawings and approved by Engineer for transparent finish or paint grade.
- b) Members shall be single thickness. Gluing to build-up members shall not be allowed.

2.5.
WOOD FRAMES

1. Door frames shall be of **Ash** wood with applied or integral stopers as detailed on Drawings, polished or stain grade, dado-jointed, assembled, and thoroughly braced.

2.6.
METAL FRAMES

1. Door Frames shall be made of mill quality cold rolled steel; exterior frames shall be galvanized steel.

2.7.
FASTENINGS

1. Wrought iron hold anchors for securing frame to walls 1-1/2 ins (38mm) by 1/8 in. (3mm) Refer to Section Finish Carpentry for other interior finish fastenings.

2.8.
ADHESIVES

1. Use adhesives for wood members as described in Section Finished Carpentry.

2.9.
OTHER MATERIALS

1. Materials and methods not specifically described but required for proper fabrication and installation of doors and frames, shall be supplied by Contractor subject to prior approval of Engineer, at no additional cost to Employer.



3.
EXECUTION
3.1.
FABRICATION

1. Wood doors and frames:
 - a) Fabricator to verify total rough openings allowing for floor finish and wall finish thicknesses before fabricating.
 - b) Fabricate wood doors and frames to BS 1186 and in strict accordance with the highest standards for the grades specified. Wood work shall be neat and true. Joints to be tenon and mortice. Heads of nails, screws etc. shall be sunk and puttied. Wood door frames shall conform to BS 1567.
 - c) Frames shall be secured to masonry by at least six iron holds or with expansion bolts.
 - d) Doors to be square and true with maximum tolerance of plus or minus 1/16 in. (1.56mm) for units with a diagonal measurement of 6 ft. (1.8 Meters) or less and plus or minus 1/8 in. (3mm) for units with a diagonal measurement over 6 ft. (1.8 Meters).
2. Pressed steel frames:
 - a) Fabricator to verify total rough openings allowing for floor finish and wall finish thicknesses before fabricating frames.
 - b) Door frames shall be extend down to structural slab with reinforcing at floor.
 - c) Contours and arises shall be true and sharp as can be produced in the thickness of material required.
 - d) Construction joints of steel work shall be welded to full depth and width, or with equivalent splice plates welded on unexposed faces of frames. Exposed surfaces of welded joints shall be dressed and ground smooth to produce invisible connections.
 - e) Finished work shall be strong and rigid, neat in appearance and free from defects. Plain surfaces shall be smooth and free from warp or buckle. Moulded members shall be clean, straight and true. Fastenings shall be concealed where practicable.
 - f) Reinforcement and stiffener shall be welded to inside of frame surfaces. Provide 3/16 in. (4.68mm) thick reinforcement for hinges and 1/8 in. (3mm) thick for lock and strike. For openings less than 48 ins (1.2 Meters) wide fabricate with 16 gauge steel. Over 48 ins (1.2 Meters) in width use 14 gauge. Heads of frames to openings wider than 48 ins (1.2 meters) shall have 10 gauge steel continuously welded to head with 1 in. legs turned upwards.
 - g) Hardware cut-outs to be located according to hardware manufacturer's approved schedule.
 - h) Frames shall be secured to the structure with strong wrought iron hold fasts. Hold fasts shall be a minimum 2 ins (25mm) wide by 1/4 in. (6mm) thick and shall be screwed to frames. Attachment shall be concealed.



- i) Exterior frames, anchors, reinforcing and related items shall be fabricated from hot-dipped galvanized steel, conforming to B.S. 729, Part 1. Following fabrication, touch up welds with liquid zinc.
- j) Surfaces of frames, hold fasts and related items shall be cleaned followed with a bonderising or phosphating process. Apply one coat of zinc chromate or synthetic resin primer in a light grey colour.

3.2.
INSTALLATION

1. Surface conditions:

- a) Prior to installation of doors and frames, carefully inspect installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
- b) Verify that doors and frames may be installed in accordance with the original design and pertinent codes and regulations.
- c) In the event of discrepancy, immediately notify the Engineer.
- d) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

2. Installation:

- a) Install doors and frames in strict accordance with pertinent codes and regulations, and original design, hanging square, plumb, and straight and firmly anchored into position for long life under hard use.
- b) Install finish hardware in strict accordance with manufacturer's recommendations, eliminate hinge-bound conditions make items operate smoothly, and firmly anchor into position.
- c) Doors shall be hung so that clearance with frame at top and lock side is 1/8 in. (300) and at hinge side 1/16 in. (1.56) Jamb stile shall have an 1/8 in. in 2 ins bevel across thickness to prevent back edge of lipping rubbing door frame or adjacent meeting stile. Double swing door shall have rebated meeting stiles.
- d) Refer to Section Sealants for mastic pointing between exterior frames and finished masonry openings.

3. Touching up:

- a) Using fine-grained sandpaper, completely eliminate scratches and abrasions in finished wood surfaces.
- b) Set nails and fasteners for putty; firmly putty holes; leave finished wood surfaces ready for painting or staining.

3.3.
CLEANING AND
PROTECTION

1. Installed units shall be adequately protected from dust, dirt and paint and other extraneous materials. Prevent disfigurements and immediately prior to hand-over of building thoroughly clean.



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**1.
GENERAL**

**1.1
RELATED
DOCUMENTS**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

**1.2.
SUMMARY**

1. Extent of each type of UPVC doors and window units required is indicated on the drawings and schedules.

UPVC door and window units required are of 'premium' or 'deluxe' quality.
2. Types of UPVC door and window units required include

following:-

Fixed
Top Hung
Vertical Pivoted
Horizontal Sliding
Skylight
3. Applications of UPVC door and windows on the project include individual units set in conventional construction,
4. Sealants for all windows are required and are specified in Section 07900

**1.3.
SYSTEM DESCRIPTION**

1. Design wind velocity at the project site is 85 mph.
2. Water Penetration: Provide units with no water penetration when tested as defined later.

1.4
SUBMITTAL

1. Product Data Submit manufacturer's product specification technical product data recommendations and standard details for each type of UPVC door and window unit required. Include the following information:

Fabrication methods.

Finishing Hardware Accessories

1. Mock-up: Submit a complete mock-up of window (Size as required by Architects) using standards components in specified finish, including glazing, gasket, flyscreening and all hardware for the approval of the Engineer.

1.5.
QUALITY ASSURANCE

1. Single Source Responsibility : Provide UPVC door and windows produced by a same manufacturer who will produce glazed panels and who is capable of showing prior production of units similar to those required.
2. Design Criteria: Drawings indicate sizes, profiles and dimensional requirements of UPVC doors and windows. Doors and Windows units having minor deviations from indicated dimensions and profiles may be accepted, subject to the Engineer's approval, provided such deviations do not materially detract from the design concept or intended performance. Submit shop drawings for approval by Architect, prior to commencement of manufacture or fabrication by supplier.
3. Field Measurements: Prior to fabrication, check actual window openings in construction work by accurate field measurement. Coordinate fabrication schedule with construction progress as directed by the Contractor to avoid delay of work. Approval of shop drawings will not relieve the contractor of deviations in field measurement and to that of actually fabricated units.

2.
PRODUCTS
2.1.



MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:-
 - a. Skypen
 - b. Turkprofil
 - c. Buraq

**2.2.
MATERIALS**

1. UPVC Section: Provide hollow, multi-chambered and steel reinforced with an outer wall thickness of 2.2mm.
2. Construction: The door and window unit is designed with all corner, transom/ mullion joints mitered and fusion welded. The entire door and window is steel reinforced, which further increases the structural integrity of the frame. The unit is designed such that water drainage does not pass through the reinforcement chamber. The product should be free from all sharp edges and blurs.

**2.3.
DOOR &
WINDOW TYPES**

1. General: The following paragraphs define the operating arrangement for the types of sash required in door and window units and specify minimum provisions for each type. The drawings indicate which panels of each window unit are operable sash and which are fixed.
2. Top Hung windows are window units containing a swing-out, top-hung projected sash, that swings the bottom edges of ventilators outward and permits staying of ventilators at any angle upto 60 degrees from vertical, with a manually controlled locking devices. Provide units with a 'tilt-in' feature to permit inside cleaning of outside glass faces. Top Hung windows may contain one or more fixed panels. Units should have fly screens.
3. Horizontal-sliding windows are window units containing one or more horizontally operable sash in. These windows should have fly screens or provision of fly screens if not indicated on drawings a weathering frame. Provide window units with sash that can be removed from the inside for cleaning.

**2.4.
HARDWARE**

1. All Hardware including its fixings is of materials resistant to or protected against atmospheric corrosion. Where hardware is fixed through the reinforcement, all screws penetrate the reinforcement by at least 2mm. The windows incorporate a large variety of security devices such as multipoint locking including espagnolettes with mushroom headed catch. Handles and locks are designed so that they cannot be released from the outside by any mechanism.

2.5.
ACCESSORIES

1. General: Except to the extent that more specific or stringent requirements are indicated, provide the manufacturer's standard accessories that comply with indicated standards.

3.
EXECUTION

3.1.
INSPECTION

1. Inspect openings before beginning installation. Verify that plastered masonry opening is correct and in plumb and the sill is level.

Plastered surfaces shall be visibly dry and free of excess mortar, sand and other construction debris, and in the profile as shown in drawings to receive the aluminum frame.

3.2.
INSTALLATION

1. Comply with manufacturer's specifications and recommendations for installation of window units, hardware, operators, and other components of the work.
2. Set units plumb level and true to line, without warp or rack of frames or sash. Provide proper support and anchor securely in place.

Separate UPVC and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.
3. Provide Sealants Refer section-07900 joint Sealer/Expansion Joints as shown in drawings.

3.3.
FIELD QUALITY CONTROL

1. Conduction-site tests for water infiltration with the Engineer and the door and window manufacture's representative present. The Engineer will select units to be tested. Tests not meeting specified requirements and units having similar deficiencies shall be corrected at no cost to the Owner. Testing shall be by spraying water with a hose pipe at 20 psi pressure from a distance of 5'-0" (125mm) to check for any water infiltration continuously for a duration of 12 to 20 hours. No water infiltration is permissible.

3.4.
ADJUSTING

1. Adjust operation sash and hardware to provide a tight fit at contact points and at weather-stripping, for smooth operation and a weather tight closure.



3.5.
CLEANING

1. Clean UPVC surfaces promptly after installation of doors and windows. Exercise care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts.
2. Clean glass of pre-glazed units promptly after installation of doors and windows, comply with requirements of the 'Glass and Glazing' section for cleaning and maintenance.

3.6.
PROTECTION

1. Initiate and maintain protection and other precautions required through the remainder of the construction period, to ensure that, except for normal weathering, door and window units will be free of damage or deterioration at the time of substantial completion.

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**1.
GENERAL**

**1.1
DESCRIPTION**

1. Work included:

The work covered under this section of the Specifications consists of furnishing all labour, equipment, scaffolding and providing glass, gaskets, sealants, compounds and accessories required for performing all operations in connections with the installation and setting of glass, glazing and glass blocks and butt jointed glazed partitions complete in every respect in accordance with the Drawings or as directed by the Engineer. The scope of this section of specifications is covered with detailed specifications as laid down herein.

Glass and glazing required for this Work includes plate glass, mirrors, wired glass, and translucent glass. Refer to drawings and glazing Schedule.

2. Contractor shall also submit printed materials manufacturer's installation instruction for specified glazing gaskets, compounds, sealants and accessories including description of required equipment, procedures and precautions to be observed.

**1.2.
QUALITY ASSURANCE**

1. Qualifications of installers:

Provide at least one person who shall be thoroughly trained and experienced in the skills required, who shall be completely familiar with the requirements of this Work, and personally direct installation performed under this Section of these specifications. Installation of glass shall be performed only by skilled glaziers.

2. a) The glazier must examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing is to be performed. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to the glazier.

b) Weather Conditions:

Do not proceed with installation of liquid sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.

**1.3.
SUBMITTALS**

1. Within 120 days after award of Contract, and before any glazing is delivered to Job Site, submit three samples of each glass type 4 ft. x 4 ft. size (1.21m x 1.21m) and two samples of glazing accessories i.e. Sealants, gaskets, etc.
2. Contractor shall also submit printed materials manufacturer's installation instructions for specified glazing gaskets, compounds sealants and accessories including description of required equipment, procedures and precautions to be observed.



**1.4.
PRODUCT
HANDLING**

1. Protection:

Protect glass and glazing materials before, during, and after installation and protect installed work and materials of other trades.
2. Delivery materials in manufacturer's original, unopened containers clearly labelled with manufacturer's name and address, material, brand, type class and rating as applicable. Store the materials in original unopened containers, with labels intact, protected from ground contact and from the elements.

Handle the materials in a manner to prevent breakage of glass and damage to surfaces, and shall exercise exceptional care to prevent edge damage to glass.
3. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

**2.
PRODUCTS
2.1.
GLASS**

1. Glass shall bear the label of its manufacturer, be clear, free of scratches and distortion-free of first quality from approved American or European manufacturers or approved equal. Conform to BS 952 and BS C.P.152/ Equivalent ASTM & AAG Standards.
2. Subject to compliance with requirements, provide products of the approved manufacturers
 - a) Ghani Glass
 - b) Tariq Float Glass
3. Glass Types:
 - a) Double glazed unit (DGU) made-up of 8mm thick tempered glass (Sunguard hp Neutral Plus 50 # 2) outer layer + 12mm Air space + 6mm clear tempered glass inner layer.
 - b) Plate tinted shall be grey tinted float, glazing quality and thickness to be mentioned on drawings / details.
 - c) Wired glass shall be clear polished plate, 6 mm thick, reinforced with 25 ASW gauge steel wire grid.
 - d) Mirror glass shall be clear polished plate, 6 mm thick, selected glazing quality. Glass shall be silver coated, hermetically sealed with a uniform electroplated



copper coating, protected by a coat of mineral oxide base paint. Use Belgium make or approved equal.

- e) Translucent glass shall be either of the following:
 - i) Sandblasted glass. Plate glass with a light, even sand blasted treatment to give obscuration.

**2.2.
GLAZING
ACCESSORIES**

1. Glazing accessories shall be new, first quality of their respective kinds, and subject to the approval of Engineer.
 - a) Sealant as specified in Section 7900.
 - b) Mirror mastic as recommended by mirror glass manufacturer.
 - c) Foam glazing tape to be closed cell polyvinyl chloride tape 3/4 in. (19mm) by 3/16 in. (5mm) thick with pressure sensitive adhesive on one side, or equal approved by Engineer
 - d) Glazing beads shall be the same wood as for frame or sash. Refer to Section on Wood Windows.

**2.3.
OTHER MATERIALS**

1. Materials and methods not specifically described but required for proper installation of glass, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.
- 2.

**3.
EXECUTION
3.1.
SURFACE
CONDITIONS**

1. Inspection:
 - a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.



3.2.
GLAZING SCHEDULE

1. Glass types described in this Section shall be applied to the following components:

- a) Plate glass:
 - i) Exterior windows.
 - ii) Glazed panels and vision panels to door in Public Spaces.
 - iii) Interior windows.
- b) Wired glass:
 - i) Interior windows to Back of House areas.
 - ii) Doors with glass panels or vision panels to Back of House areas.
- c) Plate glass mirror:
Where indicated on Drawings.
- d) Tempered glass:
Generally for toilet, locker room windows and wherelse indicated on Drawings.

3.3.
GLAZING

1. Exterior glazing:

- a) Set glass in a true plane, tight and straight, on setting blocks at quarter points, firmly anchor to prevent rattling and looseness, with edges cleanly cut. Do not nipor seam edges. Rebates and grooves shall be clean, dry and unobstructed at the time of glazing.
- b) Edge clearance shall be equal all around each panel and not less than 1/8 in (3mm).
- c) Install tape continuous to head sill and jambs of fixed stop. Ensure no voids or spaces are left in back of glazing tape.
- d) Glazing beads shall be fabricated under Section 5.2 and installed under thisSection. Attach and seat aluminum glazing beads in waterproof glue, compressingglazing tape to approximately 70% of original thickness. Trim- off excess tape, even with sight line.
- e) Apply sealant cap bead both sides of glass, tool smooth, remove excess.
- f) Glazing shall be wind and watertight.
- g) Glazing work shall comply with the recommendations of the glass and glazing materials manufacturers.

-
- h) Examine each piece of glass and discard and replace glass with edge damage or face imperfection.
 - i) Clean glazing channels and other framing members indicated to remove glass. Remove coatings which are not firmly bounded to the substrate, remove lacquer from metal surfaces wherever elastomeric sealants are to be used. Apply primer and sealer to joint surfaces wherever recommended by the sealer manufacturers.
 - j) Trim and clean excess glazing materials from surrounding surfaces immediately after installation and eliminate stains and discolorations.
 - k) Cure glazing sealants and compounds in compliance with manufacturer's instructions, to obtain high early bond strength internal cohesive strength and surface durability.
 - l) No glazing shall be considered complete until and unless paint and other stains have been removed from the surface of the glass.
 - m) While glass operation is in progress great care shall be taken to avoid breakage or damage to the glass and adjoining glazing. The Contractor shall make good at his own cost, all glass broken by his workmen while cleaning or carrying out other operations. On the completion of the glazing work, all glass that has been set by the Contractor shall, if it becomes loose, within the maintenance period, be refixed at Contractor's expense.
 - n) The glass panes shall be properly cut to fit the rebates so as to have a uniform clearance of 3mm round the panes between the edges of glass and the frame. In the event that any panel is cut short so that the clearance exceeds the required dimension and renders the gaskets loose, the panel shall be replaced by the Contractor.
 - o) Glass in butt-jointed installation shall be plain or tinted and of sizes and thickness as indicated in the drawings and the Bill of Quantities. The specifications of glass shall be as mentioned above for plain or tinted glass. The glass shall be installed with a uniform spacing between the leaves equal to the thickness of glass but not greater than 12mm. After the glass is placed on location and approved by the Engineer, the space in between shall be completely filled by a clear or opaque sealant manufactured by Dow Corning as required. All edges shall be marked adequately prior to sealant application.
 - p) Glazing vinyl beads and gaskets shall be of suitable size and shape to fit tightly between the glass and window/door section. The installation shall be carried out in a manner that the joints are confined to corners of glass panes, and no joint in beads and gaskets are visible on any side of the glass pane after completion of installation.
2. Interior glazing:
- a) Refer to 3.2.1a.
 - b) Install foam glazing tape as 3.2.1c.
 - c) Glazing beads shall be fabricated under Section for Wood Windows and installed under this Section. Attach wood glazing beads compressing tape to approximately 70% of original thickness. Trim-off excess tape, even with sight line.
-

3.4.
CLEANING UP AND
PROTECTION

1. Upon completion of glazing, thoroughly clean glass surfaces, correct imperfections, replace damaged glass, and leave labels on the glass until they have been inspected and approved by Engineer. Remove labels immediately thereafter and clean glass.

Remove all smears, labels and excess glazing sealant, leave clean inside and outside and free from scratches. The Contractor shall be responsible for the protection of installed glass. Before final acceptance, damaged or broken glass shall be removed and replaced with new glass at no additional expense to the Employer.

All glazed surfaces shall be washed clean both inside and outside prior to final acceptance by the Engineer

4.
MEASUREMENT
AND PAYMENT

1. General: No payment shall be made for the works involved within the scope of this section of specifications unless otherwise specifically stated in the Bill of Quantities or herein.

The cost there of shall be deemed to be included in the quoted unit rate of the relevant item of the Bill of Quantities i.e. windows fixed glazing etc.

- 2 Measurement of acceptably completed works will be made on the basis of net actual area in square meter of glazing material provided and installed in position as shown on the drawing or as directed by the Engineer.

- 3 Payment will be made for acceptable measured quantity of glazing material on the basis unit rate per meter or per square meter quoted in the Bill of Quantities.

The unit rate shall include the cost of glazing, sealants beads, tapes, gaskets, labour, manpower, equipment, etc. and compound for fixing the glass, all hardware fitting as per manufacturer's recommendations or as shown on the drawings. Payment shall constitute full compensation for all the works related to the item.

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**1.
GENERAL**

**1.1
RELATED
DOCUMENTS**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to the work of this section.

**1.2.
SUMMARY**

1. Extent of each type of aluminium doors and window units required is indicated on the drawings and schedules.

Aluminium doors and window units required are of 'premium' or 'deluxe' quality.

2. Types of aluminium window units required include following:-

Fixed
Top Hung
Vertical Pivoted
Horizontal Sliding
Skylight

3. Applications of aluminium doors and windows on the project include individual units set in conventional construction,
4. Sealants for all windows are required and are specified in Section 07900

**1.3.
SYSTEM DESCRIPTION**

1. Design wind velocity at the project site is 85 mph.
2. Water Penetration: Provide units with no water penetration when tested as defined later.

**1.4.
SUBMITTALS**

1. Product Data Submit manufacturer's product specification technical product data recommendations and standard details for each type of aluminium doors and window unit required. Include the following information:

Fabrication methods.

Finishing
Hardware
Accessories

1. Mock-up: Submit a complete mock-up of window (Size as required by Architects) using standard components in specified finish, including glazing, gasket, flyscreening and all hardware for the approval of the Engineer.

The Architect reserves the right to require additional samples, if unsatisfactory fabrication techniques, workmanship, hardware and accessories are found. Once selected, a full size

exterior window will be installed by the supplier as a mock-up to the exterior of the building, at no charge.

1.5.
QUALITY ASSURANCE

1. Single Source Responsibility : Provide aluminium doors and windows produced by a same manufacturer who will produce aluminum doors and glazed panels and who is capable of showing prior production of units similar to those required.
2. Design Criteria: Drawings indicate sizes, profiles and dimensional requirements of aluminium doors and windows. Doors and Window units having minor deviations from indicated dimensions and profiles may be accepted, subject to the Engineer's approval, provided such deviations do not materially detract from the design concept or intended performance. Submit shop drawings for approval by Architect, prior to commencement of manufacture or fabrication by supplier.
3. Field Measurements: Prior to fabrication, check actual window openings in construction work by accurate field measurement. Coordinate fabrication schedule with construction progress as directed by the Contractor to avoid delay of work. Approval of shop drawings will not relieve the contractor of deviations in filed measurement and to that of actually fabricated units.

2.
PRODUCTS

2.1.
MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:-
 - a. Prime Aluminum
 - b. Alcop
 - c. Al-Fattah
 - d. Pakistan Cables or other approved equivalent suppliers.

2.2.
MATERIALS

1. Aluminium Extrusions: Provide alloy and temper recommended by the window manufacturer for the strength, corrosion-resistance, and application of required finish, but not less than 22,000 psi ultimate tensile strength and not less than 0.08" (2.0 mm) thickness at any location for main frame and sash members. Width of Sections Shall not be less than 3" x 1/2" (25mm x 12mm).
2. Fasteners: Provide aluminium, non-magnetic stainless steel, epoxy adhesive, or other materials warranted by the manufacturer to be non-corrosive and compatible with aluminium window members, trim, hardware, anchors and other components of window units.

Reinforcement: Where fasteners screw-anchor in to aluminium less than 0.125" (3.125 mm) thick, reinforce interior with aluminum or non-magnetic stainless steel to receive screw threads, or provide standard non-corrosive pressed-in splined grommet nuts.

Exposed Fasteners: Except where unavoidable for application of hardware, do not use exposed fasteners. For application of hardware, use fasteners that match the finish of the member or hardware being fastened as appropriate.

3. Anchors, Clips, Doors and Window Accessories: Fabricate anchors, clips and window accessories of aluminium, non-magnetic stainless steel or hot-dip zinc coated steel or iron complying with the requirements of ASTM A 386.
4. Compression Glazing Strips: Provide manufacturer's standard replaceable compressible gaskets of molded neoprene or molded PVC.
5. Sliding Type Weatherstripping: Provide woven pile weatherstripping of wool, polypropylene or nylon pile and resin-impregnated backing fabric, and aluminium backing strips.
6. Sealant: For sealant required within fabricated window units, provide type recommended by the manufacturer for joint size and movement. Sealant shall remain permanently elastic, non-shrinking and non-migrating. Colour shall be clear. See also Section 7900 of these specifications.

2.3. DOORS AND WINDOW TYPES

1. General: The following paragraphs define the operating arrangement for the types of sash required in window units and specify minimum provisions for each type. The drawings indicate which panels of each window unit are operable sash and which are fixed.
2. Top Hung windows are window units containing a swing-out, top-hung projected sash, that swings the bottom edges of ventilators outward and permits staying of ventilators at any angle upto 60 degrees from vertical, with a manually controlled locking devices. Provide units with a 'tilt-in' feature to permit inside cleaning of outside glass faces. Top Hung windows may contain one or more fixed panels. Units should have fly screens.
3. Horizontal-sliding windows are window units containing one or more horizontally operable sash in. These doors and windows should have fly screens or provision of fly screens if not indicated on drawings a weathering frame. Provide doors and window units with sash that can be removed from the inside for cleaning.

2.4. HARDWARE

1. General: Except to the extent that more specific or stringent requirements are indicated, provide the manufacturer's standard hardware fabricated from aluminium, stainless steel, or other corrosion-resistant material compatible with aluminium and of sufficient strength to perform the function for which it is intended.

Friction Hinges: provide friction hinges for top hung windows of non-corrosive durable material.

Friction Shoes Provide friction shoes of nylon or other non-abrasive, non-staining, non-corrosive, durable material.

Doors and Window Types Provide the following equipment and operating

hardware:-Top Hung Windows

Lock : Lift type cam action lock.

Hinges : Friction type 2 per sash.

Hinges : Continuous

Horizontal-Sliding Doors and Windows

Sash Rollers: Adjustable nylon rollers.

Sash Lock : Cam action weep sash lock and keeper at meeting rails.

Spring loaded snap type lock at jambs (1 per sash).

Spring loaded plunger lock on meeting rail (1 per sash).

2.5. **ACCESSORIES**

1. General: Except to the extent that more specific or stringent requirements are indicated, provide the manufacturer's standard accessories that comply with indicated standards.

2.6. **FABRICATIONS**

1. General: Except to the extent that more specific or stringent requirements are indicated, provide manufacturer's standard fabrication that complies with indicated standards and that produces units that are re-glazable without dismantling sash framing. Include a complete system for assembly of components and anchorage of window units, and prepare sash for glazing.
2. Sizes and Profiles: Required sizes for doors, window units and profile requirements are indicated on the drawings. Variable dimensions are indicated along with maximum and minimum dimensions as required to achieve design requirements and coordination with other work.
3. Provide weep-holes and internal water passages to conduct infiltration water to the exterior.
4. Glazing Stops: Provide screw-applied or snap-on glazing stops, coordinated with glass selection and glazing system indicated. Finish glazing stops to match window units.

2.7. **FINISHES**

1. Coloured Anodized Finish: Provide (minimum 20 microns thick) integral or electrolytically deposited colour anodized finish as follows:

Colour : Champagne or as approved by the architects.

3. **EXECUTION** 3.1. **INSPECTION**

1. Inspect openings before beginning installation. Verify that plastered masonry opening is correct and in plumb and the sill is level.

Plastered surfaces shall be visibly dry and free of excess mortar, sand and other construction debris, and in the profile as shown in drawings to receive the aluminium frame.

3.2.
INSTALLATION

1. Comply with manufacturer's specifications and recommendations for installation of doors and window units, hardware, operators, and other components of the work.
2. Set units plumb level and true to line, without warp or rack of frames or sash. Provide proper support and anchor securely in place.

Separate aluminium and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3. Provide Sealants Refer section-07900 joint Sealer/Expansion Joints as shown in drawings.

3.3.
FIELD QUALITY CONTROL

1. Conduction-site tests for water infiltration with the Engineer and the doors / window manufacture's representative present. The Engineer will select units to be tested. Tests not meeting specified requirements and units having similar deficiencies shall be corrected at no cost to the Owner. Testing shall be by spraying water with a hose pipe at 20 psi pressure from a distance of 5'-0" (125mm) to check for any water infiltration continuously for a duration of 12 to 20 hours. No water infiltration is permissible.

3.4.
ADJUSTING

1. Adjust operation sash and hardware to provide a tight fit at contact points and at weatherstripping, for smooth operation and a weather tight closure.

3.5.
CLEANING

1. Clean aluminium surfaces promptly after installation of doors and windows. Exercise care to avoid damage to protective coatings and finishes. Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts.
2. Clean glass of pre-glazed units promptly after installation of doors and windows, comply with requirements of the 'Glass and Glazing' section for cleaning and maintenance.

3.6.
PROTECTION

1. Initiate and maintain protection and other precautions required through the remainder of the construction period, to ensure that, except for normal weathering, window units will be free of damage or deterioration at the time of substantial completion.

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**1.
GENERAL**

**1.1
DESCRIPTION**

1. Work included:

Work of this Section includes the supply and application of plaster materials and accessories for interior and exterior finishes indicated on the Drawings and Schedules and these Specifications.

**1.2.
QUALITY ASSURANCE**

1. Qualifications of installers:

- a) For application of coatings, use only thoroughly trained and experienced plasterers who are completely familiar with the requirements of this Work and the recommendations contained in the referenced Standards.
- b) In acceptance or rejection of installed materials, no allowance will be made for lack of skill on the part of workmen.

**1.3.
SUBMITTALS**

1. Samples:

Within 120 days after award of Contract, and before any material for this work is delivered to the Job Site, submit to the Engineer, in accordance with the provisions of these Specifications, mock-ups of the proposed plaster surfaces and accessories, etc.

**1.4.
PRODUCT
HANDLING**

1. Delivery and storage:

- a) Deliver materials of this Section to the Job Site in their original unopened containers with labels intact and legible at time of use. Where material is delivered loose, store as directed by Engineer.
- b) Store materials under cover to prevent damage and contamination. Store only the specified materials at the Job Site.

2. Protection:

Protect materials of this Section before, during, and after installation and protect installed work and materials of other trades.

3. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

2.
PRODUCTS
2.1.
MATERIALS

1. Portland Cement: Ordinary and white conforming to P.S.232 or B.S. 12/ ASTM C-150
2. Sand: Clean, sharp, angular, free from alkali, silt or organic matter, to conform to B.S. 1198 – 1200 or the draft Pakistan Standard “Sand for Plaster” (ASTM C-805)
3. Water: Potable, clean, free from deleterious amount of oils, salts, alkali, organic matter and other harmful materials conforming to B.S. 3148.
4. Colour Pigment: Salt-free, inorganic. Type and amount to be approved by Engineer.
5. Accessories:
 - a) Expanded metal lath to be flat rib diamond mesh of 1/4" short way type, galvanized to B.S. 729, conforming to B.S. 1369. Use BB 263, 2.25 lbs per sq. yds (1.22 Kg/m²) for external use and reinforcement of joints and BB 264, 3 lbs. per sq. yds (1.63 Kg/m²) for suspended plaster ceilings. Paint lath with zinc rich primer for internal conditions.
 - b)
 - i) Running and furring channels to be 16 gauge. cold rolled steel galvanized to B.S. 729.
 - i) Minimum weight per lineal foot: Furring channels 3/4 in. (18mm) depth - 0.3 lbs. (0.136 kg) Runner channels of 1-1/2 in.(38mm) depth - 0.475 lbs. (0.216 kg) or 2 ins (50mm) depth - 0.54 lbs. (0.245 Kg)
 - ii) Minimum width of flanges 7/16 in.(12mm)
 - c) Plaster stops: 26 gauge. steel with 3 -1/8 in.(78mm) expanded metal flanges, size to suit plaster depth, galvanized to B.S. 729.
 - d) Tie wire to be 18 ga. annealed steel wire galvanized to B.S. 443.
 - e) Ceiling hanger:

- i) 8 ga. annealed steel wire galvanized to B.S. 443.
 - ii) 1/8 in.(3mm) by 1 in.(25mm) flat mild steel strip or 1/4 in. (6mm) diameter steel rods, both galvanized to B.S. 729.
 - f) Fastening such as expansion bolts, galvanized nails, metal trim and other accessories to Engineer's approval.
6. Materials and workmanship for plaster not explained in these Specifications shall comply with the requirements of B.S.5262 and 5492.

2.2.
ADDITIVES

Additives for controlling the setting and working characteristics of plaster, or for imparting anti-corrosion, fungicidal or water proofing properties, shall be added to the plaster strictly in accordance with the particular manufacturer's written instructions.

2.3.
OTHER MATERIALS

1. Materials and methods not specifically described but required for proper fabrication and installation of plaster, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.
EXECUTION
3.1.
SURFACE
CONDITIONS

1. Inspection and Preparation: (ASTM C-926)
- a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
 - b) Concrete surfaces to be plastered shall be cleaned to remove grease, form oil and other impurities which will otherwise adversely affect the adhesion of plaster to the surface. Surfaces of concrete work if so required by Engineer, shall be hacked by approved means to give the required key for plastering.
 - c) Surfaces shall be washed with clean water and kept damp for 2 hours before further treatment. Surfaces thus prepared shall be treated uniformly with a cement and sand slurry of one-part cement, one-part sand mix before application of plaster.

- d) Application should not be undertaken if work is exposed to dry hot winds, where temperature is above 32 C (90 F), in the shade, and relative humidity is below 50%. Extreme caution should be taken to avoid rapid setting of mixture and resultant shrinkage cracks. Refrain from excessive trowelling.
 - e) Do not apply coatings when temperature is below 4 C (39 F) or for at least 4 to 6 days following, to ensure that conditions will permit the curing treatment specified.
2. Discrepancies:
- a) In the event of discrepancy, immediately notify Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.
WORKMANSHIP

1. Proportioning and mixing:
- a) Measurement of materials by volume shall be of known capacity to maintain consistent proportions. No lumpy or cracked material shall be used. Mixing equipment, boxes and tools shall be clean. Materials shall be proportioned as specified or as directed by the Engineer. Mixing shall be continuous until complete and ingredients are evenly distributed.
 - b) Only limited water shall be used for proper workability. Mortar shall be consumed within thirty minutes of mixing. Retempering will not permitted. Mortar which has begun to stiffen shall be discarded.
 - c) Plaster ingredients shall be thoroughly mixed by hand on a clean platform or by mechanical mixer.
2. Expanded metal lath:
- a) Before plastering, wherever reinforced concrete meets block masonry at a flush condition and at every cutting for joint of electrical conduits, install 12 ins (300mm) wide continuous strip of expanded metal lath, attached with galvanized nails, to both surfaces, covering joint completely, to prevent cracking.
3. Control joints:
- a) Strike 'V' depressions, where required to create controlled crack lines in finish.
 - b) Install plaster stops in ceilings to end plaster material or to create control joints.
4. Accessories:

Use galvanized wire dowel pushed into hollow of bead to maintain true alignment at splices.

5. Beads & Profiles:

Angle beads, corner beads, stop beads, architrave beads, depth gauge beads, edging profiles, plaster dividing profiles, interior angle profiles, plaster borders and the like shall all be manufactured from sheet steel and galvanized after fabrication, all beads & profiles shall be perforated at edges to ensure good adhesion of plaster work. Thickness and dimensions shall suit particular locations and plaster work thickness.

Nails for fixing metal lathing shall be galvanized and have either clout heads or small flat heads to suit particular locations.

All angle beads, stop beads, architrave, depth gauge beads, and the like are to be fixed in accordance with the manufacturer's instructions.

6. Internal plasterwork:

a) Where indicated on Drawings or Room Finishes Schedules, provide trowelled finish plaster with galvanized iron Corner Beads as per latest B.S. specification Corner Beads will be provided to columns, wall ends, corners, edges, openings and joints etc. for protection of plaster work.

b) Installation of Ceiling Suspension Hanger wires:

- i) Attach to hanger inserts in concrete.
- ii) Space hangers 48 ins (1200mm) o.c. and within 3 ins (75mm) of perimeter walls. Double up hanger wire or decrease spacing of hangers at light fixtures or where additional loads are located.
- iii) Locate hangers within 3 ins. (75mm) of ends of main runner channels.

Main runner channels:

- i) Spacing: 48 ins (1200mm) o.c. or as noted otherwise on the Drawings.
- ii) Locate within 6 ins. (150mm) of parallel walls.
- iii) Splicing: overlap ends a minimum of 12 ins, (300mm) interlock flanges, secure splice near end of each channel with tie wire.
- iv) Channels shall not be restrained by perimeter wall.

Cross furring - 3/4 in. (18mm) channels:

- i) Space 16 ins (400mm) o.c., wire tie to main runner channels.
- ii) Furrings shall not be restrained by perimeter wall.
- c) Metal lath installation:
 - i) Install with long dimension running perpendicular to furring channels and other supports.
 - ii) Tie to 3/4 in.(18mm) furring channels with single strand of wire, spacing ties not more than 6 ins (150mm) o.c. on each channel or other support.
 - iii) Lap lath with 1 ins. (25mm) laps. Side laps shall be tied @ 9 ins (225mm) o.c.
- d) Application of material:
 - i) Plaster mix shall comprise of one-part Portland cement and four parts sand.
 - ii) Total thickness shall not be less than 1/2 in.(12mm) over concrete and masonry surfaces, and 3/4 in.(18mm) over metal lath backing.
 - iii) Plaster shall be applied with sufficient material and pressure to form a good bond or key. Application shall be a minimum of two coats unless directed otherwise by Engineer. Surface of the first shall be scratched before second coat applied
 - iv) Plaster shall be in plumb, free of voids, finished smooth, with a steel trowel or finished textured with wood trowel as indicated on Room Finishes Schedules and Drawings, and to Engineer's approval. Edges and corners shall be straight.
 - v) Variation of colour and or texture on a wall will be the sole cause for rejection of entire wall by Engineer.
 - vi) Work shall be cured using sprayed water for a minimum of 8 days. The ring/watering of plastered surface shall start immediately after the surface is set i.e. 4-5 hours from the time of finishing, depending upon the temperature and wind condition.
- d) Tolerances:

Deviations exceeding 1/8 in. (3mm) under a straight edge 10 ft. (3000mm) applied in all directions will not be accepted for cement plaster surfaces.

7. External plasterwork:

- a) Plaster to be applied with a mix of one-part Portland cement and four parts sand, minimum thickness of 3/4 in. (18mm) Apply with sufficient pressure to completely embed. Trowel and cross scratch in horizontal direction. Ensure that base coat completely embeds expanded metal lath where applied.
- b) Maintain continuous moist for 8 days. Allow surface to dry after curing, to develop proper adherence, before applying second coat.
- c) Tolerances shall be as described for internal plasterwork.

8. Plasterwork to underground water tank and water pond shall be as follows:

- a) Install as per pertinent for External Plasterwork.
- b) Finish to be with a smooth trowel.
- c) Apply 3/4" (18mm) thickness to walls and 1 1/2" (38mm) thickness to floors of water tanks (if required) and ponds.
- d) Waterproofing to be applied in accordance with manufacturer's instructions in accordance with Division 7100.
- e) Color pigment and marble powder not required for these items.

**3.3.
CLEANING UP**

1. General:

Prevent the accumulation of scraps and debris arising from the Work of this section. Maintain premises in a neat and orderly condition at all times. In the event of spilling or splashing material onto other surfaces, immediately remove the same and traces of residue to the approval of Engineer.

**4.
METHOD OF
MEASUREMENT**

FINISHES

All sections related to Finishes comply with this Section of measurement:

Generally

Work shall be measured flat without addition for laps or seams; finishes on corrugated or ornamental surfaces shall each be so described.

Curved, spherical and conical work shall each be so described.
Internal and external work shall each be so described.

Backgrounds

Backgrounds shall be measured with the finishing to which they relate.

Finishing

Unless otherwise stated, finishing shall be measured by area, classified as follows:

1. Floors, which shall include landings.
2. Walls, which shall include returns, reveals of openings or recesses and attached and unattached columns
3. Ceilings, which shall include attached and unattached beams and soffits of staircases
4. Staircases, which shall include treads, risers and edges of landings but exclude soffits.

Skirting, bands, strings, coverings to kerbs, mouldings, coves, channels or the like shall be measured by length.

Sundries

Expansion joint covers, non-slip inserts dividing strips, metal angle beads, lathing at junction of differing backgrounds or the like shall be understood to be included with the finishing or backgrounds on which they occur.

Suspended ceilings

Suspended ceilings shall be measured by area irrespective of drop and classified as follows:

1. Ceilings
2. Up stands
3. Bulkheads

Decorations

Decorations on different surfaces shall each be given separately.

Details shall be given of any special method of application (for example, spraying).
Unless otherwise stated, decorations shall be measured by area, classified as follows:

1. Floors, which shall include landings.
2. Walls, which shall include returns, reveals of openings or recesses and attached and unattached columns.
3. Ceilings, which shall include attached and unattached beams and soffits of staircases.
4. Staircases, which shall include treads, risers, strings and edges of landings but exclude soffits.
5. Cornices.
6. General surfaces, which shall include doors, close-type fencing or the like; glazed general surfaces (measured flat over glass) shall be so described.
7. Isolated general surfaces, which shall include door frames, linings, sub-frames of a differing material to the window, skirting, rails, architraves, bars, posts, balusters or the like.
8. Windows (measured flat over glass, frames, mullions, transomes and architraves), which shall include glazed partitions or the like, but exclude sub-frames of a differing material to the window; edges of slash shall be understood to be included.
9. Radiators, measured over the area of heating surface.
10. Gutters, measured inside and out.
11. Large pipes (that is, pipes with an internal diameter exceeding 60mm), including trunking or the like, unless measured as incidental work; hangers, supports or the like (except common supports to services) shall be understood to be included.
12. Structural metalwork, which shall include roof trusses.

Decoration on small pipes (that is, pipes with an internal diameter of 60mm or less) unless measured as incidental work, shall be measured by length; hangers, supports or the like (except common supports to services) shall be understood to be included.

Decoration on gratings, rainwater heads or the like shall each be enumerated separately, irrespective of size.

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A - GYPSUM BOARD SUSPENDED CEILING

**1
GENERAL**

Note: All British Standards (BS) mentioned in this section should conform to the relevant American Standards

**1.1
MATERIALS**

a. Framing Materials:

1. Furring, Framing, and Accessories: As shown on the drawings and as manufactured by:

- a) United Gypsum (Local)
- b) Arish by Lodhia Gypsum Industries Pvt. Ltd. (Local)
- c) Approved equivalent.

2. Fasteners: Galvanized steel.

b. Gypsum Board Materials: Standard Gypsum Board: 1/2" (12 mm) thick unless otherwise indicated on the drawings, ends square cut, tapered edges, as manufactured by :

- a) United Gypsum (Local)
- b) Arish by Lodhia Gypsum Industries Pvt. Ltd. (Local)
- c) Approved equivalent.

c. Accessories: All accessories shall be as manufactured by :

- a) United Gypsum (Local)
- b) Arish by Lodhia Gypsum Industries Pvt. Ltd. (Local)
- c) Approved equivalent.

1. Acoustical Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board.

2. Casing Beads, Corner Beads: Galvanized sheet steel; perforated flanges; one piece length per location.

3. Edge Trim: Galvanized steel with J type bead.

4. Resilient Channels: RC-I manufactured by:

-
- a) United Gypsum (Local)
 - b) Arish by Lodhia Gypsum Industries Pvt. Ltd. (Local)
 - c) Approved equivalent.
-
- 5. Joint Materials: Reinforcing tape, joint compound, adhesive, water' fasteners; as recommended by board manufacturer for intended use.
 - 6. Installation to be provided with 1 non-fire rating STC = 50 as per manufacturer recommendation.

1.2
QUALITY ASSURANCE

- 1. Work to be done by a Company specializing in gypsum board installation with a minimum of 5 years documented experience and with manufacturers supervision. Minimum of one skilled supervisor to be present at all times during execution of the work.

1.3
INSPECTION

- 1. Verify that site conditions are ready to receive work and opening dimensions are as shown on the drawings.
- 2. Beginning of installation means acceptance of existing conditions.

1.4
METAL STUD INSTALLATION

- 1. Install studding as shown on the drawings, and manufacturer's instructions.
- 2. Metal Stud Spacing: 24" (600mm) o.c in or as shown on the drawings or as recommended by manufacturer.
- 3. Coordinate installation of bucks, anchors, blocking, electrical and mechanical work placed in or behind framing.
- 4. All case goods mounted on gypsum wall to be coordinated and provided supports as recommended by manufacturer.

1.5
CEILING FRAMING INSTALLATION

1. Install in accordance with manufacturer's instructions and as shown on the drawings.
2. Coordinate location of hangers with other work.
3. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 24 in.(600 mm) past each end of openings.
4. Reinforce ceiling to carry mechanical and electrical loads imposed thereon.
5. Laterally brace entire suspension system.

1.6
GYPSUM BOARD INSTALLATION

1. Install gypsum board in accordance with manufacturer's instructions, and as shown on the drawings.
2. Erect single layer standard gypsum board in most economical direction, with ends and edges occurring over firm bearing.
3. Use screws when fastening gypsum board to metal furring or framing.
4. Where double layer of wallboard is indicated or required, overlap joints of base and face layers or as recommended by manufacturer.
5. Use longest practical length. Place edge trim where gypsum board abutts dissimilar materials as indicated. Place casing beads at perimeter of gypsum board ceilings. Fasten with screws at 12 in.(300mm) on center along entire length.
6. Provide a continuous moisture resistant insulating material at edges of gypsum wallboard in contact with metal windows and exterior door frames.

1.7
TOLERANCES

Maximum Variation from True Flatness: 1/8"(3mm) in 10 ft. (3 m) in any direction.

1.8
SHOP DRAWING:

Manufacturer/Installer to provide coordinated shop drawings for all Gypsum dry wall and Ceiling to Installation.



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1.
GENERAL
1.1
DESCRIPTION

1. Work included:

Porcelain / Ceramic tiles required for this Work are indicated on the Drawings and include, but are not necessarily limited to, decorative applications to walls and general wall and floor finishing.

1.2.
QUALITY ASSURANCE

1. Qualifications of installers:

- a) For cutting, installing, and grouting of tile, use only thoroughly trained and experienced tile setters who are completely familiar with the requirements of this Work.
- b) In acceptance or rejection of installed tiling, no allowance will be made for lack of skill on the part of tile setters.

1.3.
SUBMITTALS

Samples:

Within 120 days after award of Contract, and before any tiles are delivered to the Job Site, submit to the Engineer in accordance with the provisions of these Specifications three Samples of available colours and patterns of tiles in the specified groups, from the manufacturer selected.

2. Grade Certificates:

Prior to opening tile containers, submit to Engineer a Grade Certificate, signed by an officer of the firm manufacturing the tiles used, and issued when the shipment was expedited, stating the grade, types of tiles, identification marks for tile containers, and name and location of the Project.

1.4.
PRODUCT
HANDLING

1. Delivery and storage:

- a) Deliver materials of this Section to the Job Site in their original unopened containers with all labels intact and legible at time of use.



-
- b) Store materials under cover to prevent damage and contamination. Store only the specified materials at the Job Site.
2. Protection:
- Protect tile materials before, during, and after installation and protect installed work and materials of other trades.
3. Replacements:
- In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

2.
PRODUCTS
2.1.
WALL TILE

1. Vitreous clay Porcelain tiles for wall installation shall have cushion edge, impervious porcelain and highly glazed surface. Colours shall be as approved by Architect and shall include trimmers, corner pieces, bullnose and other special shapes indicated or required. Wall tiles shall comply with B.S. 1281 and be free from flaws, cracks and crazing. Acquire reputable products from local manufacturer. Approval of the manufacturer does not relieve the Contractor to carry-out his own checking to ensure that only the best quality tiles are used and all defective tiles are rejected and removed from site immediately.
2. Glazed ceramic toilet tissue holder build-in unit, in colour matching the ceramic tile, where indicated on the Drawings.
3. Subject to compliance with requirements, provide products of one of the following manufacturers.
- a) Master Tiles.
b) Grannitto Tiles
c) Whitehorse.
d) City Tiles or other approved Manufacturers
- .

2.2.
FLOOR TILE

1. Vitreous clay Porcelain / Ceramic tiles for floor installation shall have square edges and impervious semi glazed, non-skid and non-slip surface. Floor tiles shall comply with B.S. 1286-1974 and be free from flaws, cracks and crazing.



- 2 Subject to compliance with requirements, provide products of one of the following manufacturers.

- a) Master Tiles
- b) Grannitto Tiles
- c) Whitehorse
- d) City Tiles or other approved Manufacturers.

**2.3.
CEMENT**

1. Grey and white Portland Cement. Conform to BS 12. OR ASTM C-150

**2.4.
GROUT**

1. Type:

Tile grout shall be waterproof neat white Portland cement subject to approval of Engineer. Use epoxy type grout for floor tiles as recommended by tile manufacturer.

2. Colour:

Add colouring agent to permanently tint grout to match the tile against which it is placed. Colouring pigment to conform to B.S. 1014. Use first quality, high purity mineral pigment, finely ground, sun-proof, lime-proof and with a specific gravity similar to Portland Cement.

**2.5.
WATER**

1. Water to be potable, clean, free from deleterious amount of oils, salts, alkali, organic matter and other harmful materials. Conform to B.S. 3148.

**2.6.
SAND**

1. Sand shall be clean, sharp, durable bank sand, free from silt, loam, clay, soluble salts and/or vegetable matter. Comply to BS 812, 882 and 1199 or refer structural specification.



2.7.
ACCESSORIES

1. Tile setting adhesive plaster: type as recommended by tile manufacturer. Use epoxy additive for floor tiles.

2.8.
OTHER MATERIALS

1. Materials and methods not specifically described but required proper tile installation, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.
EXECUTION
3.1.
SURFACE
CONDITIONS

1. Inspection:
 - a) Prior to work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
 - b) Verify that tiles may be installed in accordance with the original design, pertinent codes and regulations, and referenced Standards.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.
ENVIRONMENTAL
CONDITIONS

1. Maintain minimum 13 C (55 F) air temperature at tile installation area for 24 hours prior to, during and after installation.
2. Areas in which tile work is being carried out shall be closed to traffic until the installation has set or for a minimum period of 72 hours.
3. Ceramic tiles shall be soaked in clean water 24 hours before laying



3.3.
INSTALLATION

1. Install tiles to manufacturer's instructions and as indicated on Drawings. Installation shall be in accordance with _ BS 5385 Part 1, Part 5, and tile manufacturer's instructions.
2. General Wall Tiling:
 - a) Scratch coat plaster base mix shall be one (1) part Portland Cement, four parts damp sand by volume. Apply mix with sufficient pressure and thickness to completely coat the surface. Where additional thickness build-up is required to conform to indicated lines, apply as separate coats. Floor and wall surfaces to receive the tiles shall be thoroughly cleaned of all dirt, dust and oil and other objectionable matters.
 - b) Apply tile setting adhesive plaster as recommended by tile manufacturer.
 - c) Fit tile around corners, fixtures, drains and other built-in objects to maintain uniform joint appearance. Cut edges smooth, even and free from chipping. Edges resulting from splitting will be rejected.
 - d) Make joints between tile uniform and approximately 1/16 in. (1.5 mm) wide, plumb, straight, true, even and with adjacent tile flush. Where tiles are applied in sheets, ensure sheet layout is not visible after installation. Align joints vertically and horizontally.
 - e) Lay out units so perimeter tiles are minimum 1/2 size (12mm).
 - f) Sound tiles after setting and replace hollow-sounding units to obtain full bond.
 - g) Make internal angles square, external angles bullnosed or mitred. Use bullnose edged tiles for bullnosed effect.
 - h) Use bullnose edged tiles or mitred at termination of tile panels except where panel butts projecting surface or differing plane.
 - j) Grouting:
 - i) Allow minimum 24 hours after installation of tile, before grouting.
 - ii) Grout cement to be mixed with dry cement colour as directed by the Engineer.
 - iii) Mix grout to a creamy consistency in accordance with manufacturer's directions.

-
- iv) Force maximum grout into joints with trowel before it sets. Strike or tool joints to base of cushion and fill gaps. Do not permit setting bed material to show through grout joints. Cure joints by sponging down with water for three days.
 - v) Use epoxy grout in rooms scheduled to receive similar grouting to floors.
 - k) Keep building expansion joints free of mortar or grout.
3. Floor Tiling:
- a) Install tile in accordance with pertinent descriptions for wall tile.
 - b) Apply cement/sand bed to 1:6 proportion to a minimum of 1/2 in. (12 mm) thickness. Apply epoxy tile setting adhesive plaster as recommended by tile manufacturer. Grout joints with epoxy cement.
4. Decorative Tiling:
- a) Install as per pertinent description for General Wall Tiling except as described here.
 - b) Tiles shall be set flush with adjoining plaster to layout shown on Drawings.
 - c) No finished tiles shall be cut or chipped off.
5. Grout shall be tinted as approved by Engineer, to match colour of tile surfaces.

**3.4.
TOLERANCES**

1. Maximum variation shall not exceed 1/8 in. in 10 ft. (3 mm in 3 m)

**3.5.
CLEANING &
PROTECTION**

1. Upon completion of tile installation and grouting, and after ceramic tile has thoroughly set, sponge and wash tile thoroughly and diagonally across joints. Remove surface cement. Prevent damage to tiles and adjacent materials. Do not use acid cleaners. Finally, polish with clean, dry cloths.
2. Protect tile after cleaning with non-staining heavy Kraft paper or other approved coverage until acceptance of the building.



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1.
GENERAL
1.1.
SCOPE OF
WORK

This section of the specification covers the following works:-

- a) In-Situ and Precast Terrazzo work including base of concrete or mortar as specified.
- b) Precast Terrazzo Tiles
- c) Marble chips coating.

2.
PRODUCT
2.1.
IN-SITU TERRAZZO

Concrete shall be non-structural concrete 1:2:4.

White Cement shall conform to BS 12-78 or C-150 for white cement.

Grey Cement shall conform to BS 12-78 or C-150 for Ordinary Portland Cement.

Water shall be of drinking quality conforming to BS 3148.

Sand for mortar bedding and rendering shall conform to BS 1199 “Building Sands from Natural resources” and shall be clean medium coarse grained free from organic and deleterious matter.

Marble chips shall be of crushed marble, best quality, from sound and hard marble. Sizes, colours and mix proportions shall be as indicated or approved.

Panel dividers shall be of material and sizes as indicated.

Cement slurry where required to be used shall contain an average of 4.10 kg cement per square meter area.

Subject to compliance with requirements, provide products of the following manufacturer.

- Magnacrete
- Matrixx
- Cara Tiles
- Banu Mukhtar

2.2.
PRECAST
TERRAZZO

1. a) Tiles:

Precast terrazzo tiles shall be of reputable manufacture made and ground in factory. Size of tiles to be 8 ins x 8 ins x 3/4 in. with a terrazzo topping of min. 3/8 ins. (9mm). Grey cement and sand mix to be used in tile base construction. Tile topping shall be comprised of Malagori marble chips up to No. 4 size, white cement and colour pigment.

b) Skirtings:

Precast terrazzo to be same as width of tile, or as elevation or cross section shown on Drawings. Construction similar to pertinent data for tiles.

c) Curing:

Tiles and skirtings shall be cured to proper hardness and exposed surfaces ground smooth and polished.

d) Finishes:

Tiles and skirtings to be grounded and highly polished.

Subject to compliance with requirements, provide products of the following manufacturer.

- Magnacrete
- Matrixx
- Cara Tiles
- Banu Mukhtar

2.3.
SAMPLES AND
TESTS

Samples of all materials shall be submitted to the Engineer for tests and approval and materials conforming to approved samples will be used throughout the work. Rejected materials shall be removed from the site immediately.

3.
EXECUTION
3.1.
PREPARATION OF
BOTTOM SURFACE

Concrete having class U1 (rough finish) shall be thoroughly cleaned of all dirt, greasy and

foreign matter by water and brushes and/or compressed air. In case the concrete surface does not conform to class U1 finish, at least 40% of the surface area shall be hacked and cleaned. The cleaned surface shall be kept wetted for at least 2 hours before laying flooring over it.

The masonry surface having raked joints shall be cleaned of all dirt etc. and kept moist for at least 2 hours before laying skirting and dados/wall facing.

3.2.
***CURING AND
PROTECTION***

All cement work shall be kept moist for 10 days, and shall be protected from damage.

3.3.
***CONSTRUCTION REQUIREMENTS OF
IN-SITU TERRAZZO FLOORING***

Flooring shall be laid in panels of indicated sizes. Panel dividing strips of indicated height and thickness and material shall be fixed in concrete 1:2:4 to correct lines and level leaving allowance for grinding the terrazzo topping.

The terrazzo flooring shall consist of terrazzo topping and concrete base. Over the cleaned wet surface, concrete base of indicated thickness shall be laid in specified concrete within the dividing strips already installed as part of flooring. Minimum water shall be added to the concrete mix to obtain the required consistency and concrete shall be well compacted and levelled or laid to required slope. It shall not be finished smooth.

The terrazzo topping shall consist of one-part matrix (white cement or grey cement or a mixture of white and grey cements in indicated ratio, and pigment where required) and two parts marble chips by volume. If the matrix consists of a mixture of cement and pigment or a mixture of cements with or without pigment, the matrix shall be mixed dry thoroughly on a hard-dry surface in a quantity sufficient for the area of one specified shade. The matrix shall then be thoroughly mixed with measured quantity of marble chips in dry state in such quantity that it can be wholly used within 30 minutes of addition of water to the mix. Add water to obtain a stiff plastic mix, but not flowing.

Within maximum 12 hours of the laying of concrete base, and while the base concrete is still plastic, the terrazzo mix prepared as above shall be laid. In case the base concrete is not plastic at the time of laying of topping, the base concrete shall be coated with a slurry of matrix and water. The terrazzo mix shall be trowelled into the concrete base before filling to the top level of panel dividers. The terrazzo layer shall be well compacted and voids shall be filled in. A layer of matrix shall then be well-trowelled into the surface leaving a plain smooth surface.

The grinding of terrazzo shall commence 3 days after the laying is completed. The grinding of the flooring shall be done manually preferably with machine of approved type.

- a) The first grinding shall be done with an approved coarse abrasive (carborandum bricks or disk) by sprinkling fine sand over the surface and by using an ample quantity of water till trace of ground mud is removed and marble chips are visible.
- b) All holes or open pores shall be made good with matrix, the grout being well worked into the surface by rubbing with a stone and finishing a little above the level of the finished surface of floor. The portion so treated shall be kept wet till the floor is ready for the second grinding.

- c) The second grinding shall be done after about 5 days using an approved medium graded coarse abrasive (carborandum bricks or disk), and pores, if any, shall be treated similarly as after the first grinding.
- d) The final grinding shall be done with an approved fine graded carborandum stone and the surface thoroughly washed down with water. At least 50% of the chips shall be exposed.

After final grinding the floor shall be thoroughly washed. Tartaric or powder oxalic acid shall be sprinkled over the floor and rubbed with gunny bags wrapped round rods. The floor shall be allowed to dry and then more oxalic or tartaric acid shall be rubbed with clothpads.

When floor is completely dry the final gloss shall be given by an approved wax polish.

3.4.

***CONSTRUCTION REQUIREMENT OF IN-SITU
TERRAZZO SKIRTINGS AND DADOS.***

Over the prepared surface, 1:3 Ordinary Portland Cement sand of required thickness shall be applied and terrazzo mix prepared as per Article 3.3 shall be trowelled into the plaster base while it is still plastic. If the terrazzo mix is applied when the base is not plastic, the base shall have been darbied to rough surface, cleaned and wetted for at least two bours and then shall be coated with a slurry of matrix and water before applying terrazzo mix.

The terrazzo topping shall be ground, repaired, finished and polished as specified in Article 3.3. The thickness of terrazzo topping shall be finished thickness.

3.5.

***CONSTRUCTION REQUIREMENT FOR IN-SITU
TERRAZZO FLOOR TOPPING WITH PLASTER
BASE.***

Terrazzo topping of indicated thickness shall be laid over 1:3 cement, sand base in the same manner as the terrazzo topping in Article 3.3 and shall be ground, finished and polished like the terrazzo topping in Article 3.3.

3.6.

***CONSTRUCTION REQUIREMENT
FOR PRECAST TERRAZZO***

Lay solid wet sand and lime bed in proportions by volume of 1:6 to depressed depth required by thickness of tile. Apply a cement slurry adhesion coat to bed. Set and tamp tiles immediately following, with butted joints. Joints shall be grouted with white cement and pigment in same proportions as topping of tiles.

3.7.

***MACHINE SPRAYED
TERRAZZO FINISH***

It shall consist of 2 coat work, the base coat and the finishing coat.

Base Coat:

Surface shall first be prepared as per Article 3.1. The base coat shall consist of ½" thick 1:4 cement sand plaster (unless indicated otherwise in the pay item) and shall conform to specification Section 9200 except that its surface shall not be finished smooth but shall be scored, just after the material has started to set, in wavy lines by a wire nail comb to form a bond for the finishing coat, and the base coat shall be allowed to set and kept wet for a period of 24 hours before the finish coat is applied.

Finishing Coat:

The wet plastic mix of cement and specified aggregate in the proportion specified in the pay item shall then be prepared and sprayed onto the base coat, by means of machine, in a uniform specified thickness. The loose material that falls on ground shall not be re-used. The surface shall be kept wet for at least 7 days.

**3.8.
WASHED
TERRAZZO**

It shall consist of 2 coat work, the base coat and the finish coat. Surface shall first be prepared as per Article 3.1.

Base Coat shall be in 1:3 cement, sand plaster of specified thickness and shall conform to the requirements of Article 3.7 in all other respects.

Finish Coat of specified thickness shall consist of one part white cement and 1½ parts marble chips of approved colour and size, with pigment if required. The materials shall be dry mixed thoroughly and then water shall be added to the required consistency. The plastic mix shall be applied over the base coat and floated to uniform finish. Panel shall be made if specified. When the finish coat has hardened sufficiently, the marble chips shall be exposed by simultaneously brushing and flushing with water. An approved retarder may be used to expose the aggregate. The work shall be kept wet for at least 7 days.

**3.9.
INSPECTION AND
CLEANING UP**

1. Inspection:

Upon completion of the Work of this Section, make a thorough inspection and verify that units and joints have been installed in accordance with the provisions of this Section, Contractor shall make adjustments or replacements at his own expense as directed by Engineer.

2. Cleaning and Protection:

- a) Installed material shall be adequately protected from discolouration and disfigurement. Prior to hand-over of building clean surfaces of dust and residue.
- b) Upon completion of Work to this Section, promptly remove from the Job Site broken units, debris arising from the Work, tools and equipment and leave areas in a neat and orderly condition to the approval of Engineer.
- c)

4.
MEASUREMENT AND
PAYMENT

Except otherwise specified herein or else wherein the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items or the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

Supply of all types of Terrazzo, washing, polishing acid washing and finishing of tiles.

Pigments used for making of tiles or grouting material.

Adhesive for fixing tiles and flooring.

Setting base and screeding for tiles.

Preparation of concrete surfaces for laying tiles.

Cement concrete base.

Sealants, caulking, and grouting materials.

Brass, Aluminium or glass strips.

4.1.
WASTAGE OF
MATERIAL

Measurement of acceptable completed works of finished floor and skirting will be made on the basis of net actual area in square meter laid in position as shown on the drawings or as directed by the Engineer. Exposed edges of tiles or marble will not be included in the measurements.

Payment will be made for acceptable measured quantity of finished floor and skirting on the basis of unit rate per square meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the items.



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1.
GENERAL
1.1
DESCRIPTION

1. Work included:
 - a) Marble, Granite and Stone required for this Work is indicated on Drawings and Room Finishes Schedules, and includes flooring, steps, sills, pool edges, counter tops, wall finishing, but not necessarily limited to same.
2. Related work:
 - a) Adjacent plastering to Marble, Granite and Stone refer to Section 9200 Internal and External Plasterwork.
 - b) Caulking work for joining materials of this Section and dissimilar adjacent materials is described in Section for Sealants, 7900

1.2.
QUALITY ASSURANCE

1. Qualifications of workmen:
 - a) For installation, use only skilled tile setters who are thoroughly experienced with the materials and methods specified and thoroughly familiar with the design requirements.
 - b) In acceptance or rejection of installed material no allowance will be made for lack of skill on the part of workmen.
 - c) Provide one skilled supervisor who shall be present at all times during execution of the work of this Section and personally direct the execution of this portion of the Work.

1.3.
SUBMITTALS

1. Samples:
 - a) Within 120 days after award of Contract and before any material is delivered to the Job Site, submit three samples of proposed material to the Engineer for his approval.
 - b) Samples should include each colour, type and pattern proposed for use on the project. Samples shall illustrate the limit of extremes in colouring.
 - c) Installed material must conform to accepted samples.
 - d) No material shall be worked upon until the Shop Drawings have been approved by Engineer.
2. Shop Drawings:
 - a) Contractor shall prepare Shop Drawings showing details of bases (skirtings), bedding, bonding, anchoring and jointing of the work, including typical and

special anchoring. Dimensions and numbers of pieces shall be indicated on Drawings submitted to the Engineer. Work only from approved Shop Drawings. Shop drawings to confirm and reflect as built site conditions.

- b) Obtain and verify cut-out dimensions in marble slab counter tops, from Engineer before submitting Shop Drawings.

**1.4.
PRODUCT
HANDLING**

1. Transportation and handling:

- a) Finished material shall be carefully loaded for transportation using reasonable and customary precautions against damage in transit. No material which would cause staining shall be used for blocking.
- b) Stack material at the Job Site on timber or platforms at least 4 ins above ground. Prevent staining during the storage period.
- c) Protection:

Protect material before, during and after installation and protect installed work and materials of other trades.

2. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

**2.
PRODUCT
2.1.
MARBLE**

1. Physical Requirements:

- a) Marble shall be sound, free from spalls, cracks, open seams, pits, or other defects that would impair its strength, durability, or appearance. Marble shall be uniform in tone and colour as approved by Engineer.
- b) Incised marble shall be one piece slabs, with open veins and crevices filled with compatible cement. Finished surface shall be polished flush. Grade of marble and percentage of incisions shall be controlled by submittal selection.

2. Marble Types:

- i) These shall conform to Colour Schedule provided by Consultant.
- ii) Contractor shall submit current prices of various types of marble available as required by Engineer, for the purposes of adjustment of Contract under this Article.

3. Marble Sizes:



-
- i) Large tiles, 12 ins by 12 ins (300mm x 300mm) to 24 ins by 24 ins. (600mm x 600mm). Floors, 3/4 in. (18mm) thick, shaped and dimensioned to conform to patterns shown on Drawings.
 - ii) Small tiles, 4 ins by 8 ins.(100mm x 200mm), beveled edges.

Floors and walls: 3/8 in. (9mm) thick, shaped and dimensioned to conform with patterns shown on Drawings.
 - iii) Marble saddles and thresholds shall be sized as indicated on Drawings.
 - iv) Counter tops and aprons shall be in one piece. Cut shapes as shown on drawings. Expose edges radiused
 - v) Special Shapes: Shown on Drawings, sufficient thickness to prevent marble cracking from superimposed loads and dimensioned so that joints will align with those of adjacent marble surfaces where applicable.
4. Marble Finishes:
- Floors and walls in lobbies and counter tops to be highly polished. Floor and walls in other interior and exterior conditions to be moderately polished.

Subject to compliance with requirements, provide products of one of the following manufacturers.

- a. Inexterior
- b. Marble World
- c. Stone City
- d. Or approved equivalent

2.2.
GRANITE POLISHED
FLAME TORCHED

As indicated in the drawings or as directed by the Engineer.

- 1. Granite would be in 1/2" or 3/4" (12mm or 19mm) thick section, or as shown on the drawings, polished, colour to be approved by the consultant or as mentioned in the drawings.
- 2. Flame Torch Granite; Torching shall be done with the standard sand blasting procedure or as per recommendation of the consultant. Contractor to submit sample before laying the same.
- 3. Variation to approved sample shall not be acceptable.

2.3.
SETTING MATERIALS

1. Mortar bed:

Apply cement/sand bed mixed with water to 1:4 proportion to a min. of 1/2 in. (12 mm) thickness. Apply epoxy tile setting adhesive plaster as recommended by the tile manufacturer. Grout joints with epoxy cement.
2. Holes and anchors:
 - a) Anchors for marble shall be stainless steel sized to support loads to be carried. Tying of anchors shall be in dovetail inserts cast into concrete or engaged in joints of masonry.
 - b) Holes required for anchors, cramps and dowels shall be cut in accordance with approved Shop Drawings.

2.4.
**OTHER MATERIALS
AND ACCESSORIES**

1. Grout to be compatible, non-staining, white, unless otherwise indicated or approved. Colouring agent to be added to permanently tint grout where applicable. Procure grout type for terrazzo from supplier of tiles. Waterproofing admixtures or epoxy-based grouting shall be used for jointing and grouting exterior marble work.
2. Aluminum and brass edge strips 1/4 in. (6 mm) thick including anchors to same.
3. Fillers, where required, to match approved samples.
4. Sealers to be used only with approval of Engineer.
5. Waterproof membrane under screed mortar bed in areas where a floor drain occurs as shown on Mechanical or Architectural Drawings. Refer to Section on Dampproofing.
6. Caulking shall be as described in Section on Sealants.
7. Glazed ceramic soap dish build-in unit: refer to Section on Toilet and Bath Accessories and Schedule.
8. Glazed ceramic toilet tissue holder build-in unit: refer to Section on Toilet and Bath Accessories and Schedule.
9. Materials and methods not specifically described but required for proper fabrication and installation of materials in this Section, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.
EXECUTION
3.1.
SURFACE
CONDITIONS

1. Inspection:
 - a) Prior to Work of this Section, carefully inspect the area is complete to the point where this installation may properly commence.
 - b) Verify that material may be installed in accordance with the original design.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify Engineer.

3.2.
INSTALLATION

1. General:

Install unit materials as indicated on Drawings and in accordance with tile manufacturer's instructions.
2. After approval of Shop Drawings, material shall be cut to provide sizes required in a panel from the same set of raw slabs. Severe differentiation between stones within a panel will not be acceptable.
3. Panels shall be laid out prior to installation for Engineer to inspect and verify the acceptability of grain and/or colour. Unacceptable units shall be replaced or relocated, at no additional cost to Employer.
4. Waterproof Membrane:

To be installed under Section on water proofing.
5. Marble / Granite:
 - a) Floors:

Cement/sand setting bed to be 1:4 proportion laid to a min. of 1/2 in. (12mm) thickness. Apply tile setting adhesive plaster as recommended by tile manufacturer. Joints to be grouted with cement and pigment 1/16" (1.56) width, pattern as shown on Drawings.
 - b) Walls:
 - i) Install tiles in accordance with pertinent parts of Section on Ceramic Tiling. Joints to be grouted with cement and pigment 1/16 in. (1.56mm) width, pattern as shown on Drawings.
 - ii) Install anchoring to vertical marble slabs in accordance with Shop Drawings. Joints shall be grouted similar to tile work. Conform to pertinent data of BS CP 298.

- c) Exterior stone facing shall have waterproof bedding, jointing and grouting. Waterproofing agents shall be added in accordance with manufacturer's instructions. Admixtures shall not exceed 10 per cent of cement content.
 - d) Counter to bathrooms and washrooms shall have waterproof tile jointing.
 - e) Caulking shall be as described in Section on Sealants and as shown on Drawings.
6. Grout shall be tinted as approved by Engineer, to match colour of precast terrazzo and marble surfaces.
7. a) Where material of this Section adjoins dissimilar flooring material, and where no other transition material is specified, install edge strips. At door location set strips to align with face of door. Use brass with marble and aluminum with terrazzo.
- b) Set edge strips straight, true to line and properly anchored so that on completion of grinding tops of strips and floor surface are flush.

**3.3.
TOLERANCES**

1. A tolerance of no more than 1/32 in. (0.78mm) shall be acceptable in lengths and widths of individual slabs. Thicknesses shall be within 1/16 in. (1.56 mm) from those shown on Drawings except where it is exposed. Maximum variation shall not exceed 1/8 in.(3mm) in 10 feet (3m).

**3.4.
CURING**

1. Installed Stone and marble surfaces shall be cured for a minimum of 7 days.

**3.5.
GRINDING AND
POLISHING**

1. Following curing, marble and Stone tile surfaces shall be machine ground twice to attain smooth and level finish.
2. Wash down with clean water, dry and apply 'chemical' polish to surfaces with approved sealer, to the entire satisfaction of the Engineer.

**3.6.
INSPECTION AND
CLEANING UP**

1. Inspection:

Upon completion of the Work of this Section, make a thorough inspection and verify that units and joints have been installed in accordance with the provisions of this Section, Contractor shall make adjustments or replacements at his own expense as directed by Engineer.



2. Cleaning and Protection:

- a) Installed material shall be adequately protected from discoloration and disfigurement. Prior to hand-over of building clean surfaces of dust and residue.
- b) Upon completion of Work to this Section, promptly remove from the Job Site broken units, debris arising from the Work, tools and equipment and leave areas in a neat and orderly condition to the approval of Engineer.

4.
MEASUREMENT
AND PAYMENT

Except otherwise specified herein or else wherein the Contract Documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items or the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities.

Supply of all types of Marble, Granite or Stone, Grinding, washing, polishing acid washing and finishing of tiles.

Pigments used for making of tiles or grouting material.

Adhesive for fixing tiles and flooring.

Setting base and screeding for tiles.

Preparation of concrete surfaces for laying tiles.

Cement concrete base.

Sealants, caulking, and grouting materials

Brass, Aluminum or glass strips.

4.1.
WASTAGE OF
MATERIAL

Measurement of acceptable completed works of finished floor and skirting will be made on the basis of net actual area in square meter laid in position as shown on the drawings or as directed by the Engineer. Exposed edges of tiles or marble will not be included in the measurements.

Payment will be made for acceptable measured quantity of finished floor and skirting on the basis of unit rate per square meter quoted in the Bill of Quantities and shall constitute full compensation for all the works related to the items.

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1.
GENERAL
1.1
DESCRIPTION

1. Work included:

Work of this Section includes the supply and installation of granolithic or concrete topping material on interior floor slabs, providing a final finish or left ready to receive a second material, as indicated on Drawings and Room Finish Schedules.

1.2.
QUALITY ASSURANCE

1. Qualifications of installers:

- a) For application of toppings, use only thoroughly trained and experienced cement finishers who are completely familiar with the requirements of this Work and the recommendations contained in the referenced Standards.
- b) In acceptance or rejection of installed materials, no allowance will be made for lack of skill on the part of workmen.

1.3.
PRODUCT
HANDLING

1. Delivery and storage:

- a) Deliver materials of this Section to the Job Site in their original unopened containers with labels intact and legible at time of use. Where material is delivered loose, store as directed by Engineer.
- b) Store materials under cover to prevent damage and contamination. Store only the specified materials at the Job Site.

2. Protection:

Protect materials of this Section before, during, and after installation and protect installed work and materials of other trades.

3. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to the Employer.

**2.
PRODUCTS**

**2.1.
MATERIALS AND
EQUIPMENT**

1. Portland Cement conforming to B.S. 12 or ASTM C-150.
2. Sand: Clean sharp, angular, free from alkali, silt or organic matter, to conforming to B.S. 1198-1200 Alternatively hard aggregate conforming to B.S. 882, 1201 passing 200 mesh sieve.
3. Water: Potable, clean, free from deleterious amount of oils, salts, alkalis, organic matter and other harmful materials conforming to B.S. 3148.
4. Coarse aggregate:
 - a) Granolithic topping: hard angular stone chips conforming to B.S. 882, 1201, approved by Engineer. Aggregate size to be 1/4 in. (6mm) to 1/2 in. (12mm) and free from dust.
 - b) Concrete topping: well graded natural gravel, crushed gravel or crushed stone conforming to B.S. 882 and 1201. Aggregate size to be 1/2 in.(12mm) to 1/4 in. (6mm) and free from dust.
5. Concrete floor hardener to be of approved quality and manufacturer.
6. Silicate of Soda dust retarder, proprietary brand approved by Engineer.
7. Materials and workmanship for floor toppings not explained in these specifications shall comply with the requirements of BS CP 204.
8. Circular trowelling machines

**2.2.
OTHER MATERIALS**

1. Materials and methods not specifically described but required for proper fabrication and installation of floor toppings, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

**3.
EXECUTION
3.1.
SURFACE**

1. Inspection:
 - a) Prior to work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify the Engineer.

- b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.
3. Surface treatment:
- a) Concrete slabs to receive concrete topping shall be cleaned to remove grease, form oil and other impurities which will otherwise adversely affect the adhesion of the topping to the surface. Surface of concrete if so required by Engineer, shall be hacked by approved means to give the required key for topping.
 - b) Surfaces shall be washed with clean water and kept damp for 2 hours before further treatment. Surfaces thus prepared shall be treated uniformly with a cement and sand slurry of one part cement, one part sand mix brushed on immediately before application of topping.
 - c) Extreme caution should be taken to avoid rapid setting of mixture and resultant shrinkage cracks.

3.2.
WORKMANSHIP

1. General:
- a) Do not apply toppings when temperature is below 4 C (39 F) for at least 4 to 6 days after application to ensure that conditions will permit the curing treatment specified.
 - b) Do not undertake work if area of application is exposed to dry hot winds.
 - c) Thicknesses of toppings to be as per Drawings.
2. Proportioning and mixing:
- a) Measurement of materials by volume shall be of known capacity to maintain consistent proportions. No lumpy or cracked material shall be used. Mixing equipment, boxes and tools shall be clean. Materials shall be proportioned as specified or as directed by the Engineer. Mixing shall be continuous until ingredients are evenly distributed.
 - b) Only limited water shall be used for proper workability. Water cement ratio shall not exceed 0.45. Mortar shall be consumed within thirty minutes of mixing. Retempering will not be permitted. Mortar which has begun to stiffen shall be discarded.
 - c) Mix ingredients shall be thoroughly mixed by mechanical mixer.
 - d) Mortar mix for concrete topping to be one (1) part cement, two (2) parts sand, and four (4) parts coarse aggregate. Mixing shall be in accordance with B.S. CP 204
 - e) Mix for granolithic topping to be one (1) part Portland cement, one (1) part fine aggregate and two (2) parts coarse aggregate. Mix concrete floor hardener with cement in a dry state at ratio of 1:4 by weight. Mixing procedure to be approved by hardener Manufacturer.
3. Concrete toppings:

- a) Where indicated on Drawings or Room Finishes schedules provide trowelled fine finish topping, true to lines and levels shown and left ready to receive finish where applicable.
- b) Apply mix over required areas in alternate strips or bays not exceeding 250 sq. ft. (23.23 sq. M).
- c) Screeding shall be carried out immediately after placing, spreading and vibrating is complete.
- d) Darbying or bull floating shall be done immediately after screeding and shall remove high spots and fill voids left in the concrete surfaces by screeding.
- e) Mechanical or hand floating shall commence after bleed water has evaporated and concrete has stiffened sufficiently to prevent the working of excess mix to the surface. Floating shall be terminated when the coarse aggregate is firmly embedded below a thin layer of mortar and has produced a surface of uniform texture.

No cement or mixture shall be applied to the surface for hardening.
- f) When concrete is sufficiently hard the surface shall be given a steel trowelled finish. The surface shall be dense hard and smooth, and free from blemishes.
- g) Topping shall be cured for a minimum of 7 days after finishing. Use plastic sheeting, building paper or hessian.
- h) Screed battens shall be removed after 24 hours and nonabsorbent paper placed against exposed edge and folded over finish.

4. Granolithic Toppings:

- a) The concrete floor slab shall be poured, screeded and consolidated to within 3/4 in. (19 mm) of the final finished floor level.
- b) After bleed water has disappeared and surface will support workmen without appreciable indentation, the topping mixture shall be spread, compacted, floated, finished and cured as described for Concrete Toppings.
- c) Install coved bases integral with the floor and with 3/4 in. (19 mm) radius, as shown on Drawings and Schedules.
- d) Granolithic floor areas are required to have a dust free finish. After the floor is dry apply with a single application of 10 per cent solution of silicate of soda, in accordance with manufacturer's instructions or as directed by Engineer. Finish floor with machine applied chemical polish as directed by the Engineer.
- e) Stair treads shall have a non-slip finish.

3.3.
TOLERANCES

1. Deviations exceeding 1/8 in.(3mm) under a 10 ft.(3000mm) straight edge applied in all directions will not be accepted.

3.4.
CLEANING UP

1. General:

Prevent accumulation of scraps and debris arising from the work of this Section. Maintain premises in a neat and orderly condition at all times. In the event of spilling or splashing material onto other surfaces immediately remove the same, and traces of residue, to the approval of Engineer.



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1.
GENERAL
1.1
DESCRIPTION
OF WORK

1. Work included:
 - a) The types of material and surfaces to be treated are listed in "Schedule of Room Finishes" attached as part of these Specifications. Read this section in conjunction with Drawings and Schedules.
 - b) Included also in this Section are painted murals in Public Spaces as shown on Drawings.
2. Definitions:

The term “paint”, used here, includes enamels, sealers, stains, fillers, emulsions, and other coatings whether used as prime, intermediate, or finish coats.

1.2.
QUALITY ASSURANCE

1. Qualifications of painters:

Use only qualified painters for the mixing and application of paint. In the acceptance or rejection of installed painting, no allowance will be made for lack of skill on the part of painters.

1.3.
SUBMITTALS

1. Materials list:
 - a) Within 120 days after award of Contract, and before any paint materials are delivered to the Job Site, submit to the Engineer a list of materials to be furnished and installed under this portion of the Work.
2. Samples:
 - a) Accompanying the materials list, submit to Engineer two copies of full range of colours available for proposed products.
 - b) Prepare and deliver to Engineer two identical sets of Samples of selected colours painted on 8 ins by 12 ins by 1/4 in. (200mm x 300 x 6mm) thick material. Whenever possible, the material for Samples shall be the same material to which the coating will be applied at the Job Site.
3. Manufacturer's recommendations:

Where material proposed is not the same as specified or specifically described as an acceptable alternate in this Section, submit for Engineer's review the current recommended method of application published by the manufacturer.



**1.4.
PRODUCT
HANDLING**

1. Delivery:

Deliver materials to the Job Site in original unopened containers with labels intact and legible at time of use.

2. Protection:

- a) Store only approved materials at the Job Site, in a designated area restricted to paint materials and related equipment.
- b) Ensure the safe storage and use of paint materials and prompt, safe disposal of waste.
- c) Protect paint materials before, during, and after application and protect installed work and materials of other trades.

3. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

**2.
PRODUCTS
2.1.
PAINT MATERIALS**

1. Manufacturer:

- a) Materials shall be first grade and meet or exceed minimum standards of reputable manufacturers, subject to approval of Engineer.
- b) Paint material selected for each type of surface shall be the product of a single manufacturer.
- c) Subject to compliance with requirements provide products of one of the following manufacturer
 - i) ICI Dulux
 - ii) Jotun Paints
 - iii) Berger Robbialac
 - iv) Gobis or other approved Manufacturer.

2. Compatibility:

- a) Paint materials and equipment shall be compatible in use: finish coats shall be compatible with prime coats; prime coats shall be compatible with the surface to be coated; tools and equipment shall be compatible with the coating to be applied.
- b) Thinners, when used, shall be only those thinners recommended for that purpose by the manufacturer of the material to be thinned.

2.2.
COLOURS

1. Colours of approved manufacturer shall match those included in the colour and sample set.
2. Colours, shall be pure, non-fading pigments, mildew-proof, sun-proof, finely ground in approved medium. Colours used on plaster and concrete surfaces shall be lime-proof. Where a 'two colour' or tint combination may be selected or approved for the treatment of any particular surface in any space or room, no additional payment shall be made to the contractor in any instance
3. Primers shall be tinted where deep tone accent colours are used.

2.3.
OTHER MATERIALS

1. Materials and methods not specifically described but required for proper installation of paint material, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.
EXECUTION
3.1.
SURFACE
CONDITIONS

1. Inspection:
 - a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.
 - b) Verify that paint finishes may be applied in strict accordance with manufacturer's recommendations and requirements of these Specifications.
2. Discrepancies:
 - a) In the event of discrepancy, immediately notify Engineer.
 - b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.
PREPARATION OF
SURFACES, GENERAL

1. Protection:
 - a) Prior to surface preparation and painting operations, completely mask, remove, or otherwise adequately protect hardware, accessories, machined surfaces, plates, lighting fixtures, and similar items in contact with painted surfaces but not scheduled to receive paint.

- b) Surfaces shall be prepared in accordance with paint manufacturer's recommendations.
- c) Clean and remove foreign materials. Smooth out rough spots. Remove rust from metal surfaces with wire brush. Dust-off and remove all oil and grease stains with penetrating type solvent.
- d) Fill and sand smooth nail holes and similar imperfections, after prime coat.
- e) Fill and smooth, before painting, hair cracks and minor defects in plaster, interior only.
- f) Wood work that is to have a finish treatment, whether executed as field work or shop finished, shall be smooth and free from raised grain or other surface imperfections that affect its appearance and shall be lightly sanded or steel woolled during finishing operations.

After filler has been applied, if required all nail holes or other similar blemishes shall be carefully stopped with linseed oil putty.

2. Precautions:

- a) Do not apply any putty on exterior surfaces, bathrooms, kitchens and places where the moisture content in the air may be high.
- b) Do not paint plaster for at least two months after its installation.

3. Priming:

- a) Spot prime exposed nails and other metals to receive enamel paints, using a primer recommended by the manufacturer.
- b) Apply rust inhibitive primer paint to ferrous metal surfaces.
- c) Refer to Sections 5500 Metal Fabrications and 5700 Ornamental Metal for shop priming of items in these sections of Division 5.

4. Cleaning:

- a) Before applying paint or other surface treatment, thoroughly clean surfaces involved.
- b) Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- c) Prior to start of any work the Contractor shall, as a part of his contract, carefully inspect all surfaces to be painted or finished and notify the Engineer in writing of any defective workmanship, materials, or any other conditions, which, in his opinion, will affect the satisfactory execution and/or performance of his work.

No work in this section shall be initiated until all such surfaces or conditions have been corrected; the absence of any such notification will be construed as an acceptance by the Contractor of all such surfaces and later claims of defects in these surfaces that may result in finished surfaces being unsatisfactory to the Engineer will not in any way relieve the contractor from the responsibility and/or accountability under his guarantee.

- d) No work to be done under the conditions that are unsuitable for the production of good results, nor at any time when the plastering is in progress or is drying, or not dry.
- e) Neither paint nor any other finish treatment is to be applied over wet or damp surfaces unless specifically required, nor shall succeeding coats be applied until the preceding coat is thoroughly dry.

3.3.
APPLICATION

1. General:

- a) Paint surfaces as indicated on Drawings and Room Finishes Schedules.
- b) Paint grills and other pre-finished items where factory pre-finish is not in accordance with Schedules and colour selection.
- c) Apply transparent finishes and paints in accordance with manufacturer's instructions and as specified herein.

2. Drying:

- a) Allow drying time between coats, as recommended by manufacturer.

3. Environmental conditions:

- a) Comply with the manufacturer's recommendations as to environmental conditions under which paint may be applied.
- b) Do not apply paint in areas where dust is being generated.

4. Defects:

Sand and dust between coats to remove defects visible to the unaided eye from a distance of 5 feet.

3.4.
INSPECTION

1. General:

Do not apply additional coats until previous coat has been inspected and approved by Engineer.

2. Number of coats:

Only inspected and approved coats of paint will be considered in determining the number of coats applied.

3.5.
PROTECTION

- 1. a) Place drop cloths to adequately protect finished work.

- b) Do not paint any finish hardware or other finish item that is already fitted into place.

3.6.
PAINT TYPES

1. Apply the following finishes to areas or items where designated on Schedules. Type no's are prefixed by the letter 'P' on Schedules.

- a) Finish type 1 (matt finish for plaster or masonry) 1 coat alkali resisting primer, 3 coats alkyd flat enamel.
- b) Finish type 2 (gloss finish for plaster or masonry) 1 coat alkali resisting primer, 3 coats Alkyd gloss enamel.
- c) Finish type 3 (on interior and exterior wood) 2 coats shellac knotting over knots, cellulose filler to cracks and defects, 1 coat oil based primer, 2 coats alkyd gloss enamel.
- d) Finish type 4 (on shop primed metals) 1 coat of spot primer, 1 coat of alkyd enamel undercoat, 2 coats alkyd gloss enamel.
- e) Finish type 5 (on ferrous metal) 1 coat red lead or zinc chromate primer, 3 coats alkyd gloss enamel.
- f) Finish type 6 (on galvanized and zinc coated metals) 1 coat vinyl wash primer, 1 coat of alkyd enamel undercoat, 2 coats alkyd gloss enamel.
- g) Finish type 7 (special finish on masonry or plaster) 2 coats of Epoxy Concrete Paint by I.C.I.
- h) Finish type 8 (exterior plaster or masonry) 1 coat of alkali resisting primer/sealer, 3 coats of exterior emulsion. Alternatively, 3 coats of cement paint.
- j) Finish type 9 (matt finish for plaster or masonry) 1 coat of alkali resisting primer, 2 coats of vinyl or plastic emulsion.

1. Apply the following finishes to wood items designated on Schedules. Type no.'s are prefixed by the letter 'T' on Schedules.

- a) Finish type 1 (interior and exterior application to Ash Wood or approved equivalent).
 - i) Exterior: To be applied as per Manufacturer's recommendations.
(Manufacturer's : Jaffer Brothers, ICI, Jotun or approved equivalent)
 - ii) Interior: To be applied as per Manufacturer's recommendations.
(Manufacturer's : Jaffer Brothers, ICI, Jotun or approved equivalent)
- b) Finish type 2 (interior application to Ash Wood or approved equivalent)



All as per instructions and complete satisfaction of the Consultant.

3.7.
***REINSTALLATION OF
REMOVED ITEMS***

1. Following completion of painting in each space, promptly reinstall items removed for painting, using only workmen skilled in the particular trade.

3.8.
CLEANING UP

1. General:
 - a) During progress of the Work, prevent accumulation of empty containers or other items except in areas specifically set aside for that purpose.
 - b) Prevent accidental spilling of paint materials. Remove spilled material immediately and the waste of other equipment used to clean up spill. Wash surfaces to their original undamaged condition, at no additional cost to Employer.
2. Prior to final inspection:

Upon completion of this portion of the Work inspect surfaces and remove paint and traces of paint from surfaces not scheduled to be painted.



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1.
GENERAL

1.1
DESCRIPTION

1. Work included:

Work of this Section includes the supply and application EPDM Sandwich System Flooring indicated on the Drawings and Schedules and these Specifications.

1.2.
QUALITY ASSURANCE

1. Qualifications of installers:

- a) For application of Synthetic Rubber Flooring, use only thoroughly trained and experienced team who are completely familiar with the requirements of this Work and the recommendations contained in the referenced Standards.
- b) In acceptance or rejection of installed materials, no allowance will be made for lack of skill on the part of workmen.

1.3.
SUBMITTALS

1. Samples:

Within 120 days after award of Contract, and before any material for this work is delivered to the Job Site, submit to the Engineer, in accordance with the provisions of these Specifications, mock-ups of the proposed Synthetic Rubber Flooring surfaces and accessories, etc.

1.4.
PRODUCT
HANDLING

1. Delivery and storage:

- a) Deliver materials of this Section to the Job Site in their original unopened containers with labels intact and legible at time of use. Where material is delivered loose, store as directed by Engineer.
- b) Store materials under cover to prevent damage and contamination. Store only the specified materials at the Job Site.
- c) The product must be stored in sealed containers at 15-25°C. No smoking in storage area. Keep away from the child.
- d) Shelf life is 12 months from the production date in appropriate conditions.

2. Protection:

Protect materials of this Section before, during, and after installation and protect installed work and materials of other trades.

3. Replacements:

In the event of damage, immediately make repairs and replacements to approval of Engineer, at no additional cost to Employer.

2.
PRODUCTS
2.1.
MATERIALS

1. One type of Polyurethane floor coating especially for outdoor sports area, running and athletics tracks.
2. The system is consisting of one primer, elastic layer, polyurethane layer and EPDM layer.
3. Sandwich System Layers:

Layers	Materials	Consumption (g/m ²)	Mixing Ratio	Properties (25°C)
First Layer	Primer	100-160		1100 cP 1,03 kg/L
Elastic Layer (10mm)	SBR Granules	6500	100	1-3mm
	Polyurethane Binder		20	3000-3500 cP 1,1 kg/L
Polyurethane Layer	Outdoor Sealer	1460	18/2	35000 cP 1,68 kg/L
	Outdoor Self Levelling	24300	5/4	4320 cP 1,16 kg/L
EPDM Layer (3mm)	Colored EPDM	3200		1-3,5 mm

4. Mechanical Test Results:

<i>Properties</i>	<i>Results</i>
Shock Absorbance	%38
Thickness	13-14 mm
Vertical Deformation	1,5 mm
Friction	58
Tensile Strength	0,53 MPA
Elongation at Break	46mm

5. Materials and workmanship for Synthetic Athletic Track not explained in these Specifications shall comply with the requirements of World Athletics.

2.2.
OTHER MATERIALS

1. Materials and methods not specifically described but required for proper installation of Synthetic Athletic Track, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

3.
EXECUTION
3.1
SURFACE

1. Inspection and Preparation:

- a) Surface must be clean, dry, free from grease. Moisture should not be on the surface.

2. Discrepancies:

- a) In the event of discrepancy, immediately notify Engineer.
- b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.
WORKMANSHIP

1. Application Procedure:

-
- a) At the top of the surface which is covered, one component polyurethane primer is applied. Then, SBR granules and binder are mixed in a ratio of 100:20 and applied to the surface with finischer machine.
 - b) After that, pu sealer (18:2) are mixed and spread onto surface in order to fill empty spaces and obtain flat surface.
 - c) Outdoor self levelling material which is consisting of 5 A component and 4 B component are performed with level grain or trowel.
 - d) The final step of the process is application of colored EPDM granules via spreading method. After full curing, excess amount of the granules is swept up from the surface.
2. Application Circumstance:
- a) Polyurethane sealer and self levelling is ready to use after mixing of their two components with each other. While low temperature can lead to decrease in it. Below 10°C and above 30°C temperature, these materials should not be processed.
3. Hazard Identification:
- a) Moderate Eye Irritation: Signs/symptoms may include redness, swelling pain, tearing, and blurred or hazy vision.
 - b) Moderate Skin Irritation: Signs/symptoms may include localized redness, swelling, itching and dryness.
 - c) Allergic Skin Reaction: Signs/symptoms may include redness, swelling, blistering, and itching. Maybe absorbed through skin and cause target organ effects.
 - d) Respiratory Tract Irritations: Signs/symptoms may include cough, sneezing, nasal discharge, headache, hoarseness, and nose and throat pain. May be absorbed following inhalation and cause target organ effects.
4. Disclaimer:
- Do not pour directly into drains. Retain the product for later use, or if beyond shelf life, mix together and allow to cure then dispose the cured product in accordance with local regulations. Dispose of empty container corresponds with local regulations or where appropriate recycle.

3.3. **CLEANING UP**

1. General:

Prevent the accumulation of scraps and debris arising from the Work of this section. Maintain premises in a neat and orderly condition at all times. In the event of spilling or splashing material onto other surfaces, immediately remove the same and traces of residue to the approval of Engineer.

4.
***METHOD OF
MEASUREMENT***

All sections related to Finishes comply with this Section of measurement:

Generally

Work shall be measured flat without addition for laps or seams; finishes on corrugated or ornamental surfaces shall each be so described.

Curved, spherical and conical work shall each be so described.

PART 1

GENERAL:

1.1 SPECIALIST CONTRACTOR

The work specified in this section is to be undertaken by a Manufacturer who is a Member of the National Precast Concrete Association Australia, GRC Industry Group with experience in the GRC industry, which includes the production of architectural panels (or other products for which this specification is being used). With his tender, the contractor shall submit to the construction manager written evidence indicating his capability of producing panels of a reliable and consistent quality.

1.2 STANDARDS AND CODES

- AS 3972 Portland and blended cements. BS 12.
- BS 3892 Pulverised Fuel Ash for use in Concrete.
- BS 476 Test Methods and Criteria for the Fire
- Part 8 Resistance of Elements of Building Construction.
- GRC Industry Group of National Precast Concrete Association Australia,
- A Recommended Practice – Design, Manufacture and Installation of Glass Reinforced Concrete (GRC)
- AS 3582.1 Supplementary cementitious materials for use with portland and blended cement - Fly ash.
- AS 1130 Code of practice for use of fly ash in concrete.
- AS/NZS
- 1170.1 Structural design actions – Permanent, imposed and other actions.
- AS/NZS
- 1170.2 Structural design actions – Wind actions.
- AS 1170.4 Minimum design loads on structures (known as the SAA Loading Code) – Earthquake loads.
- AS 1379 Specification and supply of concrete. AS 3610 Formwork for concrete.
- AS 1478.1 Chemical admixtures for concrete, mortar and grout – Admixtures for concrete .
- BS 1014 Pigments for Portland Cements and Portland Cement Products
- BS EN 1169 Precast Concrete Products – General Rules for factory production control of glassfibre reinforced cement.
- BS EN 1170 Precast Concrete Products – Test Methods
- Parts 1-8 for glass-fibre reinforced cement.

2 PART 2 MATERIAL

2.1 GENERAL

Materials used for making the GRC unit shall generally comply with relevant British and Australian Standards and Codes. Any reference to a British Standard shall mean that current at the time of going to tender.

Where materials are not fully covered by this specification or alternative materials are offered, the Contractor shall forward to the Construction Manager prior to commencing the work, details of those he proposes to use together with supporting evidence indicating that the finished product will be capable of meeting the performance requirements of this specification.

2.2 ALKALI-RESISTANT GLASSFIBRE

Glassfibre shall be an alkali-resistant, continuous filament fibre developed and formulated specifically to have high strength retention in Ordinary Portland Cement environments. The glass fibre shall have a minimum ZrO₂ content of 16% by weight, in accordance with internationally-recognised standards, and shall have a minimum strength retention (determined by Strand In Cement (SIC) testing) of 300 MPa (Test Method: GRCA SO 104/0184).

The producer shall provide certification from the glassfibre manufacturer to show that the glass fibre conforms to these requirements, has a history of successful use in similar matrices, and is manufactured under an internationally-recognised Quality Management system. Suitable alkali-resistant glassfibres are “Cem-FIL”, manufactured by Saint-Gobain/Vetrotex and “NEG ARG Fibre” manufactured by Nippon Electric Glass.

2.3 CEMENT

The cement shall be Ordinary Portland Cement, supplied by a manufacturer of assessed capability to AS 3972–1997 and BS 12 or its derivatives, and should be supported by suitable certification. Cement shall be obtained from one source throughout manufacture.

Cement shall be correctly stored and kept dry to avoid deterioration.

2.4 SAND

Sands should be washed and dried to remove soluble matter, and to permit control of the water/cement ratio. Sand added to the mix shall not exceed 50% by weight of the total mix and sand/cement ratio shall not exceed 1:2. Sand shall be only high silica and conform to the following specification:

Silica content > 96% Water content < 2% Soluble salts < 1%
Grain size < 1.2 mm
< 10% passing a 150 micron sieve

Sands other than silica sands may be used subject to approval of the architect and engineer, but the producer must be able to show proof of their suitability.

2.5 ADMIXTURES

The manufacturer shall ensure that any admixtures used do not have any harmful effects on the product, and are used in accordance with the manufacturers' recommendations. The use of superplasticisers may be encouraged to keep water content of the composite to a minimum without loss of suitable working characteristics, especially the ease of attaining full compaction.

Any admixtures used, shall comply with AS 1478.

2.6 PIGMENTS

Any pigments used shall conform to BS 1014. These shall be:

- Harmless to the GRC's set and strength.
- Stable at high temperature.
- UV-resistant and alkali-resistant.

The client should recognise that some colour variation may occur, and must agree an acceptable range of variation with the producer.

2.7 WATER

Water shall be free from deleterious matter that may interfere with the colour, setting, or strength of the concrete.

2.8 MIX DESIGN

The mix shall have been determined by the manufacturer, and written confirmation of the mix design shall be submitted so the proportions shall be chosen to achieve the quality-control requirements specified herein.

2.9 MOULD-RELEASE AGENT

The mould-release agent shall be selected by the manufacturer and approved by the architect or engineer. This should be compatible with the surface finish required for the product. Any residue shall be removed from the finished product so that this does not interfere with any joint sealants or applied finishes which may be used.

The design, material and manufacture of the forms shall be consistent with the type and quality of the surface finish required from the panel, and with the tolerances specified. The forms shall be constructed such that the finished products conform to the profiles and dimensions indicated by the contract documents.

2.10 SUPPORT STEELWORK AND FIXINGS

The Manufacturer will be responsible for the design, manufacture and installation of all support framing, cleats and fixings inserted into and affixed to the GRC panels, or provided for the support of the GRC panels. Fixing zones are described on the drawings, together with primary structural concrete and steelwork provided by others for use by the contractor if required.

Fixings shall be concealed and cast into panels unless otherwise specified. They shall be of non-corrosive material and located at suitable spacings to ensure support of panels without creating undue stresses to the panels under thermal movements and/or moisture movement.

The recommendations of the Recommended Practice – Design, Manufacture and Installation of GRC – NPCAA Publication, August 1999 (herein after called NPCAA Recommended Practice) shall be incorporated in the design of fixings.

Steel materials and workmanship shall comply with the relevant codes, and all steel will be free from rust, loose scale, pitting and other defects.

Fabricated steel components shall be true to line and free from twists, bends and open joints.

All ungalvanised materials shall be thoroughly cleaned prior to fabrication, by grit blasting to Class 2 in accordance with AS 1627 Part 4 and painted with Red Oxide Zinc Chromate in two coats to a minimum dry film thickness of 80 microns.

Fixing cleats to existing steelwork, where indicated on the GRC cladding shop drawings, shall be site-welded unless otherwise arranged with the construction manager.

Any damage to protective coatings on steelwork, supplied as part of this contract works, shall be repaired.

3 WORKMANSHIP

3.1 WEIGHING AND BATCHING

Dry ingredients shall be batched by weight using calibrated weighing equipment capable of an accuracy of $\pm 2\%$ of the stated batch weight. Liquids should be weighed, volume-batched or automatically dispensed.

The producer must demonstrate that the method employed will give an accuracy of $\pm 2\%$.

3.2 MIXING

The cement slurry should be mixed in a high-speed shear mixer, or other high-speed mixer which can achieve a good and even dispersion of all slurry ingredients.

3.3 APPLICATION

Application shall be by spraying, using purpose-built equipment which allows the simultaneous deposition and uniform mixing of the glassfibre and cement matrix.

The glassfibre and cement slurry shall be metered to the spray head at rates to achieve the desired mix proportion and glass content. These shall be checked for each spray pump at least once per day and prior to commencing spray production after each stoppage. The test shall be conducted in accordance with the method described in BS EN 1170-3. Distribution of fibre in the mix shall be controlled by the operator in such a way as to be as uniform as possible.

Cleanliness of equipment and working areas shall be maintained at all times.

3.4 SHAPE AND FINISH

The panels are to be formed of GRC in moulds to achieve the profiles indicated by the architectural drawings.

The manufacturer shall provide a means for producing a replacement panel at any time during the building contract. Moulds shall be adequately cured to eliminate shrinkage and distortion and shall be properly braced.

The exposed face of the GRC panels surfaces shall be free of blowholes, cracks, undulation or similar imperfections.

3.5 MANUFACTURE

The panels shall be manufactured by a spray technique as detailed in the NPCAA Recommended Practice or as otherwise agreed between the manufacturer and architect/engineer to an approved method.

Spray applicators shall be experienced personnel whose proficiency meets industry standards.

If an architectural face mix is being used, this will first be sprayed into the mould. The thickness shall generally be the minimum possible to achieve the desired finish, which will normally make it at least 20% thicker than the largest sand or aggregate being used and normally 4 mm minimum and 12 mm maximum thickness. An acrylic polymer should be used in the face mix to reduce any risk of this unreinforced layer cracking.

If no face mix is being used, a mist coat consisting of the basic mortar composition without fibre may, if necessary, be sprayed onto the moulds to prevent fibres from being visible on the finished surface of the product. The mist coat is intended to be just thick enough to cover mould details and surfaces so that fibres are not visible on the surface, but not so thick that crazing of this unreinforced layer may occur.

The normal target thickness of a mist coat for non-polymer GRC is 1 mm, though the use of acrylic polymer in the mix may allow the thickness to be increased up to a maximum of 3 mm. However, it should be noted that for design purposes the thickness of the mist coat should not be considered as contributing to the strength of the GRC panel.

Spray-up of GRC backing material shall proceed before any mist coat or face mix has set.

The method of spraying the main body of material shall achieve the greatest possible uniformity of thickness and fibre distribution.

Consolidation shall be by rolling and such other techniques as are necessary to achieve complete encapsulation of fibres and full compaction.

Control of thickness shall be achieved by using a pin-gauge or other acceptable method. Minimum thickness of panels is recommended as 8 mm (hand-spray) and 6 mm (auto-spray).

All hand-forming of intricate details, incorporation of formers of infill materials and over-spraying shall be carried out before the material has achieved its initial set so as to ensure complete bonding.

Inserts shall be properly embedded into thickened, homogeneous areas of GRC. Waste material such as over-spray is not acceptable to encapsulate inserts or for bonding pads.

Any rigid embedded items bonded to the GRC shall not create undesirable restraint to volume changes.

3.6 SHOP DRAWINGS

Prior to commencing manufacturing work, the manufacturer shall submit for approval detailed shop drawings showing the following information:

layout (sectional plan and elevation) of complete wall panelling;

full-size section of typical panel and support members;

method of assembly and supports and fixings to the existing structure and provision to withstand imposed stresses;

method of installation, caulking, flashing and provision for vertical and horizontal expansion;

junction and trim to adjoining surfaces; and

fittings and accessories,

The submission of shop drawings shall be supported by engineering design computations to show that

cladding and supports comply with the design criteria specified.

3.7 TOLERANCES

The GRC elements shall be manufactured and installed to the tolerances stated in the NPCAA Recommended Practice (Section 10).

3.8 DEMOULDING AND CURING

Once the initial set has taken place, GRC elements should be covered with polythene for their protection and to prevent them from drying out fully. They must not be moved again until they are ready for demoulding.

The GRC elements must not be demoulded until they have gained sufficient strength to be removed from the mould and transported within the factory, without being over- stressed.

If the GRC elements are too large to be demoulded by hand, special demoulding sockets or loops should be embedded in the panel during manufacture, and demoulding should be assisted with a lifting frame. This procedure should be agreed with the engineer.

During demoulding, the panels shall be uniformly supported in a manner which avoids undue stresses in the panels.

If polymers are used in the mix to avoid wet curing, the panels should be stored under cover for a minimum of 7 days at a temperature of between 5°C and 35°C.

If polymers are not used in the mix, curing shall be continued after demoulding under conditions which shall provide free water on the surfaces of the panels at a temperature not exceeding 50°C for a period of not less than 7 days (including the initial cure in the mould).

3.9 IDENTIFICATION OF ELEMENTS

All panels shall be identified individually to indicate the panel type and date of manufacture.

At the time of preparation of shop drawings the manufacturer shall indicate his required order of delivery.

3.10 HANDLING, TRANSPORTATION AND INSTALLATION

The products shall be handled, transported and installed using methods which ensure that no damage or marking of architectural surfaces occurs and so that the panels are not subject to undue stress.

The safety and protection of GRC units shall be ensured throughout the whole of the contract works.

Site access and, if necessary, storage space shall be provided by the main contractor.

The main contractor shall also provide true, level and clean support surfaces and shall provide for the accurate placement and alignment of connection hardware on the structure.

3.11 TEST REQUIREMENTS

The specified glassfibre content shall be 5% by total wet weight of materials.

The GRC from which the panels are made shall have the following properties on completion of curing:

Characteristic Modulus of Rupture (MOR) 18 MPa at 28 days.

Characteristic Limit of Proportionality (LOP) 7 MPa at 28 days.

The value of MOR and LOP design stresses to be used should be determined by the design engineer for specific service requirements.

The minimum dry density shall exceed 1800 kg/m³.

3.12 TESTS

The following tests shall be carried out on coupons cut from the test boards in accordance with BS EN 1170 Parts 2, 4, and 5. If acrylic polymer is used in the mix, presoaking immediately prior to testing shall not be required for Modulus of Rupture or Limit of Proportionality.

Glass Content – BS EN 1170 Part 2

Modulus of Rupture – BS EN 1170 Part 5 (and simplified method in Part 4)

Limit of Proportionality. – BS EN 1170 Part 5

Test boards shall be produced alongside each day's production (at least one per day for each production team). The recommended size of these sample boards is 600 x 600 mm. The test boards shall be produced with the same quality, thickness and curing as the actual panels.

Those test boards which are not required for testing should be kept for the duration of the contract, or for a period to be agreed between the manufacturer and engineer.

3.13 FREQUENCY OF TESTING

The frequency of testing shall be agreed between the architect, engineer and manufacturer.

The recommendation of BS EN 1169 is as follows:

Glass content – tested in accordance with BS EN 1170 Part 2. Once per week for each spray team. (This is in addition to the calibration test referred to in section 3.3).

Modulus of Rupture and Limit of Proportionality – tested in accordance with BS EN 1170 Part 5. Should be tested by the manufacturer or by a qualified laboratory as the mix design is being set-up and thereafter at least twice per year, or when the mix design is changed.

A simplified bending strength test to determine the Modulus of Rupture (MOR) should be conducted by the manufacturer more frequently. The frequency of testing recommended by BS EN 1169 is for each 10 tonnes of GRC produced, or at least once per week.

Water Absorption and Dry Density – tested in accordance with BS EN 1170 Part 6. As the mix design is being set-up, and then for each 10 tonnes of GRC produced, or at least once per week.

3.14 COMPLIANCE

Compliance with glass content and the characteristic strength for both LOP and MOR shall be assumed if the following conditions are met:

Glass Content

The glass content shall not vary from the specific amount by more than $\pm 20\%$.

Modulus of Rupture and Limit of Proportionality The characteristic MOR and LOP is defined as the value which 95 per cent of all the mean strengths of the individual test-boards shall exceed.

Compliance with the characteristic MOR and LOP requirements shall be assumed if no single test-board mean shall be less than 85 per cent of the characteristic MOR and LOP, and the average of 4 consecutive test board results shall exceed 21 MPa (MOR), and 8 MPa (LOP).

If any single test-board fails to meet any of the compliance requirements, the GRC at risk shall be that produced between the previous complying test board and the next complying test board.

Where failure to comply arises from consideration of consecutive groups of four test-boards, the GRC at risk shall be that represented by the first and fourth test-boards, together with all intervening material.

Note: If different values for MOR and LOP are required for specific service requirements, these should be determined by the design engineer for the specific service requirements. The selection of unnecessarily high strength requirements may result in cost penalties

Dry Density

The dry density of the GRC shall exceed 1800 kg/m³.

Non-Compliance

In the event of non-compliance, the action to be taken should be agreed between the manufacturer and the client. Due regard should be paid to the technical consequences of the non-compliance and the economic consequences of adopting remedial measures or replacing the rejected products. Account should also be taken of the safety factors incorporated in the design and also the thickness of the GRC produced, compared with the design thickness.

Re-testing may be considered appropriate if it is considered that the storage conditions of the product may result in improved properties because of extended curing, or if the sampling, testing or calculation may have been at fault.

The material at risk may be reduced by the testing of additional test boards from the same, previous, or next manufacturing periods. Testing may also be performed on GRC samples cut from the actual GRC elements at risk.

3.15 WEATHERPROOFING

Responsibility for the weatherproofing of the whole installation of GRC panels rests with the GRC manufacturer.

The joint details shown on the drawings represent the appearance required and their minimum standard of weatherproofing acceptable.

Joints shall be weather-sealed with closed-cell polyethylene compressible backing rods and caulked with 2-part polysulphide sealant or other approved sealant in selected colours, installed completely in accordance with the sealant manufacturer's recommendations with regard to joint dimension, priming, substrates, mixing, curing, masking, cleaning and the like.

The GRC manufacturer shall submit details of the proposed sealant and the application recommendations

for approval by the construction manager prior to commencement of the contract works.
Joints located and indicated on the drawings are those required for sealing the GRC cladding against adjacent materials and those required for architectural purposes for division of the panels into the design modules. Should the GRC manufacturer or contractor propose to subdivide the cladding into smaller panels for ease of casting, handling and erection, additional joints may be introduced in the design, provided the location proposed is discreet. The GRC manufacturer shall submit proposed locations and designs of additional panel joints with their tender submission.

4 OTHER ISSUES

4.1 RESPONSIBILITY

The GRC manufacture shall be solely responsible for the design and performance of the GRC panels and their supports. Information provided on the drawings or this specification shall not affect this responsibility.

4.2 GUARANTEES

The Manufacturer shall warrant the GRC panels installed, or to be installed, against any and every defect or failure which may occur during the period of practical completion for the works arising out of any fault of the GRC cladding system, workmanship, fabrication, fixing or quality of materials used.

4.3 DESIGN CRITERIA

Glassfibre-reinforced wall cladding shall comply with the following:

FINISH:

Class 1 to the formwork code, smooth face suitable for high paint finish.

DESIGN LOADS:

Cladding and framing shall be designed in accordance with AS1170.

DEFLECTIONS OF MAIN FRAME STEEL MEMBERS:

The attention of the contractor is drawn to the allowance made for differential deflections between the structure at level 2 and the ground. The anticipated allowance is 30 mm. The detailing of the GRC cladding should take this into account.

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PART 1

GENERAL:

11 DESCRIPTION:

Reinforcement: Typically, fiberglass strands or mats, carbon fibers, or aramid fibers.

Resin Matrix: Commonly epoxy or polyester resin, providing bonding and weather resistance.

Additives: May include UV inhibitors, fire retardants, and pigments for color.

12 DIMENSION:

Length: Standard lengths range from 6 feet (1.8 meters) to 12 feet (3.7 meters), with custom lengths available.

Width: Standard widths commonly available in 26 inches (66 centimeters) and 36 inches (91 centimeters).

Thickness: Varies based on load requirements and application. Common thicknesses range from 0.1 inch (2.5 millimeters) to 0.5 inch (12.7 millimeters).

13 PROFILE:

Corrugation: Standard corrugated profiles provide strength and rigidity while allowing flexibility in design and installation.

Rib Height: Typically ranges from 0.25 inches (6 millimeters) to 1 inch (25 millimeters), depending on the desired strength and aesthetics.

14 LOAD BEARING CAPACITY:

Load tables and engineering data should be available from the manufacturer to specify the appropriate sheet thickness and support spacing for the intended application

15 EXECUTION:

Fastening: Specify appropriate fasteners (e.g., screws or nails) and spacing for securing the sheets to the supporting structure.

Overlaps and Sealing: Guidelines for overlapping sheets and sealing joints to ensure weather-tightness and structural integrity.

16 ENVIRONMENTAL CONSIDERATION:

Ensure compliance with environmental regulations and standards regarding material composition, manufacturing processes, and disposal/recycling at the end of the product's life cycle.

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PART 1
GENERAL:

1.1 DESCRIPTION:

1. Work included

Work in this Section includes providing and installing the following:

- i. Concrete paving, Brick Paving, Sandstone paving, and pool edging including skirtings related items and bedding, where shown on Drawings.
- ii. Masonry accessories necessary to complete the Work of this Section.
- iii. Base courses.
- iv. Cutting and patching of Work of this Section as required by the work of other trades.
- v. Cleaning and pointing of Work of this Section exposed to view.
- vi. Related work
 - a) For adjacent in-situ and precast concrete items refer to Concrete Section.
 - b) For adjacent tile work refer to Section 9300 (Tile Work).
 - c) Surface drain rock marked as 'Pebbles' on Drawings is described in Section Landscaping.
 - d) For concrete sub-bases and their base courses required under paving refer to Concrete section, Excavation and Earthwork Section.

1.2 QUALITY ASSURANCE:

1. Qualification of workmen:

- a) For cutting and placing of unit materials, use only skilled masons who are thoroughly experienced with the materials and methods specified and thoroughly familiar with the design requirements.
- b) In acceptance or rejection of installed paving units, no allowance will be made for lack of skill on the part of workmen.
- c) Provide one skilled mason who shall be present at all times during execution of the Work of this Section and who shall personally direct the execution of this portion of the work.

1.2 SUBMITTALS:

1. Samples:

- a) Within 120 days after award of Contract, and before any materials are delivered to the Job Site, submit samples of the proposed units to the Engineer for his approval in accordance with these Specifications.
- b) Samples shall indicate the total colour range, and be supplied in 4 ft. x 4 ft. (1.2m x 1.2m) squares or as required by Engineer.
- c) Samples of other materials to be used and samples for testing shall be submitted as requested by the Engineer.
- d) Submit samples of Grasscrete units and concrete Brick pavers

1.3 PRODUCT HANDLING:

1. Materials shall be delivered, stored, and handled to protect them from wetting, staining, chipping and any other damage. Store cement, and similar perishable materials in water-tight sheds with raised floors. Store paving units off the ground and under water-tight covers.

PART 2 **PRODUCTS:**

2.1 ACCEPTABLE MANUFACTURERS:

1. Subject to compliance with requirements, provide products of one of the following:
 - a) Envicrete
 - b) Magnacrete.
 - c) Banu Mukhtar
 - d) First Floor or approved by Architect

2.2 CONCRETE PAVERS:

1. Units to be 100% solid:
 - a) Sizes should be 8" x 4" x 3" (200 x 100 x 75 mm), Weight 3.8 kg approximate or 8" x 4" x 2.5" (200 x 100 x 62 mm), Weight 2.9 kg approximate or any other size.
 - b) Average compressive strength should be 4000 psi or 28 N/mm²
 - c) Material should be a mixture of sand, cement and aggregates, in necessary approved colours and additives of texture, tint and durability.
 - d) It should be resistant to attack by oils, grease and other petroleum based fuels and free from all types of salts.
 - e) The surface texture will be abrasive, and have a non slip finish to the approval of the Engineer.

2.3 PRECAST GLASSCRETE UNIT:

1. Grasscrete units are manufactured from Portland Cement complying with B.S. 12 with a minimum cement content of 320 kg/m³. Coarse and fine aggregate employed conform to the requirements of B.S. 882. Steel mesh reinforcement to B.S. 4483.

- a) Manufacture: machine made using high frequency vibration and low water/cement ratio permitting rapid demoulding.
- b) Grasscrete pavers shall be 2'-0" x 1'-4" x 4" (600 mm x 400 mm x 100 mm) deep with five longitudinal and two transverse ribs, each block completely enclosing four grass cells. The area available for grass at the upper surface shall not be less than 56%, and the area of concrete available to transmit load to the underlying layers shall not be less than 90% of the total block area.
- c) Grasscrete pavers shall be placed closely together on a 10-20 mm. layer of sharp sand for leveling, spread on the compacted sub-base composed of 6 ins (150 mm) of quarry waste or similar approved unwashed material of 3 ins (75 mm) down size containing fine soil or loam.
- d) Clean friable soil or soil with a peat mixture should be levelled off 1 1/4" (32 mm) below the top surface, sown with grass seed and covered with a thin layer of fine soil and levelled with a hard broom. The level shall be about 3/4" (19 mm) below top surface. Seed shall be sown while soil is still loose after filling.

2.4 SAND STONE:

1. Stone paving, shall be cut stone, mill finished to specific sizes, squared to dimensions each way. Slightly textured finish.
2. Pool edges to be as per details shown on the drawings. Curves and corners to be mitred. Inside and outside edges at corners and changes in direction to curved to eliminate acute angles.
3. Sizes:
 - i) Lengths and widths of Stone pavers, and special shapes shall be as shown on Drawings.

2.5 MORTAR & CONCRETE MATERIAL:

1. Ordinary Portland cement to B.S. 12. Use non stating type for stonework.
2. Sand to be clean, sharp, angular, free from alkali, silt or organic matter. Comply with BS 1198-1200.
3. Course Aggregate refer to Section 3300 Cast-in-Place Concrete.
 - a) Colour pigment for pavers shall be as described under Section 4200 Unit Masonry.
 - b) Colour pigment for stone paving and precast concrete flag shall be added at Engineers discretion or as described under Section on Unit Masonry.

2.6 GRANULAR BASE:

1. Aggregate to be 1/2 in. (12 mm) to 2 ins (50 mm) size crushed stone rock or broken stone, evenly mixed, approved by Engineer.

2.7 CAULKING:

1. Refer to Section 7900 Joint Sealants for caulking materials.

2.8 OTHER MATERIAL:

1. Materials and methods not specifically described but required for proper fabrication and installation of items in this Section, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

PART 3
EXECUTION:

3.1 SURFACE CONDITIONS:

1. Inspection:
 - a) Prior to Work of this Section, carefully inspect the installed work of other trades and verify that such work is complete to the point where this installation may properly commence.

3.2 EXCAVATION:

1. The natural subgrade shall be prepared in accordance with the cross-section shown on the plans. Soft and yielding spots or other unsuitable material shall be removed and replaced with suitable type. The subgrade shall be compacted and finished to a firm, smooth surface. Refer to Section 2300 Earthworks, for pertinent data.

3.3 BASE COURSE:

1. Apply a base course to areas receiving paving and flags on grade.
2. For paving on concrete sub-base this article does not apply. Concrete sub-base is described under Section 2510 Concrete Walks, Roadways, Curbs and Gutters.
3. When laying base course the alignment shall be controlled by an approved method, from Engineer.
4. Install 6 ins (150 mm) minimum thickness of crushed rock aggregate to B.S. 63 and roll the surface to a smooth and uniform texture, free from lumps, rock pockets, soft spots and spongy areas. Compact with a smooth wheel roller having a weight of 120 lbs per in. width to density specified in Section 2300 Earthworks.
5. Place 1-1/2 ins (38 mm) blinding concrete over crushed rock base under paving adjacent to roadways. Bring to an even surface. Mix to be 1:4:8 or as specified in the Structural Specification.

3.4 MIXES:

1. Mixes general:

- a) Use the same manufactured brands and sources for mortar material to ensure uniformity of mix.
- b) Mix mortar ingredients thoroughly in quantities needed for immediate use. Mixing shall be done by machine.
- c) Mix mortar in mechanical mixer until materials are homogeneously blended but not less than three (3) minutes after materials are in the mixer.
- d) Add colour pigment where exposed mortar joints occur, as required by Engineer.
- e) Refer to pertinent parts of this Section for mix types.

3.5 CEMENT TILES PAVERS:

- 1. This part is pertinent to laying different sizes of cement tile pavers in patterns as shown on Drawings.
- 2. Mortar to be a semi-dry mix for pavers laid on horizontal surfaces. Mix to consist of one part Portland cement to 3 parts sand aggregate with colour pigment added to match face tile work joints.
- 3. Units shall be laid out so that at end conditions no unit have to be cut to a dimension less than 3 ins. (75 mm). Mortar joints shall be according to the detail shown on the drawings.
- 4. Spread and place mortar mix to at least 1-1/2 ins (38 mm) thickness. Use hand rake, making sure mix does not become compressed. Place units in bonding pattern, as indicated on Drawings, working from hard edge. Pavers laid on edge shall be set 1/2 in. (12 mm) above finish grade and those laid flat 1/4 in. (6 mm) above finish grade. Sweep joints full of mortar mix. Tamp units by an approved method, to attain finish grade. Readjust units which may have been disrupted during tamping. Spray entire approved surface area with fine spray of water to ensure saturation of the joints and bedding material. Grout and point joints similar to face tile work, or as directed by Engineer. Finished surfaces shall be aligned to designated finish grade. Check units for evidence of rocking or movement; correct as required.

3.6 STONE PAVING:

- 1. This part is pertinent to laying different types of Stone paving including strips and steps in patterns, where applicable as shown on Drawings.
- 2. Mortar mix to be 1:3 as described for cement tile pavers or as specified in the structural specifications.
- 3. Units shall be laid out so that at end conditions no unit shall be smaller than half size. Mortar joint as shown on the Drawings.
- 4. Spread and place mortar mix to at least 1 in. thickness. Use a hand rake, making sure mix does not become compressed. Place units in bonding pattern, as indicated on Drawings, working to a hard edge and set 1/4 in. (6 mm) above finish grade. Sweep joints full of mortar mix. Tamp units by an approved method to attain finish grade. Readjust units which may have been disrupted during tamping. Spray entire approved surface area with fine spray of water to ensure saturation of the joints and bedding material. Grout and point joints to 1/8 in. (3 mm) below finish grade of flags or as directed by Engineers. Finished

surfaces shall be aligned with designated finish grade. Check flags with adjacent units to ensure there is no evidence of rocking or movement; correct as required.

- a) Step units to be cut to largest possible sizes, thus creating the least, if any intermediate joints.
- b) Bed step units on 1 in. (25 mm) mortar mix, set to 1/8 in. per ft. (3mm per 300 mm) slope from back to front edge. Grout and point joints with mortar.

3.7 CONCRETE PAVING:

1. Preparation of sub-grade

The sub-grade should be drained and protected against rain, ground water, with all drainage trenches backfilled in such a way as to be not inferior to undisturbed ground

Any unsuitable material should be removed from the sub-grade and treated or replaced with properly compacted, suitable material.

All sub-grade preparation should be completed before work starts on the sub-base.

2 Preparation of sub-base

Conventional, flexible sub-base, concrete slabs or existing roads are all suitable sub-base for concrete paving.

Where a new sub-base is to be constructed, the materials used should be one of the following:

Granular material Type 1*
Soil Cement
Cement bound granular material
Lean concrete
Wet mix macadam
Wet lean concrete

These materials should be laid in accordance with the requirements of the same Specification except for wet lean concrete, where the appropriate requirements should be followed.

Where and existing sub-base or road materials are to be employed it is important to inspect them to ensure that they are adequately drained and compacted. Any defective materials should be removed and replaced.

The top surface of the sub-base should be finished to tolerance of + 3/4" (19 mm.). It should be close-knit to prevent the loss of laying course material, and free of debris or mud.

3. Edge Restraint

Edge restraints should be provided along the perimeter of all paved areas and should be adequate to support traffic loads and to prevent the escape of laying course sand from beneath the paved surface.

The edge restraint may be in form of a kerb, combined kerb and channel, established structure or other rigid abutment, e.g. pavers fixed vertically and bedded and hunched with concrete.

4. Preparation of laying course

The laying course consists of a layer of coarse/medium sharp sand or crushed rocks fines to BS 882 which may be washed or unwashed.

It should contain no more than 3% by weight of clay or slit, and used at as constant a moisture content as possible.

The laying course should be screeded to level so that its mean thickness after compaction is 2 ins (50 mm), this allows for tolerances in the sub base, although, where laid upon existing sub-bases or where close control of the surface level of the sub-base has been maintained, this compacted thickness may be reduced to 30 - 40mm.

The laying course material may be spread in one layer and screeded to the appropriate level, making due allowance for the reduction in thickness achieved during compaction.

This will normally be in the order of 1/2 in-3/4 in (12-19mm) when compacted to 2 ins (50 mm) and 9-14 mm when compacted to 30 mm.

Alternatively, the sand may be spread in two layers, the two-thirds being pre-compacted, and the blocks placed on the upper un-compacted one-third in each case, only sufficient sand for one day's work should be prepared.

5. Bond patterns

may be laid in a variety of patterns including stretcher bond, basket weaver and herringbone.

6. Laying the Pavers

Concrete Pavers will be laid by hand with joint widths of approximately 2-5mm, in the specified pattern.

Laying should commence from an existing laying face or edge restraint wherever possible. Full pavers should be laid first through the day's work area, with closure pavers and paver cutting around obstructions following afterwards. The area should be laid as far as possible on whole pavers. and pieces smaller than 1/2 of a paver should be avoided. The paviour should work from pavers already placed taking care not to disturb them.

The easiest way to cut blocks is with a hydraulic or mechanical block splitter.

Careful attention should be paid to site organization to ensure the appropriate positioning of materials, the supply of adequate quantities of pavers to the paviour, and the right balance of activity between laying course preparation, block laying, trimming, compaction and top sanding.

7. Compacting

When cutting is complete, the surface course should be compacted by 2 or 3 passes of an appropriate plate vibrator over the entire area, taking care not to vibrate within 1m to any unrestrained edge. This initial compaction will force the pavers into the laying course causing sand to penetrate the block joints from the laying course below.

After this compaction, sand should be spread over the surface and brushed into the joints before a final pass is made with the plate vibrator. The use of clean, dry sand will assist in the process. This filling and final compaction aids the development of impermeability of the surface and should be carried out as the work progresses.

8. Brushing

When this process has been completed, the paved area may be trafficked, and indeed deliveries of subsequent pavers may be made over the area.

3.8 CURING:

1. Paved surfaces shall be kept moist with sprayed water for a minimum of 7 days, immediately following installation.

3.9 CAULKING:

1. Install caulking material, in accordance with Section 7900 Joint Sealants, at joints between edge of building and adjacent hard surfaces installed under this Section, and other locations shown on Drawings.

3.10 PROTECTION:

Cover top of completed and partially completed work not enclosed or sheltered, with waterproof coverings at end of working day. Drape cover over sides. Anchor securely in position.

3.11 TOLERANCES:

Courts and walkway surfaces shall be laid so as to provide levels and grades with rises and falls, as shown on Drawings with optical instruments. Surfaces shall be uniform and free from bulges and depressions more than 1/4 in. in 10 ft. run (6mm in 3 meters).

3.12 CLEANING:

1. Upon completion of the work of this Section immediately remove debris, excess materials and smears that may remain.
2. Point or replace defective mortar to match existing, as required by Engineer.
3. Scrub surfaces to be cleaned using a cleaning solution which will not harm finished material. Check with manufacturer for acceptable solution. Clean a trial test area and obtain approval to proceed.
4. Use an abundant amount of water do cleaning in accordance with Engineer's instructions.
5. Repeat cleaning operations as often as necessary, until work is to meet Engineer's approval.

PART 4

METHOD OF PAYMENT:

- 1 Payment made as per describe in BOQ item.

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PART 1.
GENERAL

1.1
DESCRIPTION

1. Work included.
 - a) This work of providing and installing concrete walkways, roadways, curbs, curb / gutters, walls copings, concrete posts, drainage trenches and covers, water courses, base courses and foundations to same, as shown on Drawings.
 - b) Curbs / gutters, curbs, copings, concrete posts and drainage trench units to be precast items.
 - c) Concrete slabs forming bases for paving Work.
 - d) Non metallic surface drainage pipes required to complete exterior landscaping.
2. Work not included:

Provision and setting of cast iron surface drainage pipes required under parts of the building or connecting surface water drainage trenches. Refer to Plumbing Contract.
3. Related Work:
 - a) For adjacent paving refer to Section 2780 Unit Paving.
 - b) For adjacent blockwork walling refer to Section 4200 Unit Masonry.
 - c) For adjacent precast concrete steps refer to Section 2780 Unit Paving.
 - d) Surface drainrock is described in Section 2900 Landscaping.
 - e) Miscellaneous metal required for supporting or joining units described in this Section are described under Section 5500 Metal Fabrications.
 - f) For details of excavation, filling and grading not described here refer to Section 2300 Earthworks.

1.2.
QUALITY ASSURANCE

1. Qualification of workmen :
 - a) Provide at least one person who shall be thoroughly trained and experienced in the skills required, be completely familiar with the design

and application of the Work described for this Section, be present during progress of the Work and direct work performed under this Section.

- b) For actual finishing of concrete surfaces and operation of the required equipment, use only personnel thoroughly trained and experienced in the skills required.
- 1. Make all relevant submittals affecting the work of this Section as described in pertinent Sections of Division 3 of Concrete.
- 2. Submit 4 ft x 4 ft (1.2m x 1.2m) panel samples of pigmented concrete showing finishes described in this Section, within 120 days after the award of Contract, to Engineer for his approval.

1.3.

**PRODUCT
HANDLING**

- 1. Refer to pertinent Sections of Division 3 Concrete.

PART 2.

MATERIALS

2.1.

CONCRETE FORMWORK

- 1. Refer to Division 3 Concrete Formwork.

2.2.

STEEL REINFORCEMENT

- 1. Refer to Division 3 Concrete Reinforcement.

2.3.

IN SITU CONCRETE

- 1. Material for concrete shall be the same in all respects as that used for foundations, beams and slabs. Use ordinary Portland cement. Mix design for external concrete shall be as described in Section 3300 Cast-in-Place Concrete, unless otherwise noted in this Section. No colour tinting is required unless specifically mentioned in the drawings.

2.4.

DAMP-PROOFING

- 1. Refer to section 7100 Damp-proofing and Waterproofing for horizontal damp-proof courses under copings and wherever shown on Drawings

2.5.

BASE MATERIALS

1. Aggregate for bases under walks to be 1 / 2 in. to 2 ins (12mm to 50mm) size crushed stone, rock or broken brick approved by Engineer.
2. Granular material behind low retaining walls shall be crushed rock or stone and sand, free of dirt or extraneous matter, graded in even proportions and sized as follows :
 - i) Type 1 6 ins to 4 ins (150mm to 100mm)
 - ii) Type 2 1 -1 / 2 ins to 1 / 4 in. (37mm to 6mm)
 - iii) Type 3 sand, graded 1 / 4 in/ down (6mm down)
3. Hardcore for concrete road base shall be hard, durable crushed stone or crushed rock of 3 ins to 4 ins (75mm - 100mm) size, free of thin elongated or laminated pieces, soft, disintegrated or decomposed stones. it shall be clean and free of dirt, organic and other deleterious matter.

2.6.

DRAIN PIPES

1. This item includes short lengths of non-metallic pipe for rubble drains carrying percolated water from behind the walls or transferring surface water through walls above grade.
2. Concrete pipes shall be cylindrical with plain butt ends to diameters and lengths shown on Drawings. Comply with pertinent requirements of B.S. 556.
3. Vitrified clayware pipes, similar to those used for soil drains, shall be to diameters and lengths shown on Drawings. Comply with pertinent requirements of B.S. 65.
4. Mesh used at ends of rubble drains shall be expanded metal lath of flat diamond mesh type weighing a minimum of 0.37 lbs per sq. ft. and galvanized to B.S. 729.

2.7.

MORTAR MATERIALS

1.
 - a) Ordinary Portland cement as described in Section 3300 for Cast-in-Place Concrete.
 - b) Sand to be clean, sharp angular, free from alkali, slit or organic matter. Comply with BS 1198 – 1200.

2.8.

DOWELS AND ANCHORS

1. Refer to Section 5500 for Metal Fabrications.

2.9.

CONCRETE UNITS

1. Precast concrete curbs and curb / gutters to comply with B.S. 340. Curbs to corners, turning spaces etc to be curved to radii shown on Drawings. Fabricate copings, posts and drainage trenches, etc. in accordance with pertinent data of Section 3400 Precast Concrete.
2. Copings shall be cast in 18 in (450 mm) min. lengths.

2.10.

CONCRETE WALL FINISH

1. For finishing of exposed concrete walls and foundations below masonry and above grade, refer to relevant section of Division 9 Section 9200 Internal and External Plasterwork.

2.11.

CAULKING

1. Refer to Section 7900 Joint Sealers.

2.12.

OTHER MATERIALS

1. Other materials and methods not specifically described, but required for proper fabrication and installation of items in this Section, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

PART 3.

EXECUTION

N

3.1.

SURFACE CONDITIONS

1. Inspection :
 - a) Prior to work of this Section, carefully inspect the installed work of other trades and verify that all such work is complete to the point where this installation may properly commence.
 - b) Verify that materials may be installed in strict accordance with the original design, pertinent codes and regulations, and pertinent portions of the referenced Standards.
2. Discrepancies :
 - a) In the event of discrepancy, immediately notify the Engineer.

- b) Do not proceed with installation in areas of discrepancy until they have been fully resolved.

3.2.
EXCAVATION
N

1. This article is pertinent to all items of this Section unless otherwise described.
2. The natural subgrade shall be prepared in accordance with the cross section shown on plans. Soft and yielding spots or other unsuitable materials shall be removed and replaced with suitable type. The subgrade shall be compacted and finished to a firm smooth surface. Refer to Section 2300 Excavation and Earthwork for pertinent data.
3. At road excavation remove a minimum of 1 ft of top soil from existing grade before earth filling and compacting is carried out.

3.3.
PLACEMENT OF BASE COURSE

1. Concrete walks and concrete sub-bases :
 - a) This part is pertinent to bases under concrete walks and concrete sub- bases under unit paving.
 - b) When laying base course the alignment shall be controlled by an approved method, from Engineer.
 - c) Install 6 ins (150 mm) minimum thickness of crushed rock aggregate to BS 6f3 and roll the surface to a smooth and uniform texture, free from lumps rock pockets, soft spots and spongy areas. Compact with smooth wheel roller having a weight of 120 lbs per in. width to density specified in Section 2300 Earthworks.
 - d) Place 3 ins (75mm) blinding concrete over base, under walks adjacent to roadways and bring to an even surface. Mix to be 1:4:8.
2. Curbs, gutters and roadway :
 - a) Apply a layer of 3 ins to 4 ins (75mm to 100 mm) hardcore evenly over sub-grade. Compact and blind with two passes of a smooth wheel roller of 6 - 8 tonnes (13220 - 18210 lbs). Repeat process until a fully compacted, dense close-knit surface is obtained. Finer material being added as required. Total thickness of base to be 6 ins. (150 mm). Density for compaction shall be as specified in Section 2300 Earthworks.

- b) Place 3 ins. (75mm) blinding concrete over base and bring to an even surface. Compressive strength of concrete shall be 2000 p.s.i. minimum.
- c) Precast concrete curbs shall be set on a 6 ins (150 mm) of bed of 1:6 by volume all-in concrete mix, haunched up at back.

3.4.

FORMS

1. Forms to be wood, straight and free from warp, and of sufficient strength to resist springing during the process of depositing the concrete against them. Use 1 in (25mm) minimum surface wooden planks. Thickness less than 1 in (25mm) may be used for short radii. Ensure that divider plates or other devices holding forms in place do not cause planes of weakness and cracking of concrete. Form depth to be equal to depth to be equal to depth of curbing, gutter, wall or paved walkway and securely fastened at the top.
2. Forms to be securely staked, braced, held firmly to the required line and grade, and be sufficiently tight to prevent leakage of mortar.
3. Forms to be cleaned and oiled before the concrete is placed against them.

3.5.

RUBBLE DRAINS

1. Position rubble drains as shown on drawings or as required by Engineer for proper drainage of water from behind the walls.
2. Adequately support pipe drains with concrete benching and secure to forms before casting concrete walls.
3. Ensure that pipes passing through blockwork are located correctly
4. Wrap expanded metal across end of pipe and wire tie before placement of graded aggregate to prevent backfill from entering pipe.
5. Carefully pack granular backfill material over and around pipes after insitu concrete work is complete, for protection.

3.6.

PLACING CONCRETE

1. GENERAL :
 - a) Refer to pertinent data of Section for Cast-in-Place Concrete for construction joints, where and if required.
 - b) For flat areas, complete panels between expansion joints with same or successive pours. Do not commence pouring panels which cannot be completed the same working day.

2. Insitu walls and curbs :

Placement of insitu work to conform to pertinent data of Section 3.3 Cast-in-Place Concrete. Install steel dowels to key walls to footings as shown on Drawing.

3. Walkways, roadways and concrete sub-bases :

- a) Base courses and forms to be checked and approved by Engineer before concrete is placed.
- b) Set reinforcement, where required, as per Drawings and in accordance with Section 3300 Concrete Reinforcement.
- c) Concrete to be placed on moist base and deposited to 8 ins. depth or as indicated on Drawings , as specified in Section 3300. Cast-in-Place Concrete.

3.7.

EXPANSION AND CONTRACTION JOINTS

1. Install as indicated or directed as follows:

- a) Expansions joints at maximum 20 ft. (6 meters) intervals, as required
- b) Transverse contractions joints 5 ft. (1.5 meters) intervals (except roadway).
- c) Roadway expansion joints shall occur at joints with brick border strips.
- d) Roadway control joint locations are shown on Drawings, if not then it should be placed as per instructions of the Engineer.

2. Where walkway is adjacent to curb, make expansion joints of curb, gutters and walkway coincide.

3. Install expansion joints around manholes or other penetrations and at joints adjacent to concrete curbs, buildings, or permanent structure.

4. Install softwood strips at expansion joints in accordance with Structural Drawings. Permanent strips to be immersed in water for 48 hours prior to placing, and set down sufficient to allow finishing sealant to be placed.

5. Transverse contraction joints to be 1/2 in (12mm) wide tooled 'U' shaped depressions.

3.8.

GRANULAR BACKFILLING

1. Granular material shall be placed behind retaining walls for percolation of water through to rubble drains. Material shall be placed in layers simultaneously with general fill, and such that filling is stable.
2. Placing shall be as follows :
 - a) Type 1 stones shall be hand packed behind walls to a thickness of 1 ft. (0.3 meters)
 - b) Type 2 stones placed behind Type 1 to a thickness or 1 ft. (0.3 meters).
 - c) Type 3, sand, placed behind Type 2 to a thickness of 1 ft. (0.3 meters) and above.

3.9.

DAMPROOF COURSE

1. Install damproof courses under copings, and wherelse shown on Drawings, in accordance with Section 7100 Damproofing.

3.10

PRECAST UNIT PLACEMENT

1. Pertinent data of Section 3400 Precast Concrete relating to installation shall apply to this article.
2.
 - a) Embed and joint in cement sand mortar mix 1:3 by volume, precast concrete curbs, copings, gutters and drainage trench units at locations shown on Drawings. Install dowels and anchors to copings as indicated on Drawings, min. 2 anchors per unit. This operation shall precede the placement of adjacent paved surfaces.
 - b) Placement of units shall be on sufficient bed material to allow all tamping and to attain finish grades shown on Drawings.

3.11

HOT WEATHER REQUIREMENTS

1. Refer to section 3300, Cast-in-Place Concrete.

3.12.

COLD WEATHER

1. Refer to Section 3300, Cast-in-Place Concrete.

3.13.

FINISHING CAST-IN-PLACE CONCRETE

1. Finish exposed surfaces smooth and uniform, free of open texturing and exposed aggregate, while concrete is still finishing: Do not use neat cement as a drier to facilitate finishing. Broom by lightly combing with a medium-stiff broom, after trowelling is complete. Round edges at joints with a 1/2 in. (12 mm) radius edging tool. Wood trowel finish all other exposed surfaces unless specified otherwise.
2. Cure and protect concrete in accordance with Section 3300.
3. Where occurring, forms shall be removed within 24 hours after placing of concrete. Minor defects shall be rectified and, where necessary, filled with mortar composed of one part Portland Cement and two parts of fine aggregate. Cure as described in item 2.
4. Finish exposed concrete surfaces below masonry and above finished levels in accordance with Division 9 External finish work

3.14.
BACKFILLI
NG

1. Upon completion of setting or casting items of this Section, backfill to designated levels with appropriate material to allow installation of walkways or adjacent surfaces. Compact and shape to required.

3.15.
CAULKING

1. Caulking installed under this Section shall be in accordance with Section 7900 Sealants.
2. Install caulking material at:
 - a) Joints between edge of building and adjacent hard surfaces installed under this Section.
 - b) Roadway expansion joints.
 - c) Other locations shown on Drawings.

3.16.
TOLERANC
ES

1. Materials shall be laid so as to provide levels and grades with rises and falls as shown on Drawings with optical instruments. Surfaces shall be smooth and free from bulges and depressions exceeding 1/4. in 10 ft. (6mm in 3 meters).

3.17.
CLEANING
UP

1. Upon completion of the work of this Section immediately remove debris and excess materials from the Job Site, to approval of Engineer.

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PART 1
GENERAL:

1.1 DESCRIPTION:

Work included:

1. Provision of materials and installation of:
 - a) Filling and grading base courses.
 - b) Lawn planting including protection.
 - c) Pebble drain rock around buildings.
2. Related Work:
 - a) Refer to other sections of this Division for adjacent landscaping work.
 - b) Refer to Section 2300 Excavation and Earthwork for items not covered by this Section.
 - c) Refer to Section 7100 and Section 3300 for waterproofing and concrete work to tanks.

1.2 SURVEY:

1. The Contractor shall carry out a survey of the property. If as a result of this survey, discrepancies are found which will affect the landscaping design, the Contractor shall immediately inform the Engineer. Contractor will also propose measures by which any such discrepancies may be resolved. Do not carry out any work on Site until approval of Engineer has been obtained.

1.3 JOB CONDITIONS:

1. Dust control:
 - a) Control dust on and near the Work and near off-site borrow areas if such dust is caused by the Contractor's operations during performance of the Work or if resulting from the condition in which the Contractor leaves the Site.
 - b) Thoroughly moisten surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the Site.
2. Protection:
 - a) Protect materials of this Section before during, and after installation protect objects and/or materials designated to remain.
 - b) In the event of damage, immediately make repairs and replacements necessary to the approval of the Engineer, at no additional cost to the Employer.

PART 2
PRODUCTS:

2.1 FILL MATERIAL

1. Refer to Section 2300 Excavation and Earthwork for fill material for subgrades.
 - i Topsoil furnished from one source shall be typical sterile, sandy soil obtained from well-drained and possessing characteristics of representative soils in the project vicinity that produce vigorous plant growth.
 - ii Topsoil shall be free of subsoil, brush, organic litter, objectionable weeds, clods, shale, large stones, roots or other material 1/2 in.(12 mm) in diameter or more, or any substance which might be harmful to plant growth or be a hindrance to raking, planting and maintenance operations.
 - iii 10 cubic feet (0.28 cubic meter) of topsoil shall be submitted for approval by Engineer.

2.2 WEED KILLER:

1. Weed killer to be Chlorate of Soda mixed 1 lb to 1 gal. (1 kg to 10 liters) of water applied to 10.5 sq.yds (8.78 m2) or as approved by Engineer.

2.3 LAWN MATERIALS:

- i Fertilizer:

Decomposed organic manure subject to approval by Engineer.
- ii. Sweet soil:

Sweet soil shall have an organic content of 25%, which shall consist of well decomposed organic manure. Manure shall be mixed on Site. Mixture and mixing process to be approved by Engineer.
- iii Grass seed shall be a mixture of current season's crop. Seed which has become wet, moldy or otherwise damaged will be rejected. Actual mixture to be approved by Engineer.

2.4 DRAIN ROCK:

- i Stones placed in areas marked 'Pebbles' on Drawings shall be hard, durable, oval or round river stones free from organic material or other deleterious substances. Sizes shall be between 3 ins and 6 ins. (75mm and 150 mm).
- ii Stones placed under item 'a' are described and installed under Excavation and Earthwork section.

2.5 OTHER MATERIALS:

- i. Materials and methods not specifically described but required for proper installation of items in this Section, shall be provided by Contractor subject to prior approval of Engineer, at no additional cost to Employer.

PART 3

EXECUTION:

3.1 GENERAL:

- i. Familiarization:

Prior to work of this Section, become thoroughly familiar with the Site, Site conditions, and portions of the Work falling within this Section.

- ii. Backfilling:

General provisions of backfilling shall be in accordance with Excavation and Earthwork section.

- iii. Excavation and Preparation of Subgrades:

Pertinent data of Section 2300 Excavation and Earthwork shall apply to this Section.

3.2 TOPSOIL INVESTIGATION:

1. Backfill with topsoil in 'Green areas' marked on Drawings, in layers of 9 ins. (225 mm) Water each layer, do not tamp.
2. Backfill topsoil around tree pits under direction of Landscape Contractor/Consultant or Engineer.

3.3 LAWN PLANTING:

1. General:

- i Lawn shall be planted according to acceptable Standard practice in order to ensure a completely healthy grass cover. Clarify these Standards with Engineer before proceeding with installation.
- ii No lawn shall be planted when the temperature are above 90 F (32 C) or if the ground is in a muddy condition, or other conditions that are deemed unsuitable by Engineer.

2. Planting preparation:

- i Contractor shall be responsible for preparation of lawn area and planting of lawn.
- ii Prepared surface shall be free from rivulets, crusting and caking. Subgrade soil shall be scarified to a 12 ins (300 mm) minimum depth and brought to a true and uniform grade before dumping and spreading of sweet soil.
- iii Lawn areas are to be brought up to within 3 ins (75 mm) of existing grades with sweet soil in accordance with the levels indicated on Drawings.

- iv Should the existing grades be at the proposed levels, the soil must be “trenched or plowed” 12 ins (300 mm) deep over the entire surface. Unsuitable soil must be removed and replaced with sweet soil.
- v Sweet soil shall be placed in “Grass” areas indicated on Drawings and raked. Stones in excess of 1 in. (25 mm) diameter and rubbish shall be removed. Do not spread sweet soil in muddy state.
- vi Sweet soil shall have a minimum thickness of 12 ins (300 mm) after natural settlement and light rolling, and shall conform to finish grades and levels shown on Drawings. Finish grades shall be refined under the supervision of Engineer.
- vii Cover sweet soil with 3 ins (75 mm) of fertilizer and mix into top 3 ins. (75 mm).
- viii Additional sweet soil shall be deposited, to correct settlement and erosion up to the date of acceptance at the Substantial Completion Inspection.
- ix The lawn bed shall be fine graded to remove ridges and depressions.
- x Surface irregularities resulting from these operations shall be leveled to prevent depressions. Grades shall be adjusted to assure that, after natural settlement and light rolling, they will be 1 in. (25 mm) below adjoining paved areas.
- xi Rolling shall be carried out in transverse directions. The roller shall be a water ballast hand roller weighing maximum 200 lbs and minimum 150 lbs. Rolling shall be in such a manner so as to eliminate the necessity for retreating on finished grade.
- xii Should there be a time lapse for any reason between final bed preparation and planting, the ground shall be restored to a loose friable condition.
- xiii Sweet soil surface shall be moistened with a fine spray of water immediately before planting.
- xiv Extreme care shall be taken during planting to ensure that no change shall occur in the finished grade.

3.4 TREE PLANTING:

1. General: Planting Trees with making Pits and filling Sweet Earth.

Average Height: 1800mm

Stem Size: 100mm Dia

- Vinca Minor
- Willow
- Citrus
- Jacaranda
- Laburnum
- Rosa Banksiae
- Alstonia
- Poplar
- Sheesham
- Neem
- Champa
- Sumbul

- Cyprus
- Banyan
- Or as Approved by the Architect

3.5 LAWN AND TREE MAINTENANCE & PROTECTION:

1. Maintenance by Contractor shall begin immediately after the planting operation is completed and shall continue until acceptance at commissioning. Any replacements, adjustments or maintenance of lawns shall be at no additional cost to Employer for a period of 12 (Twelve) months after commissioning.
 - a) Lawn and Trees shall be maintained by watering, weed eradication, cutting, trimming, repair of erosion, and reseeding where required to establish a uniform, knitted turf. Renew or replace faulty work without additional cost to Employer.
 - b) Initial watering of lawns and Trees shall be at 2-day intervals for a period of 18 days from time of planting. At each watering, 1/4 in. (6 mm) of water shall be applied or supplement natural rain to the equivalent of 1/4 in. (6mm)
 - c) Watering shall continue after 18 days period to maintain turf in thriving condition. After grass has started, areas which fail to show uniform stand of grass shall be planted repeatedly until satisfactory growth of grass is achieved.
 - d) Equipment used to maintain grass areas shall be approved by Engineer.
 - e) At time of first cutting and subsequent cuttings, the mower blades shall be set at a minimum height of 1-1/2 ins. (38 mm) Grass shall be cut first when it reaches a height of 4 ins. (100 mm) Regular cutting shall be done every 2 weeks until grass cover is established.
 - f) Final grading shall be carried out only after a 12 week establishment period. Contract shall allow for rolling after a further 3 month period if instructed to do so by Engineer.
2. Lay evenly mixed river stones placed approximately level with edges of border coping and to approximate depth of 6 ins to 8 (150mm 200mm)ins in areas marked 'Pebbles' on Drawings.

3.6 CLEANING UP:

1. Upon completion of the work of this Section immediately remove debris and excess materials from the Site.

PART 4

METHOD OF MEASUREMENT:

1. Paid as specified in BOQ.

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PART 1 GENERAL

1.1 DESCRIPTION

- A. Work included:
 - 1. Parking line striping.
 - 2. Directional markings and lettering.
 - 3. Wheel stops.
- B. Related work: Painting other than the work of this Section.

1.2 ENVIRONMENTAL REQUIREMENTS

- 1.2.1 Do not apply paint when the ambient temperature is below 55 deg. F. nor when there is a probability that the temperature could fall below that point. Do not apply paint when the pavement is damp nor when there is a probability of rain.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Dunn-Edwards Corp., (800) 537-4098.
- B. Frazee Paint and Wall Covering, (800) 826-9048; or
- C. ICI Paints, (323) 793-0001; or
- D. Thompson Building Materials, (909) 350-3000.

2.2 TRAFFIC PAINT

- 2.2.1 Dunn-Edwards Vin-L-Stripe W801 Series epoxy modified acrylic latex. .
- 2.2.2 Frazee 506 Acrylic Traffic Line Paint.
- 2.2.3 ICI:
 - 2.2.3.1 7000 Premium Series.
 - 2.2.3.2 3000 Handicapped Blue.
- 2.2.4 Colors:
 - 2.2.4.1 Text, parking stall striping, directional arrows and driving lane dividers: White.
 - 2.2.4.2 No parking zone markings: Yellow.
 - 2.2.4.3 Handicap zone markings: Blue.
 - 2.2.4.4 No parking curb: Red.
 - 2.2.4.5 Blue paint for symbol of accessibility: Match color no. 15090 Federal Standard 595A as specified in Section 2-1720 of CCR Title 24 Handicap Regulations (similar to Royal Blue).

2.3 EQUIPMENT

- 2.3.1 Pressurized, self-contained paint machine capable of applying a straight line from 2" to 6" wide,

with consistent coverage of a minimum of 150 sq. ft. per gal.

2.4 WHEEL STOPS

2.4.1 Thompson precast concrete parking lot bumpers using 3,000 psi concrete and complete with 5/8" diameter steel pins.

2.4.2 Epoxy adhesive: A high viscosity, standard set, epoxy paste complying with ASTM D 281, D 476; Test Method No. California 425; Federal Standard No. 595.

PART 3 EXECUTION

3.1 TRAFFIC PAINTING

- A. Prepare areas having oil and grease deposits by washing with a TSP solution or by using high pressure spray and detergent followed by a clear water rinse. Clean surfaces with excess dust and dirt build-up with water spray.
- B. Machine paint to the length, width and patterns indicated on the drawings.
 - 1. Paint lines 4" wide at a minimum rate of one gal. per 150 sq. ft.. Finish straight and true without holidays or cat's whiskers.
 - 2. Paint direction arrows for in and out traffic flow, curb markings, text, no parking or fire access areas and parking space numbers.
 - 3. International symbol of accessibility: Apply international symbol of accessibility on pavement surface. The surface of each accessible parking space or stall shall have a surface identification duplicating either of the following schemes:
 - a. By outlining or painting the stall or space in blue and outlining on the ground in the stall or space in white or suitable contrasting color a profile view depicting a wheelchair with occupant. The profile view shall be located so that it is visible to a traffic enforcement officer when a vehicle is properly parked in the space and shall be 36" high by 36" wide.
 - b. By outlining a profile view of a wheelchair with occupant in white on blue background. The profile view shall be located so that it is visible to a traffic enforcement officer when a vehicle is properly parked in the space and shall be 36" high by 36" wide.
- C. Prevent overspray and dripping paint on the paving. Keep paving clean and free of paints ports.
- D. Application:
 - 1. Apply the white traffic paint in one coat at 10 -15 mils wet film thickness.
 - 2. Apply the handicap blue traffic paint in one coat at 8 - 10 mils wet film thickness.

3.2 WHEEL STOPS

3.2.1 Install in accordance with manufacturer's recommendations to assure proper anchorage in a

neat, straight and true manner.

3.2.2 Install wheel stops with epoxy adhesive where steel rebar anchors cannot be installed.

3.3 PROTECT AND CLEAN

3.3.1 Protect: Protect work and work of other trades. Furnish and place drop cloths and masking to protect work during execution. Remove all paint droppings and repair all injured surfaces in a manner satisfactory to Architect. Do not allow traffic on painted surfaces until paint is dry.

3.3.2 Clean: Upon completion of work, remove paint spots from surfaces adjacent to those painted or finished and remove rubbish, paint cans and accumulated materials. Leave work clean, aligned and in condition acceptable to the Architect.

END OF SECTION

CIVIL & ARCHITECTURE VENDOR'S LIST

S.No.	Description	Manufacturer as Per Design Specifications	Local Representative / Vendor
1	Cement	M/s. DG Cement	Mr. Ammar (0323-3212322)
		M/s. Attock Cement	
		M/s. Power Cement	Mr. Taha (0333-3036434)
		M/s. Lucky Cement	Mr. Umair Khan (0321-2821837)
2	Steel Reinforcement	Or other equivalent approved by the Consultant / Engineer	
		M/s. Amreli Steels	Mr. Naveed Ansari (0324-5979184)
		M/s. Agha Steels	
		M/s. Union Steel	Mr. Zain (0331-8753823)
		M/s. Faizan Steel	Mr. Khurram (0333-4934931)
3	Pre Cast / Pre Stressed Concrete Wall and Columns	Or other equivalent approved by the Consultant / Engineer	
		M/s Izhaar Concrete Pvt. Ltd.	35-Tipu Block, New Garden Town, Ferozpur Road, Lahore Phone: (+92-42-111-323-111) Email: info@izhar.com
		M/s ITTEFAQ Building Solutions (Pvt.) Ltd.	Head Office: 189/190, Airline Commercial Area, Khayaban-e-Jinnah, Lahore Phone: +92 308 4444 029, +92 337 777 7929 Email: marketing@ittefaqgroup.pk
		M/s Gondal Group of Industries	Dheerke Khurd, Gujrat, Punjab, Pakistan 0317-4000084 www.gondalgroup.com
		Or other equivalent approved by the Consultant / Engineer	
4	Termite Proofing	Mirage	Mr. Badar Jamal (0336-6822155)
		Agenda 25 EC	Mr. Arif Akhtar (0300-8939992)
		Termicure 25 EC	Mr. Arif Akhtar (0300-8939992)
		Or other equivalent approved by the Consultant / Engineer	



CIVIL & ARCHITECTURE VENDOR'S LIST

S.No.	Description	Manufacturer as Per Design Specifications	Local Representative / Vendor
5	Solid & Hollow Blocks	M/s. BES Block	Mr. Shahid (0300-2307353)
		M/s. Megnacrete	Mr. Abdullah Shahid (0300-2019122)
		M/s. Envicrete	Mr. Rasheed (0331-2356101)
		M/s. Banu Mukhtar	Mr. Kamran Tola (0300-8270087)
		M/s. Caracrete Industries	Mr. Adeel (0321-2696795)
6	Bricks, Brick Tiles and Brick Jali	Or other equivalent approved by the Consultant / Engineer	
		M/s. Tasneem Bricks	Mr. Shakil (0307-2824771)
		M/s. Al-Nasir Bricks	Mr. Liaquat Malik (0303-7733567)
		Or other equivalent approved by the Consultant / Engineer	
7	Water Proofing (Bitumen, Torch Applied Membrane, Crystalline, Cementitious, Floor Hardner, Waterstopper)	M/s. Fospak	Mr. Faheem (0300-8250632)
		M/s. Sika	Mr. Mansoor Raza (0300-8430092)
		M/s. Aquafin	Ms. Kashmala (0301-8283272)
		M/s. Mitchell Construction Chemicals	Mr. Usman (0342-2839291)
		M/s. Ressichem	Mr. Hussain Zulfiqar (0309-7772464)
		M/s. Pak Hy-Oils Limited	Mr. Samad (0332-2900799)
		M/s. Mega Sealers	Ms. Mantasha Khan (0318-3880161)
		M/s. Professional Sealers	Mr. Fahad A. Khan (0321-1110475)
		Or other equivalent approved by the Consultant / Engineer	



Technical Specifications

Plumbing Works



CGD Consulting (Private) Limited- Karachi.
Head Office: 7 C, 5th Zulfikar Commercial Street, Phase-VIII-A, DHA Karachi, Pakistan.
Website: www.cgdconsulting.pk

PLUMBING WORKS AND TUBEWELL SPECIFICATIONS
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SECTION 2.1

BASIC MECHANICAL REQUIREMENTS

General:

This section includes the following basic mechanical requirements, which apply & complement Division 22 sections. The provisions of the contract including Drawings, General & Special Condition of Contract apply to this section.

Instructions to Tenderers:

- a) The Specifications & Drawings make reference to certain Standard Specifications and also to certain manufacturers and equipment model numbers. The object of these references is to ensure that the equipment and materials offered by the Tenderers and supplied by the Contractor are in accordance with the required standard of quality, workmanship and capacities, etc. The object is not to limit the selection of equipment to a particular manufacturer unless specifically mentioned in the tender documents that a particular equipment and/or material is to be supplied.
- b) It is clarified that the equipment and the materials complying with various standards and of manufacturers other than mentioned in the tender documents shall be acceptable provided they meet the required capacities as specified and meet the intent of the specifications regarding quality and workmanship.
- c) In case there is any deviation between any item or material offered by the Tenderer from the tender specifications and drawings, the Tenderer shall clearly draw attention to all such deviations and no such item or material shall be supplied by the Contractor without prior written approval of the Engineer.
- d) These Specifications and accompanying Drawings are to be considered as supplementing each other and as such are intended to serve jointly as the basis upon which the Contractor shall establish a Contract Price, and upon which he shall base the performance of the required work.
- e) It is the intent of these Specifications and Drawings to call for finished work, tested, complete, and ready for operation.
- f) These Drawings and Specifications are presented to the Tenderer with the understanding that he is an expert and is competent in the preparation of Contact Bid Prices on the basis of information such as is contained in these documents, which do not include assurance as to their complete accuracy and validity, in all details, and which may depend, for proper execution, upon interpretation by the Engineer and other Authorities, during the course of construction.
- g) For the above reasons, the Tenderer shall understand that his submission of an unqualified proposal commits him to perform all work expressed and implied in the Drawings and Specifications without additional compensation. He shall further understand that such submission commits him without extra compensation, and within the scope of the Contract, to the following:
 - i) To provide, if required by the Engineer, the items or arrangements of greater quantity, better quality, or higher cost in the event that a disagreement with regard to; such items occurs between the drawings and specifications, or within one.
 - ii) To provide any small items of work not specifically called for, but required



to complete the intended installations.

- iii) To co-ordinate his work or adjust the same so that conflicts in space do not occur with other trades involved at the project.
- iv) To co-ordinate his work or adjust the same to suit site or any other existing conditions.

Interpretation of the Drawings & Specifications:

- a) Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instructions to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.
- b) It shall be understood that the specifications and drawings are complimentary and are to be taken together for a complete interpretation of the work. Exceptions are that notes on the drawings, which refer to an individual element of work, take precedence over the specifications where they conflict with the same.
- c) No exclusions from, or limitation, in the language used in the Drawings or Specifications shall be interpreted as meaning that the appurtenances or accessories necessary to complete any required system or item of equipment are omitted.
- d) The necessary Drawings utilise symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed in accordance with the diagrammatic intent expressed on the mechanical drawings, and in conformity with the dimensions indicated on final Architectural and Structural working Drawings and on equipment shop drawings.
- e) No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.
- f) Certain details appear on the Drawings which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field co-ordination for the indicated work.
- g) Information as to the general construction not evident in this specifications and drawings shall be derived from structural & architectural drawings and specifications.

Codes, Permits & Inspection:

- a) All works shall meet or exceed the latest requirements of all authorities exercising jurisdiction over construction work at the project site.
- b) All required permits and inspection certificates shall be obtained, paid for, and made available at the time of completion of the Works.
- c) All work shall be carried out in accordance with the following codes:
 - a) Plumbing Works:
 - Uniform Plumbing Code
 - KBCA Building Rules



Shop Drawings by the Contractor:

- a) All shop drawings shall be prepared on computer using current version of AUTOCAD software.
- b) Prior to commencement of works on site and at least 3 weeks in advance of the drawing being required for actual execution, the Contractor shall submit hard-copies of shop drawings in triplicate plus soft-copy on AUTOCAD CD for approval of the Consultant/Engineer. The Consultant/Engineer shall review the drawings & (i) approve the drawing or, (ii) disapprove the drawings with comments or, (iii) disapprove the drawings with comments for rectification/revision. In the event of (iii), the Contractor shall correct/revise the drawing & resubmit 3 hard-copies of the drawings plus soft-copy on AUTOCAD CD to the Consultant/Engineer for Approval. On a drawing being approved, the Contractor shall submit 6 hard-copies plus soft-copy on AUTOCAD CD for formal approval and distribution to relevant offices.
- c) All drawings shall show plans and sections with sufficient details to clearly reflect the installation of the plant. All material specifications shall be provided on the drawings. All information required for preparing suitable foundation, for providing suitable access to the plant, for making openings in building structure, for co-ordination with electrical, plumbing, air-conditioning and other designs etc., shall be clearly provided.
- d) The Contractor shall submit to the Consultant/Engineer 3 sets of hard-copy drawings plus soft-copy on AUTOCAD CD showing all major holes, cavities, embedded frames and other parts of the plant to be embedded in the floor, ceiling and walls, channels in the floors, cable trenches, cement pipes or other major conduits, which are needed for the successful and timely completion of the works. The Consultant/Engineer after ascertaining the accuracy of these drawings, shall return 1 (one) set of the drawings to the Contractor, within 14 days of the receipt of these drawings.
- e) Installation shall not be allowed to commence unless approved shop drawings are in possession of the Contractor, for which purpose shop drawings shall be submitted by the Contractor to the Consultant/Engineer sufficiently in advance of actual requirements to allow for ample time to the Consultant in checking and approval and no claim for extension of the Contract time will be considered by reason of the Contractor's failure to submit the drawings on time.
- f) Each shop drawing submitted by the Contractor shall include a certificate by the Contractor that all related conditions on site relevant to the particular installation have been checked and that no conflict exists.
- g) Any expenses resulting from an error mistake or omission in or delay in delivery of the drawings & information mentioned in sub-clause (b) of this clause shall be borne by the Contractor.
- h) Drawings approved shall not be departed from except on the instructions of the Consultant/Engineer.
- i) The approval by the Consultant for any submitted data, working drawings, performance curves, test certificates for any items, arrangements and/or layout shall not relieve the Contractor for many responsibilities regarding the performance of the Contract. Such approval shall also not relieve the Contractor from responsibility of any error in the submitted data & workings, brought to light at any time subsequent to any approvals.



Verification of Actual Dimensions on Site:

The Contractor shall be solely responsible for verification of actual site dimensions and building layout. Building layouts shown on Consultant's drawings shall not be considered to be final with regard to dimensions and layout but shall be subject to actual verification by the Contractor. All working drawings prepared by the Contractor shall incorporate actual measurements taken on site. The Contractor shall ensure that all equipment can be conveniently fitted into the space allocated for this purpose.

If any space allocated for certain equipment or combination of equipment is insufficient or deficient in terms of clearances required for maintenance etc., the Contractor shall forthwith inform the Consultant/Engineer of the discrepancy. He shall provide all reasonable assistance to the Consultant/Engineer for verification of the same and for taking remedial measures. It is understood that all tenderers during tendering shall have checked that the equipment proposed to be supplied by them fits conveniently into the space allocated for this purpose. In case any such space is insufficient, the tenderer shall so indicate the deficiency in his tender documents and specify the space requirements. Failure on the part of the tenderer to point out any discrepancies existing in this regard shall make him liable, if his tender has been accepted, to bear the full consequences developing out of certain equipment not fitting into a certain space allocated for the purpose.

If any time during the progress of the Works any error shall appear or arise in the position, levels, dimensions or alignment of any part of the works, the Contractor on being required to do so by the Consultant/Engineer shall at his own expense rectify such error to the satisfaction of the Consultant/Engineer unless such error is based on incorrect data supplied in writing by the Consultant/Engineer, in which case the expense of rectifying the same shall be borne by the Employer.

The checking of any setting out or of any line or level by the Consultant/Engineer shall not in any way relieve the Contractor of his responsibility for correctness thereof and the Contractor shall carefully protect and preserve all bench marks, site rails, pegs and other things used in setting out the Works.

Responsibility for Accuracy of Information:

- a) The Contractor shall be fully responsible for accuracy of all information necessary for successful and timely completion of the works.
- b) The Contractor shall be responsible to make all measurements and set out all the necessary dimensions for their correctness.
- c) The Contractor shall be fully responsible for ascertaining the accuracy of the dimensions and other information given in the tender documents before carrying out the work. The Contractor shall provide the complementary dimensions and communicate the same to the Engineer/Consultant.
- d) The Contractor shall consult the drawings and documents which have been prepared for the Civil and other contracts by other engineers, which can effect his work and which are either kept on site or are available with the other Engineers.
- e) It shall be the responsibility of the Contractor to acquire all necessary information and ascertain its accuracy for co-ordination of the works with the works of other Contractors.

Approval for Material & Equipment:

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- a) **General:** All equipment and material to be used in the Works shall be subject



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to approval obtained prior to delivery of the same on site. It is to be specifically noted that any approval given by the Engineer/Consultant/ Engineer shall not relieve this Contractor of his obligations under this Contract.

- b) **Approval of Imported Equipment:** For approval of all equipment, the Contractor shall be required to submit, within two weeks of the signing of the Contract, detailed submittals stating the equipment proposed to be supplied and providing supporting literature/brochures etc., to enable the “CONSULTANT” to check conformance to the specifications. Performance curves and charts shall be submitted with the operating points clearly marked. The selection procedure for Chillers, AHU’s FCU’s, etc., shall be submitted in detail on type-written sheets. All equipment submittals shall be accompanied with a certificate stating that the equipment proposed to be supplied fits into the space allocated for it with sufficient clearance around it to allow for installation of related ducting, piping, etc., and provides for maintenance clearances as required by the manufacturer of the equipment, and that all special requirements of the equipment have been accounted for. Any additional information, test reports etc., required by the “Consultant” shall be furnished by the Contractor. All work related to the equipment shall only be commenced after receipt of written approval from the “Consultant”.
- c) **Approval of Locally Manufactured Equipment:** The procedure of approval of locally manufactured equipment shall be the same as stipulated above for imported equipment.
- d) Additionally all locally manufactured equipment shall be inspected at the manufacturer’s premises by the Consultant/Engineer, and approval given prior to delivery on site.
- e) **Approval of Imported Material:** All imported material to be used in the works shall be submitted to the Consultant/Engineer and approval obtained. Manufacturer’s literature/brochure etc. that provide complete information on the material specifications, to enable the Consultant/ Engineer to check conformance to specification, shall be submitted. Any additional information, test reports etc., required by the Consultant/ Engineer shall be supplied by the Contractor.
- f) **Approval of Locally Procured Material:** All locally procured material shall be submitted to the Consultant/Engineer for approval, and approval obtained prior to delivery of the same on site. The procedure for obtaining approval shall generally be the same as given above for imported material, except that where manufacturer’s literature is not available, a sample of the material shall be submitted along with type written notes indicating relevant source data and specs on the material. Any other samples, information, test reports etc., required by the Consultant/Engineer’s shall be submitted.

Storage Arrangements:

- a) The Contractor shall make adequate arrangements for the storage of the materials arranged by him or supplied by the Employer. No payment shall be made to the Contractor for storage arrangements whatsoever. However adequate space for store shall be provided on site to the Contractor.
- b) The location of the store area shall be within the Site premises and/or selected with the consultation and approval of the Engineer.



Cutting & Patching:

- a) Cutting will be done under Specifications of other trades. Perform cutting, fitting and patching of mechanical equipment and materials required to:
 - i) Set openings and sleeves for ducts & pipes accurately before the structural concrete are poured or set boxes on the forms so as to leave openings in the structure in which the required sleeves can be subsequently located in which case Contractor shall fill in the concrete voids around the sleeves.
 - ii) Uncover work to provide for installation of ill-timed work.
 - iii) Remove and replace defective work.
 - iv) Remove and replace work not conforming to requirements of the Contract Documents.
 - v) Remove samples of installed work as specified for testing.
 - vi) Install equipment and materials in existing structures.
 - vii) Upon written instructions from the Consultant uncover and restore work to provide for observation of concealed work.
- b) All patching will be done under Specifications of other trades. Should the Contractor neglect to perform his preliminary work and should cuttings be required in order to install the piping or equipment, then the expense of the cutting and restoring of surface to their original condition shall be borne by the Contractor.
- c) Cut, remove and legally dispose of selected mechanical equipment, components and materials as directed by the Consultant, including but not limited to removal of mechanical piping, heating units and trim and other mechanical items made obsolete by new work.
- d) Protect structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
- e) Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

Patch and refinished existing finished surfaces and building components using new materials matching existing materials and experienced installers.

Measuring Instruments:

The Contractor shall acquire and maintain on site various required measuring instruments in perfect working condition to enable the representative of the Employer Consultant/Engineer to check the quality and standard of all material and performance of equipment.

Standards & Typical Design:

The specification either cites or implies IEEE, IEC, ASME, ASHRAE, or BS Standards where the context so refers. Other comparable United States, European or Japanese standards and typical designs are equally acceptable providing that they in no way detract from the quality, safety, operability or durability of the equipment and material furnished. However, when other standards or typical designs than those cited or implied are offered by a tenderer, he shall set forth in his proposal the alternate standards and/or designs he proposes so that a direct comparison can be made by the Engineer before the issue of a Letter of Award. Each specific difference from the specifications shall



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be clearly spelled out by the tenderer. If no alternates are set forth by the Tenderer in his proposal, it will be assumed that the equipment and material will be in accordance with the standards and typical designs as cited or implied in the Specifications.

Abbreviations for Standards:

The standards, codes of practice and recommendations of the following societies or institutions have either been used in the specifications and are cited here as a general level of quality for the equipment, materials and workmanship.

a) Abbreviations for International institutions are given below:

- International Electro technical Commission ... IEC

b) Abbreviations for some European societies and standards institutions are as follows:

- Association Francaise de Normalisation ... AFN
- American Society of Heating Refrigeration
Air-conditioning Engineers Inc ASHRAE
- British Standard Institution BSI
- Chartered Institution of Building Services.....CIBS
- Dentsches Institute fur Normung.....DIN
- Institution of Electrical Engineers, London.....IEE

c) Abbreviations for Pakistani Societies and Standard Institutions:

- Pakistan Standards Institution.....PSI
- Water and Power Development Authority.....WAPDA

d) Abbreviations for various United States Societies and Standard Institutions:

- American Standards Association ASA
- American Society of Heating, Refrigerating and
Air-conditioning Engineers ASHRAE
- American Society of Mechanical Engineers.....ASME
- National Electrical Manufacturers Association.....NEMA
- American Society for Testing and Material.....ASTM
- American Refrigeration Institute.....ARI
- Sheet Metal and Air-conditioning
Contractors National Association SMACNA
- Instrument Society of America ISA
- National Bureau of Standards.....NBS
- National Fire Protection Association.....NFPA
- Thermal Insulation Manufacturer's Association TIMA

e) Where differences or contradictions appear between any of the laws,



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standards, codes, specified herein, the decision of the Consultant shall be final and binding on the Contractor and the Contractor shall not claim any additional charges for carrying out the same.

Operating & Maintenance Instructions:

- a) **Bound Instructions:** Five complete sets of operating and maintenance manuals, duly approved by the Consultant/Engineer, shall be supplied by the Contractor, prior to handing over of the project to the Employer. Each set shall be permanently bound and shall have a printed hard cover. Each manual shall be inscribed with suitable legend for proper identification and use of the manual. The matter shall be legibly typed and/or shall be clear photostat copies of the original documents, catalogues, photographs of site and equipment, etc., including complete set of as installed drawings.

Fly sheets shall be placed before instructions covering each subject. The instructionsheet shall be approximately 8.5" by 11", with large sheets of drawings folded in.

- b) **Framed Instructions:** Approved piping, wiring and control diagrams showing the complete layout of the entire system, including equipment, piping, valves and control sequence, framed under glass or in approved laminated plastic, shall be posted; where directed. In addition, condensed operating instructions, explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures of safely starting and stopping the system shall be prepared in typed form, framed as specified above and posted beside the diagrams. Proposed diagrams, instructions and other sheets shall be submitted for approval prior to the posting. The framed instructions shall be posted before acceptance testing of the system.
- c) **Field Instructions:** During the two months of the operation and maintenance period upon completion of the work the services of one or more project engineers shall be provided by the Contractor to instruct the representative of the Employer in the operation and maintenance of the Works. The field instructions shall cover all the items contained in the bound instructions.

As Built Drawings:

The Contractor shall maintain an accurate record of changes as work progresses on a set of Record Drawings supplied for this purpose, by the Engineer. Keep Record Drawings at the Site Office, and adopt the following procedure:

- a) Make records in a neat and legibly printed manner with a non-smudging medium.
- b) Identify each Record Drawing as the "Project Record Copy", maintain Drawings in good condition, do not use them for construction purposes, and make them readily available to the Engineer.
- c) Maintain project Record Drawings in a state current to the project. Failure to comply with this requirement may prejudice Progress Payments. The Engineer's visual inspections shall constitute proof that Record Drawings are current.
- d) The Contractor on the completion of the Contract shall submit to the Employer through the Engineer one complete set of Contract Drawings (one transparency, six prints of each drawing and one set of soft-copies of all drawings on AUTOCAD CD) showing Work as actually constructed.



Mechanical Installations:

Sequence, coordinate, and integrate the various elements of mechanical systems, materials and equipment. Comply with the following requirements:

- a. Coordinate mechanical systems, equipment and materials installation with other building components
- b. Verify all dimensions by field measurements.
- c. Arrange for chases, slots and openings in other building components during progress of construction, to allow for mechanical installations.
- d. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- e. Sequence, coordinate and integrate installations of mechanical, materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing the building.
- f. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
- g. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Provide required connection for each service.
- h. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Consultant/Engineer.
- i. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- j. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- k. Install access panel or doors where units are concealed behind finished surfaces.
- l. Install systems, materials and equipment giving right of-way priority to systems required to be installed at a specified slope.
- m. Provide fire stopping materials in all annular spaces surrounding piping, conduits, ducts, etc. that penetrate fire-resistive construction.

Delivery of Equipment / Material on Site

No plant or Contractor's Equipment shall be shipped or delivered to the Site until intimation in writing has been applied for and obtained by the Contractor from the Engineer that the plant may be delivered. The Contractor shall be responsible for the reception on Site of all plant and Contractor's Equipment delivered for the purpose of the Contract.

Unloading & Storage at Site



- a) The Contractor shall unload all owner supplied or otherwise equipment & material at the site from delivery vehicles as the case may be. Items for permanent installation shall be properly stored in areas designated by the Engineer and shall be protected as required to prevent damage or deterioration of any type. Storage methods shall be such as to cause minimum inconvenience to others and shall be arranged to facilitate inspection.
- b) All equipment and material storage shall be subject to the approval of the Engineer.
 - i) Items stored shall be blocked up at least six (6) inches off the ground.
 - ii) The ends of all nozzles, pipes, tubes and conduits while in storage at the site shall be covered with a tube cap to save against entrance of rain water, blowing dirt, and other foreign matter. Tubing shall be shipped and stored in neat bundles.
 - iii) Miscellaneous steel, plate work, pipes, etc. shall be protected by a prime coat of paint and kept painted throughout the storage and erection period to inhibit rusting unless such items are galvanised or have other corrosion proof finish.
- c) All packing boxes, shipping containers, planking, covering, etc., shall become the property of the Employer as soon as the equipment and material which is contained therein arrives at the site. The Employer, on application from the Contractor, may permit the Contractor to use some of the boxes, containers, etc., without charge for equipment and material storage purposes.

Equipment Lifting

The contractor shall be solely responsible for safe lifting of the equipment from place of storage to location of final installation and finally on the foundations.

Prior to lifting the equipment's the following procedure shall be adopted:

- a) Submit comprehensive insurance policy for the full value of the equipment to the Engineer/Employer from approved insurance company.
- b) Submit complete information of specialist firm of lifters/riggers to the Engineer & obtain approval.
- c) Submit complete procedure & equipment to be used for lifting the equipment in place. Identify on plans location of tripods, hoist, etc. that will transfer weight to the equipment, to the structure & obtain approval.
- d) All the above to be completed with one month before the date of lifting of equipment.

Qualification of Equipment & Material Manufacturer

- e) All minor equipment and all materials shall be manufactured by companies which have had at least five years previous experience in the design and manufacture of equipment and or material of comparable type, capacity and operating conditions.
- f) Where the requirements of this clause make any material non-obtainable the Employer and/or Engineer reserves the right to waive any portion or portions of it as required to obtain the intent of the Specifications.
- g) When manufacturer's product is specified by name or equivalent, it shall be the sole judgment of the Engineer/Consultant to determine the acceptability of any product which is offered as an equal to that specified.
- h) Proposals shall be based on the equipment and materials specified, and any request to substitute any time shall be so mentioned in the proposal and the amount to be



added or deducted shall be given. Any request for substitution after the date of Letter of award shall likewise be accompanied with the difference in price.

- i) If the Contractor in his tender proposal has offered more than one source of equipment or material the selection of the source shall be at the judgment of the Consultant/Engineer.

Safety Program

- a) The Contractor shall strictly follow at his own cost the Safety Programme outlined below and such additional measures as the Engineer or Engineer's Representative may determine to be reasonably necessary.
 - i) Prior to commencement of work the successful Contractor shall submit safety programme for discussion with the Employer and the Engineer.
 - ii) The Contractor shall prepare a plan of the Works' Site to assure that storage areas for materials and equipment are located on the project/work site for maximum efficiency. This plan will be subject to the approval of the Engineer.
 - iii) Activities between different operations and different crafts will be co-ordinated.
 - iv) The Contractor shall layout and provide an efficient access system with information and directional signs posted as necessary.
 - v) All employees will be instructed on safe work method.
 - vi) The Contractor shall advise all his supervisory staff of their responsibility for the prevention of injury to persons or damage to property or equipment in their respective areas of supervision.
 - vii) Safety will be included in all job planning. This will include providing safe construction equipment and vehicles, protective equipment necessary for protection of workmen, and establishing methods for safe operation.
 - viii) Good housekeeping will be maintained at all times.
 - ix) Scaffolds, ladders, ramp", runways etc. will be constructed properly and maintained in safe conditions.
 - x) Ample fire protection will be provided and fire hazards guarded, by the Contractor.
 - xi) Adequate lighting, ventilation etc. will be provided as necessary, by the Contractor.
 - xii) Equipment will be properly and regularly inspected and maintained by the Contractor to the satisfaction of the Engineer.
 - xiii) The Contractor will assign to his employees only such duties as are within their physical and mental capabilities.
 - xiv) The Contractor will hold monthly meetings with his supervisory staff and the man in charge at the lower level will hold safety meetings of 10 to 15 minutes with his crew each week.
 - xv) First Aid facilities will be provided at job sites, the services of doctors and hospitals made available, and all supervisors instructed in handling of injured employees.



- xvi) Adequate toilet facilities will be provided, maintained in a hygienic condition and their use enforced by the Contractor.
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- b) Accident reports will be furnished to the Engineer for onward transmission to the Employer within 2 days of the reported accident.
- Copies of the safety programme will be supplied by the Contractor to the Engineer and will be promptly posted in all offices in use of projects/works under this Contract.
- c) At all construction sites the following instructions shall be followed:
- i) availability of safety (hard) hats, which should be worn by anyone visiting or working within the designated work area
 - ii) controlled entry to the designated work area
 - iii) proper distribution of temporary electric power (use of RCDs/ELCBs, switch gear, cabling, socket outlets)
 - iv) Proper guarding of shafts, stairs and floor edges up to a height of 42".
 - v) proper access stairs and ladders with handrails
 - vi) properly demarcated passageways, which are kept clear of materials, equipment, and rubbish
 - vii) daily cleaning of debris and rubbish from the site
 - viii) adequate temporary lighting
 - ix) Proper housekeeping to reduce slipping and tripping hazards.
 - x) proper protection to pedestrians and adjoining buildings
 - xi) contractor's All-risk Insurance policy to be in place.
- d) To ensure safety of all people on the Site during the construction process, including Contractors' personnel and Employer's representatives, the following procedures shall be adopted by all Contractors for the use of temporary electricity supply.
- i) Work shall generally be carried out in accordance with 16th Edition of UK IEE Wiring Regulations, BS CP 1017 "Distribution of Electricity on Building Sites", and the Pakistan "Electricity Rules, 1937" all legal formalities of the Electric Inspector's office shall be complied with.
 - ii) Construction of cables used shall be as follows:
 - ◇ To fixed distribution boards and fixed equipment, PVC/PVC/SWA/PVC, to BS 6346.
 - ◇ To moveable plant, flexible armoured cables, to BS 6116.
 - ◇ To welding electrode-holders, flexible cables to BS 638.
 - ◇ to portable tools and hand-lamps, flexible cords to BS 6500
 - iii) Installation of cables shall be as follows:
 - ◇ outdoors, directly buried at least 500mm below grade, with tile covers and cable markers (at minimum 10 meter intervals and at bends), and in RCC pipe at



- ◇ Indoors, clipped to the surface at least 3000mm above floor/ground level.
- Strain relief shall be provided at termination of all cables at equipment, plugs, etc.
- iv) Double earthing, with stranded copper conductors, shall be used to establish a TNS system. No separate earthing electrodes are required at each location.
 - v) A main distribution board, to BS 4363, of totally enclosed sheet-steel construction (IP 54) shall be provided, with 30mA trip residual current device(s) for the earth-leakage protection of circuits. Short-circuit and overload protection shall be provided by circuit-breakers of the appropriate rupturing capacity.
 - vi) Plugs, sockets, and accessories of a robust, unbreakable construction, to BS 4343, shall be used for all equipment. Portable tools, to BS 2769, shall preferably be of double-insulated construction and be operated at 110V.
 - vii) A layout drawing of the proposed temporary installation with schematics, cable sizes and routes, earth conductors, and protection details shall be had approved from the Employer. After installation, test results (insulation resistance, earth-loop impedance, etc.) shall be submitted, re-testing shall be done every three months.

Guarantees/Warranties for Equipment/Plant

- a) The period of guarantee/warranty on the equipment/plant shall be the period stated in Section 400, Condition of Particular Application.
- b) The Contractor's guarantee does not cover the normal wear & tear.
- c) Manufacturer's equipment warranties if they exceed the Maintenance Period as defined in these Documents shall be transferred to the Employer at the end of the Maintenance Period.
- d) The Contractor shall guarantee that the material & workmanship incorporated into the plant/equipment are new and the best of their respective kinds for the service intended and that all items will be free from inherent defect in design, workmanship & materials, and that all equipment in its several parts will operate successfully at all capacities up to and including the maximum specified load without undue noise, heating, straining of parts, wear and vibration and that an ample factor of safety is included in every design.
- e) Guarantee/Warranty, shall be furnished by the Contractor upon forms approved by the Consultant/Engineer and shall be signed by both the Contractor and the Sub-Contractors whose work is involved.
- f) If the equipment/plant manufacturer's standard guarantee/warranty is applicable, the guarantee/warranty form and conditions must be submitted along with the equipment/plant 'technical submittals'.
- g) The Contractor's liability shall be limited to the replacement of defective parts that may develop in the equipment or material of his own work or manufacture or his Sub-Contractors under proper use and arising solely from faulty design, material, or workmanship provided always that such defective parts are not repairable at the Site, and are not essential in the meantime for commercial use of the equipment, are promptly returned to the Contractor's or Sub-Contractor's factory unless otherwise arranged. The equipment so replaced or repaired shall be in conformity with the specifications.
- h) For indigenous equipment, all replacements shall be made free of cost at the Site by the Contractor.



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- i) For imported equipment, all replacement shall be made free of cost ex-Karachi port, and the Employer shall arrange to have then cleared, pay all duties and hand-over thereplaced parts to the Contractor.
- j) The return of defective parts to the Contractor's or Sub-Contractor's factory shall be the Contractor's responsibility and shall be made at his expense. The Employer will, however, render such assistance as necessary to expedite the same. In the case of defective parts not repairable at the site but essential in the meantime for the commercial use of the equipment, the Contractor shall, whenever possible, replace free of cost at the site the said defective parts before the defective parts are removed from the site.
- k) If it becomes necessary for the Contractor to replace or renew any defective portions of the Plant under this clause, the provisions of this clause will apply to the portions of the plant so replaced or renewed until the expiration of six months from the date of such replacement or until the end of the guarantee period, whichever shall be later. If any defects are not remedied within a reasonable time, the Employer, after due notice to the Contractor, may proceed with the work at the Contractor's risk and expense without prejudice to any other rights which the Employer may have against the Contractor in respect to such defects.
- l) If the replacements or renewals are of such a character as may effect the efficiency of the plant, the Engineer/Consultant shall have the right to give to the Contractor within one month of such replacement or renewal, notice in writing that performance tests be made, in which case tests shall be carried out as provided in these Documents. Should such tests show that the guarantees of the Contract are sustained, the cost of the tests shall be borne by the Employer should the guarantees not be sustained, the cost of the test shall be borne by the Contractor.
- m) If during the guarantee period the services of the Contractor's personnel are required for the rectification or replacement of any defective part or work due to defective material, design or workmanship, such services shall be made by the Contractor without charge to the Employer.

Tests on Completion

- a) The Contractor shall give to the Engineer/Consultant/Engineer in writing 15 days' notice of the date after which he will be ready to make the "Tests on Completion". Unless otherwise agreed the tests shall take place within 10 days after the said date on such day or days as the Consultant/Engineer shall in writing notify the Contractor.
- b) If the Consultant/Engineer fails to appoint a time after having been asked to do or to attend at any time or place duly appointed for making the said tests, the Contractor shall be entitled to proceed in his absence and the said tests shall be deemed to have been made in the presence of the Consultant/Engineer.
- c) If in the opinion of the Consultant/Engineer the tests are being unduly delayed he may, by notice in writing, call upon the Contractor to make such tests within 10 days from the receipt of the said notice, and the Contractor shall make the said tests on such day within the said 10 days as the Contractor may fix and of which he shall give notice to the Consultant/Engineer. If the Contractor fails to make such tests within the time aforesaid, the Consultant/Engineer may himself proceed to make the tests. All tests so made by the Consultant/Engineer shall be at the risk and expense of the Contractor.
- d) The Employer, except where otherwise specified, shall provide free of charge subject to the provisions of Sub-clause (e) of this clause; electricity, fuel and water, as may be reasonably demanded to carry out such tests efficiently.



- e) If any portion of the works fail to pass the tests, tests of the said portion shall, if required by the Consultant/Engineer or by the Contractor, be repeated within a reasonable time upon the same terms and conditions, as aforesaid, save that all expenses to which the Employer may be put by the repetition of the tests shall be deducted from the Contract Price.

Inspection of Completed Works

- a) The Contractor is required to give the Employer/Engineer/Consultant due notification when he expects the work to be completed, a report in triplicate of the measurements carried out with regard to pressure testing of pipes and leak testing of duct work and other specified tests shall be attached to this application. The final inspection should then be carried out, without unnecessary delay, and if possible within four weeks.
- b) At the request of either party, inspection of such Sections of the work as will not be accessible after completion, or will be difficult to alter, which are to be taken into use by the Employer before the time of the final inspection, may be carried out in advance. (Advance Inspection).
- c) An inspection is to be carried out immediately before the expiry of the guarantee period. (Guarantee Inspection).
- d) Inspection of corrected faults or omissions noted in connection with advance, final, or guarantee inspection is also to be done (Supplementary Inspection).
- e) Inspections are to be carried out by the Consultant/Engineer or any other suitable and competent person appointed by the Employer.
- f) The costs of Advance Inspection, Final Inspection & Guarantee Inspection are to be met by the Employer, where the inspection has been carried out by a person appointed by him.

The costs of supplementary inspections and re-inspections are to be borne by the Contractor.

It is the responsibility of the Contractor to provide & pay for, any help or assistance necessary in connection with the inspection work.

- g) The inspector's decision as to what faults or omissions may have occurred is binding on both sides.
- h) The Contractor is required to carry out, without delay, any improvements, alterations or additions which may be considered necessary as the result of an inspection report.
- i) When the final inspection has taken place, the work is to be handed over to the Employer in so far as has been found to be in the state required by the Contract, and can suitably be put into use for this purpose for which it was intended.
- j) The Employer has the right to put into use any Section of the work contracted for and not approved at the time of inspection, provided this can be done without jeopardising the progress of the work, and he may use it without special compensation even before the faults or omissions have been made good.
- k) Where special dates are specified under the Contract for the completion of different Sections of the work, the provisions of this Clause are to apply to each part separately.



- i) The inspection report required under this Clause is to be delivered in writing, and signed by the inspector, giving the date on which it is to be made available for the parties 'inspection. The report should cover the following points:
 - i) State whether the work has been approved or not.
 - ii) State the reasons for failing to approve it, if it has not been approved.
 - iii) State faults or omissions for which the Contractor is to be held responsible, together with the time within which they are to be made good.
 - iv) Include notes on matters which do-not require immediate action, but ought to be finally settled in connection with the guarantee inspection.
 - v) The sum to which the Employer is entitled.
 - vi) Date on which the insurance taken out by the Contractor lapses.
 - vii) If the work has been approved at the final inspection, the date from which the guarantee/maintenance period is to run and the day after which it expires.
 - viii) Distribution of costs connected with the inspection.

Acceptance & Interim Operation

- a) After the performance tests, if the equipment supplied by the Contractor is found to meet the guarantee and any other specified requirement, and if all other work called for hereunder has been completed, the Employer's acceptance will be forth-coming and final payment will become due as provided for under the terms of payment. This acceptance shall, however, not relieve the Contractor of his responsibility for the first inspection.
- b) Should the equipment furnished by the Contractor fail to operate as required, or in case of failure to meet any of its guarantees, the Employer shall have the right to operate the equipment, using the Contractor's supervisory operating personnel, until such defects have been remedied and guarantees met with. In the event that defects necessitate the rejection of the equipment or any part thereof, the Employer shall have the right to operate the equipment until such time as new equipment is provided to replace the rejected equipment. Such operation shall not be deemed as an acceptance of any equipment.

Inspection & Testing During Manufacture

- a) The Consultant/Engineer shall be entitled at all responsible times during manufacture to inspect, examine and test on the Contractor's premises the materials and workmanship of all plant to be supplied under the Contract, and if part of the said plant is being manufactured on another premises the Contractor shall obtain the Consultant/Engineer's permission to inspect, examine & test as if the said plant were being manufactured on the Contractor's premises. Such inspections, examination or testing if made shall not release the Contractor from any obligation under the Contract.
- b) The Contractor shall give to the Consultant/Engineer reasonable notice in writing of the date and place at which the plant will be ready for testing as provided in the Contract, and unless the Engineer shall attend at the place so named within ten days of the date which the Contractor has stated in his notice, the Contractor may proceed with the test and also get the inspection and test carried out by an



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international testing agency of repute in the country of manufacture of the plant and thereafter forward to the Engineer duly certified copies of the test report carried out by him and the inter-national inspecting agency, who on basis thereof give his opinion/decision, Provided that the Engineer shall give the Contractor twenty four hours' notice in writing of his intention to attend the test.

- c) Where the Contract provides for tests on the premises of any Sub-Contractor, the Contractor shall provide such assistance, labour, materials, electricity, fuel, stores, apparatus and instruments as may be requisite and as may be reasonably demanded to carry out such tests efficiently.
- d) As and when any Plant shall have passed the tests referred to in this Clause the Consultant/Engineer shall furnish to the Contractor a certificate in writing to that effect.

END OF SPECIFICATIONS



SECTION 2.2

Basic Mechanical Materials and Methods

PART 1 – General

1.1 Related Documents:

Drawings and general provisions of Contract, including General and Special Conditions apply to this Section.

1.2 Summary:

- a) This Section includes the following basic mechanical materials and methods to complement other Division Sections.
 - i) Piping materials and installation instructions common to most piping systems.
 - ii) Non shrink grout for equipment installations.
 - iii) Field-fabricated metal and wood equipment supports.
 - iv) Installation requirements common to equipment specification sections.
 - v) Mechanical demolition
 - vi) Cutting and patching
 - vii) Touch-up painting and finishing
- b) Pipe and pipe fitting materials are specified in piping system Section.

1.3 Definitions:

- a) Pipe, pipe fittings and piping include tube, tube fittings and tubing.
- b) Finished spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, spaces above ceiling, crawl spaces and tunnels.
- c) Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- d) Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- e) Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

1.4 Quality Assurance:

- a) Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code – Steel."
- b) Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications."
- i) Comply with provisions of ASE B31 Series "Code for Pressure Piping."
- ii) Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.



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- c) ASME A13.1 for lettering size. Length of color field, colors and viewing angles of identification devices.
 - d) Equipment Selection: Equipment of greater or larger power, dimensions, capacities and ratings may be furnished, provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors bases and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.
 - e) For products manufactured for 50 Hz use, that do not carry or qualify for UL labels, a manufacturer's certification is required that the product meets the minimum requirements of Internationally Recognized Testing Laboratories (IRTL) meeting the requirements of International Electro Commission (IEC), which are deemed equal to UL and other U.S. testing laboratories.

1.5 Delivery, Storage And Handling:

- a) Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-and damage and prevent entrance of dirt, debris and moisture.
- b) Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.
- c) Protect flanges, fittings and piping specialties from moisture and dirt.

1.6 Sequencing And Scheduling:

- a) Coordinate mechanical equipment installation with other building components.
- b) Arrange for chases, slots and openings in building structure during progress of construction, to allow for mechanical installations.
- c) Coordinate the installation of required supporting devices and set sleeves in poured-in- place concrete and other structural components, as they are constructed.
- d) Sequence, coordinate and integrate installations of mechanical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning prior to closing in the building.
- e) Coordinate connection of mechanical systems with utilities and services. Comply with requirements of governing regulations, service companies, and consultants.
- f) Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.
- g) Coordinate installation of identifying devices after completion of covering and painting, where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

1.7 Shop Drawings:

- a) Shop drawing detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
- b) Coordination drawings for access panel and door locations.
- c) Prepare coordination drawings to a 1:50 scale or larger. Detail major elements,



components and systems of mechanical equipment and materials in relationship with other systems, installations and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the work. Include the following:

1. Proposed locations of piping, ductwork, equipment and materials. Include the following:
 - i) Planned piping layout, including valve and specialty locations and valve stem movement.
 - ii) Planned duct systems layout, including elbows radii and duct accessories.
 - iii) Clearances for installing and maintaining insulation.
 - iv) Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
 - v) Equipment services connections and support details.
 - vi) Wall penetrations.
 - vii) Fire-rated wall and floor penetrations.
 - viii) Sizes and location of required concrete pads and bases.
2. Scheduling, sequencing, movement and positioning of large equipment into the building during construction.
3. Floor plans, elevations and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.
4. Reflected ceiling plans to coordinate and integrate installations, air outlets, and inlets, light fixtures, communications systems components, sprinklers and other ceiling-mounted items.

PART 2 – Products

2.1 Pipe And Pipe Fittings:

- a) Refer to individual piping system specification Sections for pipe and fitting materials and jointing methods.
- b) Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 Joining Materials:

- a) Refer to individual piping systems specification Sections in Division 15 for special joining materials not listed below.
- b) Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.
 1. ASME B16.21, non-metallic, flat, asbestos-free, 3.2mm maximum thickness, except where thickness or specific material is indicated.
 - i) Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.
 - ii) Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.
 2. ASME B16.20 for grooved, ring-joint, steel flanges.



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- 3. AWWA C110, rubber, flat face, 3.2mm thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.
 - c) Flange Bolts and Nuts: ASME B18.2.1 Carbon steel, galvanised, except where other material is indicated.
 - d) Solder Filler Metal: ASTM B 32.
 - 1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent), and silver (approximately 5%), having 0.10-percent lead content.
 - e) Brazing Filler Metals: AWS A5.8.
 - 1. BAg1: Silver alloy.
 - f) Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - g) Flanged, Ductile-Iron Pipe Gasket, Bolts and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

2.3 Piping Specialties:

- a) Escutcheons: Manufactured wall, ceiling and floor plates; deep-pattern type, where required to conceal protruding fittings and sleeves.
 - i) Inside Diameter: Closely fit around pipe, tube and insulation of insulated piping
 - ii) Outside Diameter: Completely cover opening,
 - iii) Cast Brass: One-piece, with set-screw, with chrome plated finish.
 - iv) Cast-Iron Floor Plate: One-piece casting.
 - v) Finish: Polished chrome plate.
- b) Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
 - i) Description: Combination of copper alloy and ferrous; threaded, solder, plain and weld neck end types and matching piping system materials.
 - ii) Insulating Material: Suitable for system fluid, pressure and temperature.
 - iii) Dielectric Union: Factory-fabricated, union assembly, for 17.5 kg/cm² minimum working pressure at 82°C temperature.
 - iv) Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 10.5 or 21 kg / cm² minimum pressure to suit system pressures.
 - v) Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full- face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers and steel backing washers.

Provide separate companion flanges and steel bolts and nuts for 10.5 or 21 kg/cm² minimum working pressure to suit system pressures.
 - vi) Dielectric Couplings: Galvanized-steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 21 kg/cm² minimum working pressure at 197 degrees C temperature.



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- c) Mechanical Sleeve Seals: Modular, watertight, mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber seal elements to expand when tightened.
 - d) Sleeves: The following materials are for wall, floor, slab and roof penetrations:
 - 1. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends or BS1387 (medium grade).
 - 2. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets and pipe sleeve, with 1 mechanical-joint and conforming to AWWA C110 and 1 plain pipe-sleeve end.
 - i) Penetrating Pipe Deflection: 5 percent without leakage.
 - ii) Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts and rubber gasket conforming to AWWA C111, offhousing and gasket size as required to fit penetrating pipe.
 - iii) Pipe Sleeve: AWWA C151, ductile-iron pipe.
 - iv) Housing-to-Sleeve Gasket: Rubber or neoprene, push-on type of manufacturer's design.
 - 3. Cast-Iron Sleeve Fittings: Commercially made, sleeve having integral clamping flange, with clamping ring, bolts and nuts for membrane flashing.

2.4 Grout:

- a) Non shrink, Non-metallic Grout: ASTM C 1107, Grade B
 - i) Characteristics: Post-hardening, volume-adjusting, dry hydraulic-cement grout, non-staining, noncorrosive, nongaseous and recommended for interior and exterior applications.
 - ii) Design Mix: 350 kg/cm², 28-day compressive strength.
 - iii) Packaging: Premixed and factory-packaged.

PART 3 – Execution

3.1 Piping Systems – Common Requirements:

- a) General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 15 specify piping installation requirements unique to the piping systems.
- b) General Locations and Arrangements: Drawings (plans, schematics and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
- c) Install all piping with slopes to provide low point drainage.
- d) Install components having pressure rating equal to or greater than system operating pressure.
- e) Install piping in concealed interior and exterior location, except in equipment rooms and service areas



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- f) Install piping free of sags and bends.
 - g) Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited.
 - h) Install piping tight to slabs, beams, joists, columns, walls and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
 - i) Install piping to allow application of insulation plus 25mm clearance around insulation.
 - j) Locate groups of pipes parallel to each other, spaced to permit valve servicing.
 - k) Install fittings for changes in direction and branch connections.
 - l) Install couplings according to manufacturer's printed instructions.
 - m) Install pipe escutcheons for all pipe penetrations of concrete and masonry walls, wallboard partitions and suspended ceilings.
 - n) Install sleeves for all pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - i) Cut sleeves to length for mounting flush with both surfaces. Exception; Extend sleeves installed in floors of mechanical equipment areas or other wet areas 10 mm above finished floor level, unless otherwise indicated on drawings.
 - ii) Build sleeves into any new walls and slabs as work progresses.
 - iii) Install large enough sleeves to provide 6mm annular clear space between sleeve and pipe or pipe insulation.
 - 1. Steel Pipe Sleeves: For pipes smaller than 150mm.
 - 2. Steel Sheet-Metal Sleeves: For pipes 150mm and larger, penetrating gypsum-board partitions.
 - 3. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 50mm above finished floor level.
 - 4. Seal space outside of sleeve fittings with non-shrink, non-metallic grout.
 - iv) Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using approved elastomeric joint sealants.
 - o) Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 25mm annular clear space between pipe and sleeve for installation of mechanical seals.
 - i) Install steel pipe for sleeves smaller than 150mm.
 - ii) Install cast-iron "wall pipes" for sleeves 150mm and larger.
 - iii) Assemble and install mechanical seals according to manufacturer's printed instructions.
 - p) Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings and floors at pipe penetrations. Seal pipe penetrations with approved fire stopping sealant material.



- q) Verify final equipment locations for roughing-in.
- r) Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping system specification Sections
 - i) Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - ii) Remove scale, slag, dirt and debris from inside and outside of pipe and fittings before assembly.
 - iii) Soldered Joints: Construct joints according to AWS “Soldering Manual”, Chapter 22 “The Soldering of Pipe and Tube”.
 - iv) Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream thread pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:
 - 1. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
 - 3. Align threads at point of assembly.
 - 4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - 5. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe section that have cracked or open welds.
- s) Piping Connections: Except as otherwise indicated make piping connections as specified below.
 - i) Install unions, in piping 50mm and smaller, adjacent to each valve and at final connection to each piece of equipment having 50mm or smaller threaded pipe connection.
 - ii) Install flanges, in piping 60mm and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
 - iii) Dry Piping Systems (Gas): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - iv) Wet Piping Systems (Water): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.2 Equipment Installation – Common Requirements:

- a) Install equipment to provide the maximum possible headroom, where mounting heights are not indicated.
- b) Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to the Consultant.
- c) Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.
- d) Install mechanical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. Connect equipment for ease of



disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

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

3.3 Direction of Metal Supports And Anchorage:

- a) Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor mechanical materials and equipment.
- b) Field Welding: Comply with AWS D1.1 “Structural Welding Code-Steel”.

3.4 Demolition:

- a) Disconnect, demolish and remove work specified under Division 15 and as indicated.
- b) Where pipe, ductwork, insulation or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- c) Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.
- d) Removal: Remove all demolished materials and equipment from the project site.
- e) Temporary Disconnection: Remove, store, clean, reinstall, reconnect and make operational equipment indicated for temporary or permanent relocation.

3.5 Cutting and Patching:

- a) Cut, channel, chase and drill floors, walls, partitions, ceilings and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved. Obtain prior approval of Consultant before performing work.
- b) Repair cut surfaces to match adjacent surfaces.

3.6 Grouting:

- a) Install non-metallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates and anchors. Mix grout according to manufacturer's printed instructions.
- b) Clean surfaces that will come into contact with grout.
- c) Provide forms for placement of grout, as required.
- d) Avoid air entrapment when placing grout.
- e) Place grout, completely filling equipment bases.
- f) Place grout on concrete bases to provide a smooth bearing surface for equipment.
- g) Place grout around anchors.
- h) Cure placed grout according to manufacturer's printed instructions.

END OF SPECIFICATIONS



SECTION 2.3

Painting & Coating

General:

Painting shall include furnishing labor, materials, equipment, ladders, scaffolding, protective covers, other items required to prepare and finish surfaces of work specified herein or in any of the other sections. Paint color scheme shall be specified at the time of painting or earlier and shall be based on American Standard "Scheme for Identifications of Piping System" ASA A-13.1 of 1975 & shown on FND detail drawing no: FND/D/57 & 58, which form part of these specifications.

Surface Preparation:

- a) Surface to be painted shall be dry and free from burrs, weld spatter, flux, dirt, dust, rust, loose mill scale, grease, oil and other foreign matter before any paint is applied.
- b) All rust and loose mill scale etc. shall be removed by thoroughly chipping, scraping and wire brushing. Oil, grease, dust etc. shall be removed by washing down with a suitable solvent, as recommended by the paint manufacturer, and wiping with clean rags.
- c) The minimum acceptable standard for surface preparation shall be SSPC-SP2, 'Hard Tool Cleaning'.
- d) All tools shall be used in such a manner so as not to leave rough or sharp surfaces. No cuts shall be made on steel surfaces.
- e) Before applying the finish coat the primed surface shall be scuffed lightly with sandpaper recommended by the paint manufacturer.

Application:

- a) All material shall be applied in strict accordance with the paint manufacturer's directions unless otherwise specified.
- b) Paint shall be applied by brush, spray or any other paint manufacturer's approved method in such a manner that a uniform thickness (as per manufacturer's recommendation) is maintained in each coat and no defects are produced in the previous coats.
- c) Each coat shall preferably be of a different color so as to produce a contrast assuring complete covering by the next coat. Sufficient time shall be allowed between coats to permit drying. A minimum of 24 hours between applications on any one surface shall be allowed unless otherwise specified by the manufacturer.
- d) No painting work shall be done on exterior surfaces during rainy, damp, foggy or dusty weather and no painting material shall be applied if the temperature is above 122°F (50°C) or below 41°F (5°C). Painting work shall be avoided in cases where the surface is damp or when there is dirt and dust deposition due to blowing winds. The Owner's representative shall determine whether the conditions are suitable for painting or not.
- e) The primer coat of paint shall be applied as soon as possible after the surface preparation but, in any case, on the same day.



- f) Before application of painting material, the Owner's/Engineer's representative shall inspect and approve the quality of surface preparation and the preparation of painting material.

Paint System:

- a) Materials & Equipment: All materials & equipment factory fabricated, imported or otherwise shall be provided with a fresh coat of paint of same color as the original factory paint, if in the opinion of the Consultant the same has deteriorated to an extent to require fresh painting. Paint shall be applied as per the accepted norms and as directed by the Consultant. The items covered under this head shall include chillers, air handling units, and fan coil units, pumps, cooling tower, fans and other equipment that are a part of this contract.
- b) Un-insulated Surfaces: including piping, valves, and fittings, tanks, etc., shall be painted with two coats of primer followed by two coats of enamel paint.
- c) Insulated Surfaces including piping, valves, fittings, vessels, etc., shall be painted with two coats of primer.
- d) Insulated piping provided with cladding, installed in ceiling cavities & concealed shafts, need not be painted. Exposed insulated piping and piping in Mechanical Equipment Rooms, with or without cladding, shall be painted with galvanizing primer and two finish coats of enamel paint.
- e) Underground Piping shall be painted with one coat of asphalt-based primer followed by two layers of PVC anti-corrosion tape of approved quality.
- f) Galvanized Piping exposed to view shall be painted with special primer and two coats of enamel paint.
- g) Hangers & supports for ducting and piping shall be galvanized, and need not be painted.
- h) Galvanized Sheet Metal Duct work created in ceiling cavities & shafts need not be painted. Exposed Ducts in finished areas shall be painted with galvanizing primer and two finish coats of enamel paint for bare ducts, and two finish coats of enamel paint for insulated ducts. All insulated ducts in Mechanical Room shall also be painted with two coats of enamel paint.

Paint:

- a) Primer for Iron Surfaces shall be Dulux Synthetic Red Primer as manufactured by ICI. This should preferably be Lead free.
- b) Primer for Galvanized Surfaces shall be ETCH PRIMER AND "ZINC CHROMATE YELLOW PRIMER" as manufactured by ICI.
- c) Finishing Paint shall be generally enamel paint, unless the application requires special paint, in which case suitable special paint shall be used.
- d) All paint supplied from factory shall be ready for application. The application of thinner or any other material shall be subject to approval by the Consultant. In any case all instructions of the paint manufacturer shall be strictly followed.



Galvanizing:

Galvanizing shall comply with BS 729. The term 'galvanized' shall apply to hot dip or electrolytic galvanizing, zinc spraying or cadmium plating. All surfaces shall be degreased, washed with mineral turpentine and given a coat of latex based primer prior to the application of final coats.

After fabrication, pickle or abrasive blast clean all steelworks to be hot dipped galvanized

Powder Coating:

All surfaces to be powder coated shall be cleaned as for galvanizing. Powder shall be applied by using an electrostatic gun in a clean atmosphere to ensure that no dust particles or other impurities blemish the final product.

Coated components shall be baked in special ovens at controlled and accurately predetermined temperatures, and powder applied to a thickness of 0.0125mm on wearing surfaces and 0.01mm on non-wearing surfaces, unless otherwise specified.

END OF SPECIFICATION



SECTION 2.4

Valves & Strainer

Butterfly Valves:

Butterfly valves shall be used applications requiring 50mm or larger diameter valves, and shall have a rating suitable for the service intended, but a minimum of 10 bars.

Butterfly valves shall be wafer type with modular cast iron body, suitable for mounting between ANSI 150 lb flanges. Two flanges plus required nuts and bolts shall be provided with the valves.

The center disc shall be of stainless steel, with extended shaft for accommodating insulation depth.

The liner shall be replaceable, of Nitrile or EPDM rubber. Each valve shall be provided with one replaceable liner as spare.

Actuator shall be worm gear type of aluminum or cast iron, weather proof to IP65, complete with hand wheel, position indicator, and with adjustable stops at both fully open and fully closed positions. The actuator shall be self-locking, lubricated for life and free of maintenance.

Gate Valves:

a) Ø 50mm (2 inch) & Smaller:

125 psi (860 kPa) SWP, 250°F (120°C), threaded ends, bronze body, union bonnet, non-rising stem, wedge disc. Hand wheel nut, packing nut, gland, stuffing box, bonnet, bonnet ring, disc and body shall be of bronze. Hand wheel shall be of malleable iron. Packing shall be suitable for specified usage but shall not use asbestos. Stem shall be manganese bronze.

b) Ø 65mm (2 1/2 inch) & Larger:

125 psi (860 kPa) SWP, 250°F (120°C), cast iron body bronze mounted with flanged ends. The disc shall be of solid wedge disc type, with outside screw and yoke (rising stem). Body and bonnet shall be of cast iron. Wedge shall be of cast iron with bronze disc. Seat rings shall be bronze. Packing shall be suitable for specified usage but shall not use asbestos. Packing gland shall be cast iron. Yoke shall be of cast iron and yoke nuts shall be of bronze. Hand wheel shall be of cast iron.

Globe Valves:

a) Ø 50mm (2 inch) & Smaller:

125 psi (860 kPa) SWP, 250°F (120°C), bronze, threaded ends. Body, bonnet, disc holder, stem lock nut, packing nut and disc lock nut shall be of bronze. Hand wheel shall be of malleable iron with stem of manganese bronze. Renewable composition disc shall be provided suitable for water & steam. Packing shall be suitable for specified usage, but shall not use asbestos.

b) Ø 65mm (2 1/2 inch) & Larger:

125 psi (860 kPa) SWP, 250°F (120°C), cast iron body, bronze mounted with bronze faced disc and yoke bonnet, and shall be flanged. Hand wheel, gland, bonnet and body shall be of cast iron. Stem shall be of manganese bronze. Packing shall be suitable for specified usage but shall not use asbestos. Stem lock nut, disc and seat ring shall be of bronze. Disc shall be



renewable composition type.

Ball Valves:

- a) Ø 50mm (2 inch) & Smaller:

125 (860 kPa) SWP, Screwed; two-piece cast bronze body, chrome plated brass ball, Teflon ball and flange seals, rods silicon brass stem, Teflon and Viton "O" ring stem seals, zinc plated carbon steel handle with vinyl grip and brass handle nut.

Swing Check Valves:

- a) Ø 50mm (2 inch) & Smaller:

125 psi (860 kPa) SWP; 250°F (120°C), threaded ends. Cap, hinge pin, body, hinge, disc nut and disc shall be of bronze.

- b) Ø 65mm (2 1/2 inch) & Larger:

125 psi (860 kPa) SWP; 250°F (120°C), cast iron body, including valve cap and disc. Hinge pin, seating and disc ring shall be of bronze. Ends shall be flanged.

Guided Check Valves:

- a) Ø 80mm (3 inch) & Smaller:

125 (860 kPa) SWP, Screwed, (pump discharge): bronze or cast steel wafer body, bronze or stainless steel trim, Centre guided, silent type.

- b) Ø 100mm (4 inch) & Larger:

125 (860 kPa) SWP, Flanged, (pump discharge): bronze or cast steel globe body, bronze or stainless steel trim, Centre guided, silent type, flanged.

Y-Strainers:

- a) Ø 50mm (2 inch) & Smaller:

125 psi (860 kPa) SWP; 250°F (120°C), "Y" type, with bronze body and threaded ends. Screen shall be of 20 mesh Monel.

- b) Ø 65mm (2 1/2 inch) & Larger:

125 psi (860 kPa) SWP; 250°F (120°C), cast iron body with flanged ends. Screen cover shall be provided with blow off tapping. Screen shall be of perforated stainless steel, (33 holes per sq.cm.), with 1.1mm diameter and 0.41mm thickness.

Bucket Strainers:

Shall be fabricated from Ø 300mm, Black Steel, Schedule 40 pipe. Flanges shall conform to ANSI B16.5. After fabrication the entire assembly shall be hot dipped galvanized. Bolts shall be galvanized. The strainer shall consist of a brass perforated screen bucket. Perforation shall be as approved.

Pressure Reducing Valves (PRV):

Pressure Reducing Valves (PRV's) shall be pilot operated.

PRV's shall be suitable for the service specified & shall be able to maintain downstream pressure at all flow rates & shall be sized for the maximum flow & pressure specified or required on the basis of manufacturers published data.



PRV's upto Ø 40mm shall be of bronze with screwed ends, while higher size PRV's shall be of cast-iron body with flanged ends. Nominal working pressure shall be 16 barg. PRV shall be able to sustain working temperature up to 70°C (158°F). Pilot shall be adjustable for 1.4 barg to 12 barg.

Float Valve:

Shall be best quality heavy duty type provided with Ø 150mm Plastic ball and heavy duty bronze float arm. Valve shall provide tight shut off at full closed position.

Foot Valve for Pump Suction Line:

Shall be installed where required or indicated on the drawing. Foot valve shall be of brass, and shall be provided with integral strainer. Foot valve shall be provided with a spring loaded vertical check disc with gasket for tight shut-off.

Gaskets:

General: non-asbestos, compressed gasket material with high-strength aramid fibers bonded with high grade nitrile NBR synthetic rubber, suitable for 750°F (400°C) and 1450 psi (10000kPa).

Thread Lubricant:

General: non-hardening, non-poisonous as approved.

Dielectric Couplings:

General: provide sweat-to-screw dielectric couplings at junction of copper pipe to steel pipe and insulation bushings for flanged connections to steel or cast iron valves and fittings.

Installation of Valves and Strainers:

All gate valves, globe valves, check valves, control valves, butterfly valves, drain cocks, etc. necessary for satisfactory operation of the system shall be provided whether indicated or not. All valves having stem over 2m height shall be provided with galvanized chain operators. Valves in horizontal lines shall be installed with stem horizontal or above. Isolation gate valves shall be installed on each side of each piece of equipment as pumps, coils and other similar items; at the midpoint of all looped mains; and at any other points indicated or as required for draining, isolation or sectionalizing purposes. Each valve shall be identified with not less than 35mm round or square black over white laminated plastic tags secured to valve with suitable brass chain. Tags shall be engraved to identify valve by number and valve function. Strainers shall be installed wherever necessary to protect equipment and control valve, where proper functioning would be affected by dirt on the seat or scoring of the seat. Strainers shall be arranged not to clog piping and allow easy disconnection for change. All strainers 50mm and above shall be provided with Ø 20mm ball valves for blow-off. Strainers shall allow removal of accumulated dirt and screen replacement without disconnecting main piping.

END OF SPECIFICATIONS



SECTION 2.8 Plumbing Specialties

Trapped Floor Gully:

Shall be of uPVC similar to Terrain model 279/281 with inlet model 282/283. The drain shall be provided with a trap having a minimum water seal of 50mm. The drain grating and all visible parts shall be of CP brass with level adjusting arrangement.

Vent Cows:

All vent-lines terminating above the building shall be provided with best quality uPVC vent cows similar to Terrain model 150.

Clean-out for Finished Floor Areas:

Shall be similar to ZURN Model No. Z 1323. These shall be of cast iron, designed to provide an air tight seal. The clean-out shall be provided with a threaded brass plug that shall fit into the hub and provide an airtight seal. A key to unscrew the plug shall be provided. A brass ferrule shall be provided, that shall screw into the hub with the capacity of level adjustment. The ferrule shall be provided with a round scoriated brass top and a long brass screw threaded into the plug below, shall hold down the top cover. All visible parts shall be chrome plated.

Stainless Steel Floor Trap/Waste:

These shall be fabricated out of SS 304 in accordance with FND drawing.

Stainless Steel Floor Outlet:

These shall be fabricated out of SS 304 in accordance with drawing.

Roof Drain: (Cast iron)

Shall be similar to Zurn Model Z 100, cast-iron body with combination membrane flashing/clamp/gravel guard and low silhouette dome.

Roof Drain (PVC)

These shall be similar to the cast-iron roof drain specified above, except manufactured in uPVC. It shall have a membrane flashing arrangement and gravel guard with a low silhouette dome.

Drain Gratings: (Mild Steel)

Drain gratings shall be installed on open channel drains where shown on the drawings. These shall be fabricated out of mild steel formed members & hot dipped galvanized after fabrication, in accordance with details shown on the drawings. Edge support angle iron member shall be grouted into the concrete edge of the channel, and the drain gratings laid loose on top. Grating length shall not exceed 4ft, & each grating shall fit level & smoothly on the support member.

Drain Gratings (PVC)

These shall be installed in open channel drains where shown on the drawings. Gratings shall be of PVC, width as shown on drawings & BOQ, and with sufficient thickness to sustain vehicle loading without damage. The PVC drain gratings shall be installed on galvanized angle-iron supports edging the top of the open drain channel, and grouted into the concrete floor using hold fasts. The PVC drain grating shall be laid loose into the angle iron lined channel width.

PVC Drain Channel & Grating



This shall consist of uPVC rounded drain channels, of width & depth as shown on plans/BOQ, and provided with uPVC drain gratings as per Clause 9 above.

END OF SPECIFICATIONS



SECTION 2.9

Domestic Water Pumps

Scope:

These specifications cover vertical split case end suction centrifugal pumps for hydronic applications. Pump curves certifying pump operation, BHP & NPSH curves shall be submitted to the Consultant for approval.

Service Condition:

Pumps shall be designed and constructed to operate satisfactorily in a typical hydronic application, and shall be the product of a manufacturer regularly engaged in the production and marketing of these pumps.

Operating Conditions:

The flow rate, pump head & other required data are indicated in the EQUIPMENT SCHEDULE and the pumps supplied shall conform to these requirements. The Contractor is required to ensure non-overloading selection of motor for parallel pumping operation.

NPSH required by the pump shall be stated & the NPSH as available checked by the Contractor for the specific application. The pump RPM shall be as specified in the EQUIPMENT SCHEDULE. Pump casing shall be designed to withstand the discharge pressure specified on the Schedule Sheet plus the static head on the system, plus 50% of the total head, but not less than 125 psi (8.5 bars).

Pump Construction:

Details of pump construction shall be as follows:

- a) Casing shall be vertical split with centerline discharge, foot-supported and made of cast iron. Casings shall be provided with tapped & plugged holes for priming, vent & drain.
- b) Casing Connections: shall be ANSI B16.1, 125PSI (8.5 bars), ASA Standard flat face flanges.
- c) Casing Wearing Rings: Easily replaceable casing wearing rings of suitable material for service shall be provided in front and rear of impeller.
- d) Casing Joint Gasket: An O-ring shall be provided at the casing joint to prevent leakage.
- e) Impeller: shall be the single section enclosed type of bronze. Impeller shall be statically and hydraulically balanced. Drilled holes shall be provided through the impeller hub to balance axial thrust loads and keep positive pressure on the stuffing box. Impeller shall be keyed & locked to the shaft with a hexagonal head impeller nut and shall be easily removable without the use of special tools.
- f) Shaft: Pump shaft shall be high strength stainless steel sized to provide a minimum amount of deflection. Shaft shall be protected in the stuffing box area by a replaceable shaft sleeve.
- g) Seal: Pumps shall be provided with gland packing seal or mechanical seal as indicated in the EQUIPMENT SCHEDULE.



- h) Bearing Frame: shall be rigid, one piece cast iron construction. Frame shall be provided with catch basin reservoir with tapped drain hole to collect and pipe away stuffing box leakage.
- i) Bearings: shall be ball type on both ends of the frame. Both bearings shall be locked in place and be sized to provide long life under thrust loads encountered. Both bearings shall be enclosed by replaceable box.
- j) Bearing Lubrication: Ball bearings shall be grease lubricated with provisions for the addition & relief of grease.
- k) Deflector: A replaceable shaft deflector of non-corrosive material shall be provided to prevent the entrance of contaminants into the pump bearings at the inboard end of the bearing frame.

Baseplate & Coupling:

- a) Baseplate: shall be of heavy duty, fabricated steel or cast iron, sufficiently rigid to support the pump and the driving motor with tap hole to pipe away leakage and condensation.
- b) Coupling: shall be spacer type.
- c) Coupling Guard: shall be metallic and fastened to baseplate and conform to the requirements of ANSI B.15.1.

Rotation:

Pump shall have clockwise rotation viewed from its driven end.

Motor:

Motor shall conform to specifications given. It shall be selected in accordance with the pumps non-overloading performance characteristics. Motors shall be mounted with pump on baseplate in manufacturer's plant and shipped as one unit.

Foundation:

Foundation for the pump shall be 1:2:4 concrete, sized to provide an inertia block having a mass equal to 3 times the weight of the pump and motor. The foundation shall be isolated from the structure and plant room floor by using 40mm thick high density cork. Edges of the foundation shall be provided with 25×25×3mm angle iron frame work and painted with two coats of oil paint. When shown on drawings, or with pumps mounted on upper floors, the pump's concrete foundation shall be supported on four suitably sized spring isolators.

Installation:

During installation, the pump shall be properly levelled, grouted in and realigned before operation in accordance with the manufacturer's recommendations. Suction & discharge connections shall be installed through flexible connectors, and electrical wiring shall be done. Drain lines from pump base plate at drip pocket shall be installed equal to the size of the opening.

Commissioning and Testing:

The pump shall be commissioned and tested by the Contractor, in accordance with the manufacturer's recommendations. The pump operational curve shall be identified by taking no-flow reading and shall be charted on the pump curve. Operational point at full flow shall be identified and submitted to the Consultant. Tests shall be conducted and test report submitted to the Consultants and approval obtained.



Reference Specification

The following specifications shall be construed to be part of these specifications.

- 01 10 00 - Basic Mechanical Requirement
- 01 10 10 - Basic Mechanical Materials and Methods
- 09 90 00 - Painting & Coating

END OF SPECIFICATIONS



SECTION 3.2

Soak Well

Percolation Test:

Prior to construction of the Soak well, this Contractor shall be required to perform a percolation test to determine the absorption capacity of the soil. The test shall be conducted as follows:

- a) A test pit shall be dug approximately 1.5m in diameter and to such a depth as to reach porous soil, but not less than 2.4.
- b) In the bottom of this pit a 300mm square and 300mm deep hole shall be made.
- c) The hole shall be filled with water for a depth of 175mm. For pre-watering purposes, the water level shall be allowed to drop to 150mm, before time of recording is started.
- d) After the level of the water has dropped to 150mm, the time required for the water level to drop every inch shall be recorded, till the level is 50mm.
- e) The hole shall again be refilled and the test repeated.
- f) After the test, the thickness of the porous soil below the point of percolation shall be determined by using a soil auger, and the depth indicated in the test report.
- g) If sub-soil water is encountered, the test report shall indicate the level of the same.

The final number and size of the soakage pits shall be provided to the Contractor after the result of the percolation test are received.

Construction:

- a) Size: The soakage well shall be constructed as shown on the drawing. The size and quantity of the soakage pits shall be finally determined after receipt of the percolation test results by the Consultants. Soakage pit shall not penetrate ground water table.
- b) Excavation: The excavation of the soakage pit shall be greater in diameter than the outside diameter of the vertical side walls to allow for the footing. To prevent soil collapse, excavation of the soil at an angle may be required.
- c) Annular Space: The annular space between the outside of the vertical walls and the excavation shall be filled with broken stone, coarse gravel or other suitable material.
- d) Bottom: The soak well bottom shall be open, with an outer ring to support the side walls.
- e) Side Walls: The side walls shall be made of brick up to the level of the porous soil. In the porous soil strata, 8 columns shall support the masonry wall on a lintel. The columns shall support the lintel and shall have a footing at the bottom of the soakage pit. The space between the columns shall allow the effluent to pass out into the porous soil.
- f) Top: the soak well top shall be of 200mm thick 1:2:4 RCC and shall be provided with one 600mm C.I. frame and cover, heavy duty type.
- g) Reinforcement: Reinforcement to construct a structurally sound structure shall be provided as per good engineering standard.



- h) Payment: Payment shall be made per unit rate for the complete soak well as specified in the BOQ, and shall be deemed to include the cost of the percolation test, excavation, backfilling, all masonry & concrete works, soak-well fillers, manhole cover and otherworks required to complete the soak well in all respects.

END OF SPECIFICATIONS



SECTION 3.3

Septic Tank

Septic Tank shall be of dimension as shown on the drawings. Tank shall be constructed of 1:2:4 RCC, having specifications given in the civil works section. The external face of the septic tank shall be provided with 15mm thick cement plaster and coated with PB-4. The complete internal surface of the tank shall be provided with 15mm thick mudlo plaster.

The Contractor shall submit structural shop drawings of the Septic Tank prepared by a certified structural engineer, together with all calculations & shall submit the same to the Consultants for review. Work shall be carried out on drawings approved by the Consultants.

The septic tank shall be provided with cast iron frame and manhole covers where shown on the drawings. The frame shall be embedded in the top slab of the tank, as neatly as possible.

The sewage shall enter the tank through an inlet channel, which shall feed 2 Nos. Ø 150mm cast iron dip pipes. The dip pipes shall have the outlet 450mm below the T.W.L. in the tank. The level of the invert of the inlet pipe should not be below or more than one inch above the T.W.L. in the tank.

The tank shall be provided with a Ø 150mm vent outlet provided with an elbow to face the outlet downward.

The septic tank shall be provided with built-in steps of galvanized wrought iron. The rungs shall not be less than 250mm in width and spaced approximately 300mm apart, and alternate rungs shall be staggered or offset 150mm. Bars or rods where used for steps shall not be less than 25mm in diameter.

Payment shall be made for the complete construction of the septic tank, as per the unit price quoted in the BOQ, and shall include all material and labor necessary for a complete installation and shall include excavation and backfilling, and all accessories.

END OF SPECIFICATIONS



SECTION 3.4

Plumbing Fixtures & Accessories

General:

All fixtures shall be free from imperfections, true as to line, angles, curves and colors, smooth, water tight and complete in every respect.

All fixtures specified to be of vitreous ware, shall be fired vitreous china ware of the best quality, non-absorbent and burned so that the whole mass is thoroughly fused and vitrified producing a material white or colored, which when manufactured will show a homogeneous mass, close grained and free from pores. The glazing and vitreous china fixtures shall be of a color approved by the Consultant, thoroughly fused, and united to the body, without discoloration, chips, or flaws and shall be free from craze. Warped or other imperfect fixtures will not be accepted.

All plumbing fixtures supplied shall be as specified & from source indicated.

All fixtures shall be furnished from one manufacturer unless otherwise specified.

All fittings, cast brass set screws, escutcheons faucets, traps, exposed piping, etc., shall be of brass, chrome plated over nickel plate with polished finished. Any supports nuts etc., visible shall likewise be chrome plate over nickel plate.

After installation of plumbing accessories, the Contractor shall ensure their protection against damage, misuse and general deterioration. Fixture outlets shall be plugged with suitable material to prevent entry of external debris. All chrome plated and other metallic fittings shall be provided with a coat of grease to prevent their deterioration. All items prior to handing over must be in perfect condition in the visual and operational sense.

All fixtures and accessories shall be first quality, imported, unless otherwise indicated.

All cracks between fixtures and walls shall be filled using approved silicone sealant.

Fixtures & Fittings:

See Drawings & BOQ.

Installation:

- a) All screws, bolts and other anchoring devices shall be of stainless steel or chrome plated brass.
- b) Install toilet fixtures, fittings and accessory units in accordance with manufacturer's instructions, using fasteners, which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored with brass screws and nylon anchors at locations and at heights indicated in drawings.
- c) Set accessories plumb, level, and square at locations approved, in accordance with manufacturer's instruction for type of substrata involved.
- d) Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.



- e) Remove and replace accessories which are broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.
- f) Clean and polish all exposed surfaces after removing temporary labels and protective coatings.

END OF SPECIFICATIONS



SECTION 3.5**Excavation and backfilling****Excavation:**

Excavate in such a manner that buried items can be laid to the alignment and depth indicated; excavate only so far in advance of pipe laying as approved.

- a) Width of trenches:
 - i) Hold to a manner that buried items can be laid to the alignment and depth indicated; excavate only so far in advance of pipe laying as approved.
 - ii) Width at the top of the trench; Not more than 600mm plus outside diameter of pipe.

Back-filling:

- a) In filling around pipe, deposit backfill material in successive horizontal layers not exceeding 150mm thickness before completion. Compact each layer thoroughly by means of approved mechanical tampers. Take special care to obtain compaction under pipe haunches. Deposit backfill adjacent to pipes on both sides to approximately same elevation at the same time. Continue this method of filling and compacting until backfill is at least 450mm above top of pipe.
- b) Backfilling for the remainder of pipe trenches to sub-grades of paved or landscaped areas: Perform by mechanical tamping and rolling equipment, except that use of such equipment is prohibited when said use may result in damage to pipe lines or structures.
- c) Moisten backfill as necessary for proper compaction. Water setting of fill will not be permitted.
- d) Complete backfilling of pipe trenches as soon as possible after the pipe is laid and tested.
- e) Restore to original condition existing pavements, roadways, walkways, curbs and landscaped areas disturbed during the progress of the excavation and backfill work.
- f) Compaction: Minimum of 90% of modified AASHTO maximum density as defined by ASTM D-1557.
- g) Fill not compacted to the required density: compact until the specified density is achieved or remove the layer and replace with new material.

END OF SPECIFICATIONS



SECTION 3.6

Over Head Storage Tank

High quality fiber glass reinforced plastic (FRP) tank shall be supplied and installed where shown on the drawings. FRP tank shall be smooth inside, with sufficient thickness & additives in the material to prevent sunlight from penetrating.

Tank shall be suitable for drinking water application and shall be so certified. Manufacturer shall be selected based on satisfactory manufacturing record of at-least 5 years.

Tank shall be provided with high level inlet connection, & high level overflow connection, a low level outlet connection, a low level drain connection, and an access manhole to allow cleaning. Tank shall be provided with legs/supports for direct mounting on a concrete slab.

Tank capacity shall be as stated on the drawings or Bill of Quantities, and the dimensions & nozzle sizes on the tank shall be as approved by the Consultant.

END OF SPECIFICATIONS



SECTION 3.7

DRILLING OF BORE HOLE AND TUBE WELL

Objective:

The objective of this Technical Specifications is to carry-out Drilling of a Test borehole and Conversion into Tube well as per the standard drilling procedures. The following procedure is to be adopted for exploration of underground water reserves through Straight Rotary.

Drilling Method

1 - Drilling of borehole

The scope of work will include the following but not necessary be limited to the following:

- a - Selection of location & depth of the borehole
- b - Mobilization and Demobilization
- c - Drilling of Bore hole
- d - Geo-Physical Logging
- e – Water sampling in three (03) different zones
- f - Submission of Test bore Report
- a - Selection of location of Boreholes

Location of borehole will be selected as per the result of ERS Survey or on Client's discretion.

b - Mobilization & Demobilization

All necessary equipment will mobilize at the drilling location in order to perform the work at the selected location in a satisfactory manner under the existing conditions. Demobilization will consist of removal of all the equipment from the site after completion of the work.

c - Drilling of Test Borehole

Test borehole drilling of 6-8" dia will be carried out with straight rotary rig with straight circulation rotary drilling will be used for the job. Drilling fluid have to circulate down the drill pipe and out openings in the bit where it cleans, cuttings from beneath the bit, cools the bit and carries cuttings to the surface where they are separated from the fluid. Weight on the bit has to apply by the heavy drill collar assembly.

d - Geo Physical Logging

The types of geo physical logs which have to carry-out for hydro-geological work are as follows:

- SP
- SPR
- Natural Gamma
- Gamma-Gamma Density Log

The purpose of Geo Physical Logging is to demarcate water bearing formation which is very useful in designing of blind/strainers in the well.



A comprehensive Report with all the pertinent results shall be submitted along with recommendations and tube well casing design and the recommended depth of the bore to be converted into tube well.

2- Conversion of Test bore into Tube well

Conversion of test borehole will be carried-out by enlarging the 6-8" dia. borehole into 12" dia. The conversion of test bore into tube well is based on the results of Test borehole drilling Report.

3- Classification, Procurement and Installation of Blind & Strainer

The 10" dia. uPVC shall be of Class "E" Supreme/ E Plus, with 16mm.-18mm. wall thickness (blind and strainers) will be procured & inserted in the borehole. The Lab Report and Quality Certificate of uPVC Casing shall be reviewed before placing the order. The setting depth of blind and strainer shall be designed as per the actual lithological conditions & Geo Physical Logging.

The slot size of strainers shall be as designed as per the geological results of the bore. The strainers will be installed in water yielding formations and blind pipe sections in non-water Yielding formations.

4- Classification, Procurement and Installation of Piezometer pipe

A 1 – 1.5" dia. uPVC pipe is to be installed in the annular space of the well upto the depth of 700ft. for measurement of water levels in the bore. The standard of 1-1.5" dia. uPVC pipe, shall be Sch. 40.

5- Silica Gravel

The course sand/gravel (shrouding) will be cleaned, washed, water-worn, calcium free hard and well rounded. The size of gravel shall be finalized on the basis of formation encountered and the slot size of strainer.

Gravel will be placed at constant rate to provide a continuous and uniform gravel flow so as to minimize segregation and of particle sizes. In all the cases water will be circulated steadily during gravel placement, by inserting the drilling rod into pump housing and operation the circulation pump on the drilling rig. The water level in the annular space outside the pump housing shall be maintained at or above natural ground surface level by return flow from the cutting pit.

7- Development of Tube well with air-compressor

Development will consist of all work required in connection with the development of tube well to produce the design capacity of sand-free water with a minimum draw down and the testing of tube well to determine the effectiveness of the development will include.

The development of the tube well will be performed with compressed air by using a compressor,



capable of developing a suitable pressure necessary for complete the development operation.

8- Long Duration Pumping Test

A temporary Submersible pump with motor & accessories will be installed and run for 48hrs. The purpose of the long duration pumping test is to ascertain the safe discharge from the well so the Submersible Pump, Motor & Accessories will be selected as per the discharge in the well. Water samples shall be obtained from the well and sent to the laboratory for chemical analysis.

9- Chemical Analysis

The collected sample after development of tube well will deliver to the laboratory within 24 hours for detailed analysis listed below.

S.No.	Parameters	S.No.	Parameters
1	pH	13	Manganese
2	Color	14	Arsenic
3	Odor	15	Total Chromium
4	Turbidity	16	Copper
5	Sulphate	17	Lead
6	Chloride	18	Selenium
7	Total Dissolved Solids	19	Silver
8	Nitrate	20	Zinc
9	Nitrogen	21	Mercury
10	Fluoride	22	BOD
11	Cyanide	23	COD
12	Total Iron	24	Temperature

SECTION 3.8

HORIZONTAL CENTRIFUGAL PUMP

HORIZONTAL CENTRIFUGAL PUMPS

1.0 GENERAL INFORMATION

- 1.1. This section presents the general guidelines and details of horizontal centrifugal pumps to be procured under the scope of this section and shall not be limited to the pumps specified under clause no. 3.0 below. For other horizontal centrifugal pumps in the scope of this specification, these general guidelines as specified hereinafter shall be followed.

2.0 CODES AND STANDARDS

- 2.1 The design, manufacture and performance of the horizontal centrifugal pumps as specified hereinafter, shall comply with the requirements of the following codes and standards and shall include all the latest amendments subsequent to the year of publication as mentioned below.
- 2.1.1 IS-6595 Part-2/: Horizontal Centrifugal pumps for clear, cold 1993 and fresh water.
 - 2.1.2 IS-5120/1977: Technical requirements for Rotodynamic special Purpose pumps.
 - 2.1.3 IS-5639/1970: Pumps for handling chemicals & corrosive liquids.
 - 2.1.4 IS-5659/1970: Pumps for process water.
 - 2.1.5 IS-6536/1972: Pumps for handling volatile liquids.
 - 2.1.6 IS-9137/1978: Code for acceptance tests for centrifugal, mixed flow and axial flow pumps - Class 'C'.
 - 2.1.7 ISO 3555/1977: Acceptance tests for centrifugal, mixed flow and BS 5316/1977 axial flow pumps - Class 'B' tests.
 - 2.1.8 ISO 2548/1973: - Do - Class 'C' tests. BS 5316/1976
 - 2.1.9 API-610/1989: Centrifugal pumps for general refinery services.
 - 2.1.10 Standards of the Hydraulic Institute of USA (1983).
 - 2.1.11 PTC 8.2/1965: Power Test Codes - Centrifugal pumps.
- 2.2. In case of any contradiction with the above standards and annexures, the stipulations in the annexures shall prevail and shall be binding to the Contractor.

3.0 SCOPE OF WORKS

- 3.1. Scope of Supply
- 3.1.1 The scope of supply under this section shall be as below. Items specifically not mentioned but deemed necessary by the Tenderer for making the system completely reliable and efficient shall also be included.
- a) Equipment Accessories
- Each pump set for all the above groups shall be supplied with the following accessories:
- i) Couplings of approved design to connect pump shaft directly with the motor shaft.
 - ii) Vibration monitoring and analysis system mounting provision shall be provided for pumps.
 - iii) Sets of base plates, support plates, grounding pads, lifting lugs, eye bolts, nuts etc for each pump and motor set.
 - iv) Slip-on type drilled steel flanges of proper rating for both suction and discharge connections of each pump set. All the counter-flanges shall be complete with requisite number of bolts, nuts, gaskets etc.
 - v) Air release cocks and drain plugs for each pump set.
 - vi) Discharge line pressure gauge and suction line pressure/vacuum gauges complete with isolating cocks for each pump set.
 - vii) All internal/integral piping with valves, fittings, and pressure gauges for lubrication, cooling and sealing, wherever applicable, shall be tapped of directly from respective



pump discharge.

4.0 PERFORMANCE REQUIREMENTS

- 4.1 Pumps shall preferably be designed to have the best efficiency at the specified duty point. The pumps shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated in the annexures attached with this section.
- 4.2 Pumps shall preferably have a continuously rising head-capacity characteristics from the specified duty point towards shut-off point, the maximum being at shut-off to enable parallel operation. Under all circumstances, the 'range of operation' of the pumps shall exclude any unstable operating zone of the head - capacity curve.
- 4.3 Wherever specified in the annexures attached to this section, pumps of each category shall be suitable for parallel operation. The head vs. capacity, the BHP vs. capacity characteristics etc. shall be identical to ensure equal load sharing and trouble-free operation of any pump when the other pumps working in parallel with it trip.
- 4.4 The pump set along with the drive motor shall run smooth without undue noise and vibration.

5.0 DESIGN AND CONSTRUCTION

- 5.1 Pump Casing
 - 5.1.1 Pump casing shall be provided with adequate number of vents and priming connections with valves unless the pump is made self-venting and priming. Casing drain, as required, shall be provided complete with drain valves.
 - 5.1.2 Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.
 - 5.1.3 In cases where an expansion joint is located at pump discharge, the pump assembly will be subjected to an additional thrust which will be transmitted to the foundation. This additional thrust shall be taken into the consideration of pump design.
- 5.2. Impeller
 - 5.2.1 The rotor assembly shall be dynamically balanced and designed with critical speed substantially above the operating speed.
- 5.3. Wearing Rings
 - 5.3.1 Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing.
- 5.4. Shaft
 - 5.4.1 Shaft size shall be selected considering that the critical speed shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runaway speed.
- 5.5. Shaft Sleeves
 - 5.5.1 Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the other faces of gland packing or seal end plate so as to distinguish between the leakage past shaft and shaft sleeve and that past the seals/glands.
 - 5.5.2 Shaft sleeves shall be properly fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.
- 5.6. Bearings
 - 5.6.1 Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each of the bearing housing.
 - 5.6.2 Heavy duty sleeve/ball/roller type bearings shall be provided to take care of the radial loads.
 - 5.6.3 In case of sleeve type radial bearings, axial thrust shall be absorbed in suitable hydraulic devices and/or thrust bearings.
 - 5.6.4 Bearings and hydraulic devices (if provided for balancing axial thrust) shall be of adequate design for taking the entire pump load arising from all probable conditions of continuous operation.
 - 5.6.5 The bearings shall be oil/grease lubricated. Suitable lubricating arrangement for the



bearings shall be furnished with the pump complete all accessories like pump, filters, piping, fittings, valves, interlocking and supervising instruments etc. as necessary. The design shall be such that the bearing lubricant does not contaminate the liquid being pumped.

5.7.0 Stuffing Boxes

5.7.1 Stuffing box design shall permit replacement of packing without removing any part other than the gland.

5.7.2 Stuffing boxes shall be sealed /cooled by the fluid being pumped/external clear water, as specified in the Annexures. All necessary pumps, piping, fittings, valves, instruments etc. as required for safe and trouble-free operation of the pumps and as specified in the Annexures shall be included in the scope of supply.

5.8 Mechanical Seals

5.8.1 Mechanical seals shall be provided. The pump supplier shall co-ordinate with the seal maker in establishing the circulation rate for maintaining a stable film at the seal face in the chamber. The seal piping system shall form an integral part of the pump assembly.

5.8.2 When handling liquids near their boiling point, suitable arrangement for external cooling shall be provided so as to prevent flashing at the seal faces.

5.8.3 For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure, even when the pumps are not operating.

5.9. Drive Unit

5.9.1 The pumps shall be driven by electric motor or other driving equipment like diesel engine etc. directly coupled or through a gear box/belt drives. A heavy duty coupling along with coupling guard shall be provided between the pump and drive unit (except for belt drives). Belt guard shall be provided for all belt drives.

5.9.2 Unless otherwise specified, drive unit power rating shall be the maximum of the following requirements.

- a) Pump shaft input power required considering the overloading of the pump assuming single pump operation in the event of tripping of one or more of the pumps operating in parallel.
- b) 15% (for LT motor) or 10% (for HT motor) margin over the pump shaft input power at the rated duty point.
- c) 5% margin over the maximum pump shaft input power required within the 'Range of Operation'.

6.0 INSPECTION AND TESTING

6.1 The Contractor shall carry out the following specific tests and inspections to ensure that the equipment furnished lies in strict conformance with the specification and also in accordance with applicable codes/standards and good engineering practice.

a) Identification and Testing

i) All materials used for pump construction shall be of tested quality. Material shall be tested as per the relevant standards and test certificates shall be made available to the Owner.

ii) Tests for each pump included under this section shall include but not be limited to the following:

- The entire surface of the impeller castings shall be subjected to Dye Penetration Test as per ASTM Specification no.: E165-65.
- Shaft shall be subjected to Dye Penetration and Ultrasonic Tests.
- Wearing rings shall be subjected to Dye Penetration Test.
- Verification of material, witnessing of pouring, casting and inspection of finalized fabricated/cast castings.
- Inspection of finished castings for impeller and verification of materials.
- Inspection of pump shaft and verification of material.
- Witnessing of NDT/review of NDT reports.



- Static balancing test for impeller and dynamic balancing of complete rotating parts as per ISO- 1940.
- Complete Inspection of assembled pump.
- b) Hydrostatic Testing

The pump casing shall be hydrostatically tested at 150% of the shutoff pressure. Pressure shall be maintained for a period of not less than one (1) hour. While arriving at the above values maximum suction pressure shall be taken into account.

- c) Performance Test at Shop
 - i) Each pump shall have to be tested to determine the performance curves of the pumps. These tests are to be conducted in presence of Owner's representative.
 - ii) Performance tests are to be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 130% of rated capacity up to pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point, shut-off point and the two extremities of the range of operation as specified in the annexures. After completion of performance test, all pumps shall be stripped down for inspection of internals.
 - iii) Tests shall be conducted with actual drive motors being furnished.
 - iv) NPSH tests are to be conducted on one pump of each type at 3% head drop conditions.
 - v) Mechanical run test shall be carried out on all pumps to determine the vibration levels, noise levels etc. This test shall be conducted at site also. However, test value at site shall be used for the acceptance of the equipment.

7.0 DRAWINGS, DATA, CURVES AND INFORMATION

7.1 The Bidder shall submit the following along with his formal proposal besides the different information plate required as indicated elsewhere in this section.

7.1.1 Drawings

- a) General arrangement drawings showing the principal dimensions, weight and location of the suction and discharge connections of the pumps offered. Details of lubrication and sealing arrangement shall be included.
- b) Typical cross-section drawing showing various components of the pumps offered materials of construction etc.

7.1.2 Data and Curves

- a) Determination of pump total dynamic head and rated capacity as per guidelines specified in Section-I of this Volume. Detailed calculations shall be shown by the Bidder.
- b) Anticipated performance curves showing the following characteristics:
 - i) Capacity vs. head
 - ii) Capacity vs. power
 - iii) Capacity vs. efficiency
 - iv) Capacity vs. NPSH required
 - v) System resistance curves
- c) Speed vs. torque curve of the pump corresponding to recommended mode of pump starting superimposed on speed vs. torque curves of the drive unit corresponding to 80%, 90%, 100% of the rated voltage (applicable only in the cases of pumps with drive motor power rating of 100 KW and above).

7.2 The successful Bidder shall furnish the following drawings/data for Purchaser/Engineer's approval after award of the contract.

END OF SPECIFICATIONS



MECHANICAL & PLUMBING VENDOR'S LIST

S.#	NAME	MANUFACTURERS / BRANDS	COUNTRY OF ORIGIN	COUNTRY OF MANUFACTURING	LOCAL REPRESENTATIVE(S)		
					COMPANY NAME	CONTACT PERSON	CONTACT NUMBER
	MECHANICAL, PLUMBING & DRAINAGE WORKS						
1	PLUMBING FIXTURES	PORTA	CHINA	CHINA	M/s. CHAND SANITARY	MR. ATIQ	0331-2494134
		ZILVER	TURKEY	TURKEY	M/s. KARACHI TILE MART	MR. MUHAMMAD IBRAHIM SIRAJ	0301-8244314
		GROHE	GERMANY	GERMANY	M/s. S.ABDULLAH HOMES	MR. HARIS	0343-8863525
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
2	TOILET ACCESSORIES	PORTA	CHINA	CHINA	M/s. CHAND SANITARY	MR. ATIQ	0331-2494134
		ZILVER	TURKEY	TURKEY	M/s. KARACHI TILE MART	MR. MUHAMMAD IBRAHIM SIRAJ	0301-8244314
		GROHE	GERMANY	GERMANY	M/s. S.ABDULLAH HOMES	MR. HARIS	0343-8863525
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
3	FAUCETS & TRIMS	PORTA	CHINA	CHINA	M/s. CHAND SANITARY	MR. ATIQ	0331-2494134
		ZILVER	TURKEY	TURKEY	M/s. KARACHI TILE MART	MR. MUHAMMAD IBRAHIM SIRAJ	0301-8244314
		GROHE	GERMANY	GERMANY	M/s. S.ABDULLAH HOMES	MR. HARIS	0343-8863525
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
4	UPVC PIPES & FITTINGS (PRESSURE PIPES, SCHEDULE 40 & 80 etc.)	DADEX	PAKISTAN	PAKISTAN	M/s. DADEX	MR. ZUBAIR SIDDIQUI	0345-3099156
		CIVIC PIPES	PAKISTAN	PAKISTAN	M/s. PELIKAN PIPE INDUSTRIES	MR. MOHSIN NAQVI	0300-3945580
		JEDDAH POLYMER	PAKISTAN	PAKISTAN	M/s. JEDDAH POLYMER	MR. MURTAZA	0300-2929079
		AGM	SAUDI ARABIA	SAUDI ARABIA	M/s. MALIK CORPORATION	MR. ABDUL MATEEN	0345-9997722
		BINA PLASTIC	MALAYSIA	MALAYSIA	M/s. CEMENTATION COMFORTS	MR. KHALID	0332-2326969
					M/s. ALFAH TRADERS		
					M/s. NATIONAL HDPE & UPVC PIPES		
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
5	CPVC PIPES & FITTINGS	NEROPLAST	SAUDI ARABIA	SAUDI ARABIA	M/s. BUILDCON	MR. TARIQ SHARIF	0300-0225947
		ZENT					
		AGM	SAUDI ARABIA	SAUDI ARABIA	M/s. MALIK CORPORATION	MR. ABDUL MATEEN	0345-9997722
		BAHRAIN	KINGDOM OF BAHRIAN	KINGDOM OF BAHRIAN	M/s. CEMENTATION COMFORTS	MR. KHALID	0332-2326969
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
6	PPR-C PIPES & FITTINGS	DADEX	PAKISTAN	PAKISTAN	M/s. DADEX	MR. ZUBAIR SIDDIQUI	0345-3099156
		CIVIC PIPES	PAKISTAN	PAKISTAN	M/s. PELIKAN PIPE INDUSTRIES	MR. MOHSIN NAQVI	0300-3945580
		RAKTHERM	UAE	UAE	M/s. MALIK TRADERS	MR. SABIR KHAN	0321-8211686
		Q-THERM	UAE	UAE	M/s. MALIK CORPORATION	MR. ABDUL MATEEN	0345-9997722
			UAE	UAE	M/s. MALIK CORPORATION	MR. ABDUL MATEEN	0345-9997722
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
7	HDPE PIPES & FITTINGS	DADEX	PAKISTAN	PAKISTAN	M/s. DADEX	MR. ZUBAIR SIDDIQUI	0345-3099156
		PAK ARAB	PAKISTAN	PAKISTAN	M/s. PAK ARAB	MR. FAIZAN KHAN	0345-8289318
					M/s. NATIONAL HDPE & UPVC PIPES		
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
8	M.S SCHEDULE 40 SEAMLESS PIPES	BAOLAI	CHINA	CHINA	M/s. CRESCENT CORPORATION	MR. ATIF MUNAWAR	0302-8443780
		PROTEK	CHINA	CHINA	M/s. SAEED SONS	MR. SAAD HUMAYUN	0320-2111305
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
9	M.S FITTINGS	MUELLER (Threaded) JINTAI (Welded) (AS PER APPROVED SAMPLE AFTER LAB TEST)	CHINA	CHINA	M/s. CRESCENT CORPORATION	MR. ATIF MUNAWAR	0302-8443780
		NEFT / BIS (Threaded) NEFFT (Welded) (AS PER APPROVED SAMPLE AFTER LAB TEST)	CHINA	CHINA	M/s. FAKHRI BROTHERS	MR. MUSTAFA MAJAL	0321-8297941
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					



MECHANICAL & PLUMBING VENDOR'S LIST

S.#	NAME	MANUFACTURERS / BRANDS	COUNTRY OF ORIGIN	COUNTRY OF MANUFACTURING	LOCAL REPRESENTATIVE(S)		
					COMPANY NAME	CONTACT PERSON	CONTACT NUMBER
10	VALVES & ACCESSORIES 1/2" to 2" Brass Body 2-1/2" to above C.I Body	GALA	CHINA	CHINA	M/s. CRESCENT CORPORATION	MR. ATIF MUNAWAR	0302-8443780
		RUB	ITALY	ITALY	M/s. SAEED SONS	MR. SAAD HUMAYUN	0320-2111305
		HATTERSLEY	CHINA	CHINA	M/s. KHAN BROTHERS	MR. ASIM	0334-3369488
			PAKISTAN	PAKISTAN	M/s. REHMAN ENGINEERING WORKS	MR. MUBASHIR	0322-2762222
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
11	R.C.C PIPES	RAZIA PIPES	PAKISTAN	PAKISTAN	M/s. PAKISTAN PIPE & CONSTRUCTION COMPANY (PRIVATE) LIMITED		0327-8430358
			PAKISTAN	PAKISTAN	M/s. BALOCHISTAN R.C.C PIPE FACTORY	MR. ZAMAN	0300-2616660
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
12	G.I PIPES	I.I.L PIPE	PAKISTAN	PAKISTAN	M/s. INTERNATIONAL INDUSTRIES LTD.	MR. AZFAR FAROOQI	0335-6600611
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
13	G.I FITTINGS	H.E/T.G	CHINA	CHINA	M/s. SATTAR & SONS	MR. ASAD	0331-1391530
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
14	PUMPS	LOWARA	ITALY	ITALY	M/s. FLUID SYSTEMS INTERNATIONAL PVT. LTD.	MR. AADIL KHAN	0307-2230774
		WILO	GERMANY	GERMANY	M/s. ZARA ENGINEERS	MR. MIFTAH ALI	0322-2887225
		GRUNDFOS	EU	EU	M/s. ORIENT ENERGY SYSTEMS	MR. HASSAN KHAN	0346-2112200
		KSB	PAKISTAN	PAKISTAN	M/s. IDEA	MR. ZAID FAREED	0300-8203317
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
15	C.I COVERS, GRATINGS & S.S CLEANOUT PLUGS	JAWS	PAKISTAN	PAKISTAN	M/s. JAWS TECHNICAL EXPERTS	MR. ASGHAR REHMAN	0321-5138520
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
16	RAIN WATER GRATINGS, FLOOR DRAINS, GULLY TRAPS & PARKING DRAINS	DADEX	PAKISTAN	PAKISTAN	M/s. DADEX	MR. ZUBAIR SIDDIQUI	0345-3099156
		DACTA (BY HEPWORTH)	UAE	UAE	M/s. BUILD CON	MR. TARIQ SHARIF	0300-0225947
		FLOWTECH	UAE	UAE	M/s. SANITARY SOLUTIONS	MR. RAHEEM KHATRI	0334-2311786
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
17	ELECTRIC HOT WATER HEATERS WORKING PRESSURE 30 TO 60 PSI	ARISTON	ITALY	ITALY			
		ISRA	PAKISTAN	PAKISTAN	M/s. A.M GHANCHI COMPANY	MR. IRFAN GHANCHI	0332-8262751
		SINGER	PAKISTAN	PAKISTAN	M/s. SINGER PAKISTAN	MR. ARSALAN	
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
18	VALVE & SPECIAL VALVES (PVC)	ASTRAL	SPAIN	SPAIN	M/s. NETWORKLD	MR. JAVED KHAN	0300-8287787
					M/s. ANNUA OLYMPIC POOL	MR. SHAHID MAHMOOD	0300-8051022
					M/s. ORIENT POOL	MR. AMIR ALI	0300-8268517
		PENTAIR	USA	USA	M/s. ANNUA OLYMPIC POOL	MR. SHAHID MAHMOOD	0300-8051022
					M/s. ORIENT POOL	MR. AMIR ALI	0300-8268517
		HAYWARD	USA	USA			
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
19	UPVC SCHEDULE 80 PIPES & FITTINGS	DADEX	PAKISTAN	PAKISTAN	M/s. DADEX	MR. ZUBAIR SIDDIQUI	0345-3099156
		CIVIC PIPES	PAKISTAN	PAKISTAN	M/s. CIVIC PIPES	MR. MOHSIN NAQVI	0300-3945580
		JEDDAH POLYMER	PAKISTAN	PAKISTAN	M/s. JEDDAH POLYMER	MR. MURTAZA	0300-2929079
		AGM	SAUDI ARABIA	SAUDI ARABIA	M/s. MALIK CORPORATION	MR. ABDUL MATEEN	0345-9997722
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					
20	VALVE & SPECIAL VALVES (BRASS, C.I)	GALA	CHINA	CHINA	M/s. CRESCENT CORPORATION	MR. ATIF MUNAWAR	0302-8443780
		RUB	ITALY	ITALY	M/s. SAEED SONS	MR. SAAD HUMAYUN	0320-2111305
		HATTERSLEY	CHINA	CHINA	M/s. KHAN BROTHERS	MR. ASIM	0334-3369488
		OR OTHER EQUIVALENT APPROVED BY THE CONSULTANT / ENGINEER					



Technical Specifications

Electrical Works



CGD Consulting (Private) Limited- Karachi.
Head Office: 7 C, 5th Zulfikar Commercial Street, Phase-VIII-A, DHA Karachi, Pakistan.
Website: www.cgdconsulting.pk

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1. GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS

1.1. GENERAL

The work under this section consists of supply, transportation at site, storage, safety, installation, testing & commissioning of **MV, LV, ELV, ICT, Solar** and **Security System** equipped with and fulfilling latest technology requirements and ensuring to achieve Distribution Management System (DMS) and Energy Management System (EMS). The Contractor shall furnish all labor, materials, services, and skilled supervision necessary for the construction, erection, installation, connection, and commissioning of all equipment as a System. The extent of work specified herein and/or shown on the drawings/Technical Specifications represent the minimum requirements and include all civil, mechanical, electrical works associated with to commission the System.

Electrical Works generally are to be in accordance with the requirements of the MV, LV and ICT underground system in the Project Area, including MV cables, LV cables, ICT conduit and OFC, Street Lighting Cables, Earthing conductor, Pad/Pole Mounted Unit (PMU) Type Sub-stations, Switching Sub-stations, LV Feeder Pillar Boxes, Street Light Control Panel (SLCP), protective earthing and related works including and ensuring compatibility of the equipment and system to achieve Smart Grid concept for distribution and energy management.

Contractor shall submit the drawings as per specifications for approval of Engineer (one who is assigned by the Client to provide Consultancy Services and/or supervise execution at site).

1.2. SCOPE

The works related to the electrical system which are included in the scope of this Contract are shown in the Drawings, stated in the Specifications and Bill of quantities. The Contractor shall also be responsible to supply any other equipment not specifically mentioned in these documents, but necessary for proper operation of the works/system included in the scope of this Contract. The Contractor shall solely be responsible for ensuring proper functional requirements of various equipment and shall be responsible for furnishing any additional piece of equipment and for making modification in the equipment as desired and / or approved by the Engineer to achieve proper compatibility/co-ordination with various equipment offered in the bid and also with those installed by others.

1.3. APPLICABLE STANDARDS & GUIDANCE DOCUMENTS

The Electrical work shall be carried out in accordance with the BS (British Standard), IEC and IEE Standards, Specifications and Rules & Regulations as adopted in Project Area. The latest published rules of the National Electrical Code (NEC) and Regulations of Local Authorities shall be considered, as and where applicable.

- International Electro technical Commission (IEC)
- K.E/WAPDA Design Criteria
- NEPRA March 2022 Version
- National Electrical Code (NEC)
- Relevant British Standards (BS)
- European Standards like EN, DIN
- IEE Regulations
- CIBSE Guideline

- Relevant NFPA Standards
- European Committee for Standardization (CEN) and European Committee for Electro technical Standardization (CENELEC)
- International Organization for Standardization (ISO)
- Institute of Electrical & Electronic Engineers (IEEE)
- American Society of Testing Materials (ASTM)
- Under writers Laboratory (UL)
- National Fire Protection Association (NFPA)
- Pakistan Standards Institution (PSI)
- Pakistan Energy Codes
- CIBSE Code for Lighting, IESNA
- IEEE
- ITU-T
- ITU-R
- PTA
- PEMRA

Other Standards and Codes can be used in areas not covered by these standards. The Electrical products used, should be tested and approved to meet the applicable standards by one of the independent test laboratories including following:

- KEMA
- CESI
- RAWAT
- UL or other similar laboratories

The following international standards (latest version) or equivalent shall be followed:

IEC 61869-2	Current Transformer
IEC 61869-3	Potential Transformer
IEC 60050	International Electro technical Vocabulary
IEC 60051 (Part 1,2,3,5 & 8)	Measuring instruments
IEC 60060	High Voltage test techniques
IEC 60068	Environmental Testing
IEC 60076 (part 1-5&10)	Power Transformers
IEC 60137	Bushings for alternating voltages above 1000 V
IEC 60228	Conductors of insulated cables
IEC 60255	Measuring Relays and Protection equipment
IEC 60270	High Voltage Test Techniques-Partial Discharge Measurements
IEC 60296	Mineral Insulating oils for transformers & switchgear
IEC 60439	Low voltage switchgear and Control gear assemblies
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV
IEC 60529	Degrees of protection provided by enclosures (IP Code) Common Specifications for High Voltage Switchgear and Control gear Standards
IEC 61000	Electromagnetic compatibility (EMC)
IEC 61243-5	Voltage Detecting system (VDS)
IEC 61439	Low voltage switchgear and Control gear assemblies
IEC 61869-1	Instrument transformers-General Requirements
IEC 61869-2	Instrument transformers - additional requirements for current transformers
IEC 61869-3	Instrument transformers-additional requirements for inductive voltage transformers
IEC 62053	Electricity Measuring Instruments (ac)
IEC 62056	DLM/COSEM communication protocol for reading utility meters

IEC 62271-1	Common specifications for high voltage switchgear and Control gear
IEC 62271-100	High voltage switchgear and Control gear-High voltage alternating current circuit breakers
IEC 62271-103	High voltage switchgear and Control gear-Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
IEC 62271-200	High voltage switchgear and Control gear-Alternating current metal-enclosed switchgear and Control gear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-206	High voltage switchgear and Control gear-Part 206: voltage presence indicating systems for rated voltage above 1kV and up to and including 52kV High voltage switches for rated voltages above 1 kV and less than 52 kV.

1.4. SYSTEM AND CLIMATIC CONDITIONS

All materials and equipment supplied and installed shall be designed, manufactured and tested to meet the following system and climatic conditions unless specifically stated otherwise.

System Conditions

Nominal System Voltage	MV	11,000	Volts
	LV	400	Volts
Highest System Voltage	MV	12,000	Volts
	LV	440	Volts
Highest Voltage for Equipment	MV	15,000	Volts
Phases	MV	3	
	LV	3 (4 wir	
Frequency	MV/LV	50	
Rated Short Circuit Current	MV	20	
BIL (Basic Insulation Level)	MV (peak)	75 kV	
System Earthing	Neutral Grounded through Resistor at Grid-Stations to limit the earth fault current to 1.5 kA.		

Climatic Conditions

Maximum Ambient Air Temperature	-	50°C
Maximum Daily Average Temperature	-	45°C
Minimum Ambient Air Temperature	-	0°C
Maximum Sun Temperature on Exposed Horizontal Surface	-	60°C
Highest Radiation Intensity	-	1000 W/meter sq.
Maximum Relative Humidity	-	95 %
Isokeraunic Level	-	9.7 days/annum
Altitude	-	Sea level
Location	-	Semi-desert
Pollution	-	Windblown sand

1.5. DOCUMENTS TO BE SUBMITTED

The Contractor shall submit following documents at the time of bidding or as per Instruction of the Engineer.

1. Documents and certificate to be submitted for approval, including.
 - Information to be provided with the bid.
 - Document to be provided by the owner.
 - Documentation.
2. Warranty.
3. Packing and delivery.
4. Marking.
5. Testing, including:
 - Type tests.
 - Routine Tests.
 - Special test.
6. Technical data sheet
7. Maintenance and operation manual
8. Training Program

1.6. SHOP AND CONSTRUCTION DRAWINGS

The shop drawings and/or technical data to be furnished by the Contractor for each electrical equipment shall include, but not limited to the following:

- i. Complete working drawings with necessary execution details such as number of wires, size of conduit, etc.
- ii. Technical literature and manufacturer's specification datasheet, with the description of materials and weights of all equipment as instructed by the Engineer.
- iii. At least three (3) copies of the shop drawings and /or Technical Data of the equipment shall be submitted to the Engineer for checking and approval.
- iv. Submit drawings for approval including, but not limited to, the following:
- v. Layout of equipment in exact positions with mounting detail of Street light control Panel with foundation dimensions and reinforcement, routing, trenches, backfill and packing material, earthing set etc.
- vi. Cabling and wiring diagrams, single line drawings, loads, phase distribution, protection and control, earthing. Single Line Diagrams require, from Existing Feeder Pillar to Street Light Control Panel then Street Light Pole RYB (Red, Yellow, and Blue) Circuits along with earthing
- vii. Calculations of illumination levels and glare, based on CIE methods.
- viii. Samples/ Mockup
- ix. Submit fully equipped sample of Luminaries or other materials or components to the Engineer.
- x. Installed street light, decorative Pole and complete system at site as mockup basis for approval, after approval contractor will start their work.
- xi. The Contractor shall prepare Erection / Installation check list for each item, listing all components to be checked after the erection / installation of the item. The check list shall be approved by the Project Engineer and shall be presented to the inspecting Engineer. The check list shall include all the items to be checked for satisfactory erection / installation works prior to test, energize and commissioning the equipment.

1.7. GUARANTEE

The Contractor shall furnish written guarantee of the manufacturer or supplier with respect to satisfactory performance of each equipment. Guarantee shall be given for replacement and repair of part or whole of the equipment, devices, components, etc. which may be found defective in material or workmanship. The guarantee shall cover the duration of Maintenance Period as defined in the Conditions of Contract. This guarantee shall not relieve the Contractor of his obligations and he will be fully responsible for the repair or replacement of any defective material in time, so as not to cause any undue delay in carrying out the repairs and or replacements.

1.8. MATERIAL AND CONSTRUCTION REQUIREMENTS

1.8.1. LV cable

The LV cable shall be stranded Aluminum conductor, XLPE insulated, extruded PVC Bedded, steel wire armored and PVC sheathed overall, as shown in BOQ.

The cable shall be laid in trenches complete with bricks, sand, warning tape with all accessories.

The cable trench shall be of depth 1.0 m & width 0.9 m. The backfilling of trenches should from the site (excavated) material after removing large size boulder and compaction in layers. The Contractor is responsible to keep the site clean and tidy. Proper safety measures (warning tape, sign boards, lighting etc.) be taken to avoid any accident.

The danger sign for LV cable shall not be less than 250 x 125 mm enameled.

1.8.2. LV Feeder Pillar & Street Light Control Panel

The feeder pillar and Street Light Control Pane housing shall be floor mounted installed on RCC pad. The housing shall be of GRP, dust & weatherproof, ingress protection to IP55 and weather proof and rigid construction suitable for outdoor use. The feeder pillar & Street Light control panel housing shall have front compartments with three indication lamps showing incoming phases on front door. The feeder pillar shall have provision for incoming and outgoing cable entry & Terminations. All incoming and outgoing cable entry points shall be provided with suitable cable glands.

1.8.3. Earthing

All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation by way of flexible jumpers/strips & lug arrangement. The earth resistance shall not exceed 3Ω for each earth pit. If the required resistance is not achieved, additional earthing set shall be provided and connected in parallel until the specified resistance is achieved at the risk & cost of the Contractor.

The components to be connected to the earthed system shall include:

- The enclosure of the Pad Mounted Unit (PMU) sub-stations and Switching Stations.
- The enclosure/ compartment of MV Switchgear & Control gear from the terminal provided for the purpose.
- The metal screen & MV cable earth conductor.
- The transformer tank or metal frame of transformer.
- The enclosure/ compartment of LV panel
- The enclosure/ compartment of Battery Bank.
- The enclosure/ compartment of Battery Charger.

- The enclosure/ compartment of ICT equipment.
- The enclosure/ compartment of Solar equipment.

1.9. TRANSPORT, STORAGE, ERECTION/ INSTALLATION AND MAINTENANCE

The manufacturer should provide instruction for the transport, storage, erection/installation and maintenance of specified equipment and material. The instruction for the transport and storage should be given at a convenient time before delivery and the instructions for the erection and maintenance should be given by the time of delivery.

1.10. TESTING AND INSPECTION

The first Electrical Equipment such as Generators, elevator, Transformer, PMU, Switching station, Feeder pillar, Street Light control panel, Pole, Light fixtures, MV, LV, ELV, ICT and Security system etc. in complete assembled form before delivery at Project Area stores, shall be inspected including enclosure in detail by Client/Engineer to ascertain that it conforms to good engineering practice and these Specifications. The defects and short-comings pointed out by the Client/Engineer shall be rectified and the remaining equipment, components or Unit be produced accordingly.

1.11. TYPE TESTS

The Bidder shall furnish Type Test reports in respect of transformer, 15 kV complete switchgear panel and LV circuit breaker, all Electrical, ICT and security system, The reports shall be from an independent laboratory of international repute such as KEMA, or the one approved by Client/Engineer. All the relevant manufacturing drawings are to be approved by the Client/Engineer before the manufacture of the equipment.

Complete switchgear with enclosure, current transformers, voltage transformers, bus bars, post insulators, earthing switch, relays etc. and other MV system, LV System, ELV System and security system will be subjected to type tests in accordance with latest versions of IEC, IESNA, BS or International standards and codes Publications. These tests are to be carried out only once unless other major design change is proposed in the presence of Client/Engineers. These tests are to be conducted at HV & SC Laboratory Islamabad or Laboratory of International Repute acceptable to Client/Engineer in the presence of their representative(s). Cost of Visa Processing, air travel, boarding, and lodging (as applicable) shall be borne by the Contractor. Air tickets and hotel accommodation be agreed upon by the Client/Engineer before booking confirmation.

In case of type tests already carried out at an independent laboratory of international repute for the same type of equipment and supplied in reasonable quantity to the utilities, the reports shall be attached along with the name of utility & the number of equipment supplied with the bid, for technical evaluation purposes. Validity of Type test Reports shall be for five (05) years from the date of testing.

1.12. ROUTINE TEST

The following routine tests are to be carried out at the manufacturer facility in accordance with procedures laid down in relevant IEC standards. Client/Engineer may visit and check the routine testing as stage inspection. Cost of Visa Processing, air travel, boarding, and lodging (as applicable) shall be borne by the Contractor. Air tickets and hotel accommodation be agreed upon by the Client/Engineer before booking confirmation.

1.13. SAMPLE TESTS

The following sample (or quality acceptance) tests shall be carried out in the presence of the Client/ Engineer on the selected samples of MV, LV, ELV, ICT and Security system equipment.

- Visual inspection.
- Verification of dimensions of various components including thickness of mild steel sheets and paint.
- Functional tests of all major components according to the Specifications and relevant IEC standards.

1.14. SAMPLE, ACCEPTANCE AND REJECTION

After the order has been placed on the Contractor and before starting the production, the Contractor shall manufacture one sample for approval of Client/Engineer. This sample shall be thoroughly inspected by representative(s) of the Client/Engineer and any defects or short comings with respect to these Specifications shall be rectified. Thereafter, the sample shall be approved and used for comparison with other products. The successful sample shall be counted as one piece of the ordered equipment.

1.15. ACCEPTANCE AND REJECTION

The Manufacturer shall provide all the necessary facilities for carrying out tests free of cost. Three units, from each lot size of 10 pieces or part thereof, shall be selected at random and subjected to various tests and verification of components. In case there is no defective unit, the lot shall be deemed to have passed the tests. If the number of defective units is one or more, the whole lot shall be subjected to re-tests. Units not complying with the requirements of the tests shall be rejected.

For other quality acceptance tests another three sample units shall be randomly selected and subjected to tests specified. If there is no defective unit, the lot shall be deemed to have qualified the tests. If the number of defective units is one or more, another lot of five units shall be taken and tests will be conducted second time. Any failure in the second attempt shall mean testing of the entire lot. Units not complying with the requirements shall be rejected.

1.16. MARKING AND PACKING

1.16.1. Marking

Rating plates of various major components shall be fixed on them at suitable locations to be read easily. Another marking/name plate of suitable size shall be fitted at prominent place on the enclosure, which is impervious to weather and indelible. The plate shall carry details including the following:

- Name of Purchaser and Project/Contract name/ID
- Name of Manufacturer or identification symbol
- Type and production number
- Year of manufacture
- Brief ratings of major components
- Weight of assembled unit

1.16.2. Packing

The MV, LV, ELV, ICT and Security System shall be supplied from factory in completely



assembled form. No special packing is required but sufficient arrangement shall be made to ensure that the paint does not receive scratches and components are not damaged by jerks during transportation. Paint and components if damaged during transportation shall be repaired/replaced by the Contractor free of cost. The stuffing boxes for incoming and outgoing cables shall be supplied separately packed in cartons.

1.16.3. Warranty

The supplier shall provide warranty (duration as per Contract) for replacement of any faulty / damaged part due to transportation to site or otherwise.

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1. LV DISTRIBUTION SYSTEM (U.G/O.H)

1.1. LV Aluminum Armored Cable for U.G System:

It shall comprise of the following cable, as per K.E standards & specifications:

- i. 4 core 300 mm² AL, PVC/PVC/ARMORED/PVC cable
- ii. 4 core 185 mm² AL, PVC /PVC/ARMORED/PVC cable
- iii. 4 core 120 mm² AL, PVC /PVC/ARMORED/PVC cable
- iv. 4 core 70 mm² AL, PVC /PVC/ARMORED/PVC cable
- v. 4 core 25 mm² AL, PVC /PVC/ARMORED/PVC cable

1.2. LV Arial Bundle Cable for O.H System:

It shall comprise of the following cable, as per K.E standards & specifications:

Arial bundle cable (ABC) 600/1000V Stranded Aluminum alloy XLPE Insulation, XLPE Insulation only, as per K.E, consultant and IEC standards and specification.

- i. 3x50mm²+1x35mm² + 1x25mm² -5 Cores
- ii. 3x95mm²+1x70mm² 1x25mm² -5 Cores

1.3. Feeder Pillars

4-Way, 6-Way Distribution Feeder pillar boxes as per K.E Standards & Specifications shall be used for L.T Distribution system.

2. STREET LIGHTING SYSTEM

2.1. LED Street Light Fixtures:

This specification specifies the requirements for design, calculation, manufacture, testing and supply of Light Emitting Diode (LED) lighting system for Road / Street lights and shall be in accordance with the applicable requirements of owner/client and International Electrical and lighting Standards.

The light source shall be high efficiency and high brightness white light emitting diode (LEDs) with individual minimum efficacy of at least **120 - 140 lm/W**.

LEDs shall be arranged modularly to provide the required lighting output.

All lumen figures shall be Deliver (Hot) Lumens.

The LEDs shall be from a reputed manufacturer of LEDs with proven past performance in accordance with ANSI/NEMA/ANSI – C78.377.2008 – (American National Standard for Chromaticity of Solid-State Lighting Products) or similar approved International Standard.

2.2. Controlling System:

All Street Light Control Panel to have copper bus bars, isolators, breakers and other components as required.

The Bus Bars shall be made of 99.9% pure high conductivity annealed electrolytic copper and shall be completely isolated and mechanically braced for the specified fault level. The phase identification of bus bars shall be by colors applied on bus bars and these shall be red, yellow and blue for phases and white for neutral. The earth bus bar shall be green.

The Major Components of Street Light Control Panel, which shall be approved by Engineer are:

- a) Surge Protection
- b) Miniature Circuit Breaker Three Pole-25A
- c) Timer 24Hours with 200 hrs backup
- d) Magnetic Contactor -3Phase, 18Amp
- e) Miniature Circuit Breaker Single Pole-16A
- f) Miniature Circuit Breaker Single Pole-6A
- g) Bus Bar – TP + N + E
- h) HOA ON/OFF
- i) Manual ON/OFF Switch
- j) 3-Phase Indication Lamp
- k) HRC Fuse which shall be installed at nearest feeder Pillar

2.3. Pole:

The poles shall be hot dip galvanized to conform to ASTM: A-123 or equivalent European Standards. Prior to galvanizing the poles shall be free from burrs, cleaned and thoroughly prepared, so that the zinc coating shall be adherent, dense, smooth, continuous, and uniform. Care shall be taken to completely remove all welding scale. The galvanizing shall be completely free from lumps, blisters or porous spots, black spots, flux, or any other imperfection. The galvanizing shall bear salt spray Tropical Marine and industrial pollution in atmosphere and abrasive wind-borne sand pollution. The average coating thickness shall not be less 90 microns. Chemical Laboratory / Laboratory Tests shall include:

- a. ASTM A90 Zinc coating weight tests
- b. ASTM A239 Zinc coating homogeneity tests
- c. ASTM A123, A143 and A153 hot dip galvanizing tests
- d. EN ISO 1461 hot dip galvanizing tests coating tests
- e. Micro structural investigation of metals for zinc coating and welding quality

3. LV DISTRIBUTION SYSTEM (VERTICAL)

3.1. LV Switchgear:

LV Switchgear comprising of ATS System, Phase sequence and Pfi system, we proposed LV Switchgear at ground floor for proper distribution and minimize the voltage drop at LV side for making the project as cost effective and ease to maintenance and minimize the blackout the entire building.

Distribution boards will comply with BS 5846 and BS EN 60439. LV Distribution boards shall be surface mounted, and floor wise Distribution boards are recessed type and shall be located in appropriate location for proper distribution of lighting & small power circuits. Distribution board shall have adequate internal space for ease of installation and maintenance. Spare breakers shall be provided with a of 20-25% additional capacity for future load requirements. Necessary measuring instrument shall be provided.

Appropriate Breakers (ACB, MCCB, MCB, MPCB, and ELCB) will be provided.

The indoor boards shall be manufactured to IP 20 rating and the outdoor boards (if required) shall be manufactured to a minimum rating of IP 54.

3.2. Power Cable – Aluminum (Al)

A Power Cable, in the context of electrical engineering, refers to an insulated electrical conductor used for the transmission of electrical energy from a power source to an electrical load. The insulation is designed to protect against electrical shock, heat, and fire hazards, and to maintain the integrity of the electrical signal. The cable is typically composed of a core of one or more conductive wires, surrounded by insulation material and a protective outer layer. The complexity of the cable design and construction is dependent on the specific application and operating conditions.

3.3. Power Cable – Copper (Cu)

Power cable copper used in electrical engineering is the specific type of metal that is used to transmit electricity from one power station to another. It is typically a copper wire wrapped around a cotton strand core, either un-insulated or insulated with rubber, fiberglass, paper or other suitable material. The cable can be stranded for flexibility and ease of handling.

Power cables are an economical method of transporting electrical power from generating stations, such as fossil fuel powered plants, nuclear plants or hydroelectric dams, to the industrial, commercial and residential users.

3.4. Busway (Cu)

A Copper Busway is a type of electrical distribution system that uses copper as the primary material for the conductive elements. Copper is known for its high electrical conductivity, making it an ideal material for use in electrical power distribution systems. The copper busway system is designed to provide power to various electrical loads, such as in industrial, commercial, and mass transit applications. Compared to other materials, copper busways offer excellent thermal stability, high reliability, and improved safety features. Additionally, copper busways are known for their ease of installation and maintenance, making them a popular choice for electrical power

distribution systems.

3.5. Busway (Al)

An Aluminum Busway system refers to a power distribution mechanism that utilizes aluminum as the primary conductive material for transmitting electrical energy. This type of electrical distribution system is commonly utilized in industrial, commercial, and mass transit applications to supply power to various electrical loads. The use of aluminum as the conductive material offers a cost-effective solution compared to other alternatives, while still providing high electrical conductivity and light weight properties. Furthermore, the aluminum busway system boasts improved reliability and safety features, as well as easy installation and maintenance procedures, making it a favored choice for electrical power distribution needs.

3.6. Cable Containment:

Various types of cable containment system such as cable trays, cable trunking and PVC conduits will be used for the project depending upon the type of cables / area. All the primary containment distribution routes will be earthed in accordance with BS 7671.

PVC Conduit: PVC type conduits will only be used where they are concealed in the building fabric with sufficient concrete/screed cover (i.e. a minimum of 20mm cover). Where conduits are required to run surface on the building fabric within a ceiling space then these will either be GI type or an agreed high impact resistance type LSOH plastic. An additional space diversity of 40% will be maintained in design criteria.

G.I Conduit: GI conduits shall be used for surface installations to the building, in the areas where the conduit cannot be buried into the building fabric or concealed securely within the building cladding. Generally, where plastered walls are available, conduits should be concealed within.

3.7. Wiring:

Electrical wiring is an integral part of modern-day life and is used in a variety of contexts, from powering residential and commercial properties to industrial settings. It involves the installation of electrical components, such as cables, conduits, and switches, in order to create safe and efficient power systems. With the complexity of these systems growing ever larger, it is important for those who are responsible for their design to have comprehensive knowledge and understanding of the principals involved.

- 1.0 Sq.mm (RYB+N+E)
- 1.5 Sq.mm (RYB+N+E)
- 2.5 Sq.mm (RYB+N+E)
- 4.0 Sq.mm (RYB+N+E)
- 6.0 Sq.mm (RYB+N+E)

3.8. Receptacle and switches:

Wiring accessories in the facility will be as per British Standards and will have plastic plates.

Socket outlets 10A, 13A and 15A as per BS codes shall be provided throughout the facility for small power. Industrial socket of appropriate ratings. Socket outlets will be one or two gang, mounted normally flushed in walls.

Wiring accessories in wet areas and external areas etc. will be weatherproof toughened polycarbonate type. Supply to mechanical equipment will be provided from SMDBs/MDBs depending upon the power requirements. All Mechanical equipment

including AC outer units, HVAC fans and pumps will be provided with an isolator to ensure safe access for the purposes of maintenance and repair.

3.9. Small Power Receptacle and Industrial Sockets

Small Power Receptacle and Industrial Sockets refer to a type of electrical socket that is specifically designed to accommodate smaller electrical appliances and equipment within industrial settings. These sockets are characterized by their compact size and high electrical current rating, allowing them to handle a variety of power requirements efficiently. They play a crucial role in the seamless operation of various electrical devices within industrial facilities, providing a secure and reliable electrical connection for the flow of energy. The design of these receptacles and sockets is optimized for durability and performance, incorporating robust materials and advanced construction techniques to ensure long-lasting, safe, and efficient power distribution. These power receptacles and sockets serve as the critical interface between electrical devices and the larger electrical distribution system, enabling the reliable transfer of electrical energy and facilitating the seamless functioning of essential machinery and equipment within the industrial environment.

3.10. Indoor Lighting:

The complete internal artificial lighting system, throughout the facility will meet the design criteria and reflect the architectural and aesthetic requirements of each area and location respectively.

The lighting LUX level will be designed in accordance with recommendations of the Chartered Institution of Building Services Engineers (CIBSE) codes and IESNA. The type of light fixtures with IP rating will be selected depending upon the area of installation and the required illumination levels. Lighting software DIALUX shall be used for lighting calculation

3.11. Outdoor Lighting:

The external lighting will be designed to provide adequate illumination for the safe passage of people, vehicles around the external areas of the building and also to provide illumination of the façade and landscaped areas in accordance with the architectural concept. Additionally, Pole Mounted Light Fixtures will be provided along the roads for sufficient illumination for movement of automobiles.

3.12. Emergency Lighting:

The objective to provide the emergency lighting during power shutdown or when the normal lighting of the facility fails. The emergency lighting shall fulfill the following functions:

- To clearly indicate the escape routes.
- To provide the illumination along such routes to allow safe movement towards and through the provided exits.
- To ensure the fire alarm call points and firefighting equipment provided along escape routes can be readily located.
- The emergency lights shall be 3 hour back up self-contained type.

3.13. Exit Lighting:

Dedicated emergency exit luminaries will be provided within escape routes, areas and exit doors. Emergency exit lighting luminaries shall incorporate pictograms in accordance with European signs directive “Running Man symbols”. The symbol orientation will be selected to suit the escape route.

3.14. Façade & Landscape Lighting

Façade and Landscape lighting refers to the illuminating of exterior architectural features and outdoor landscapes through the strategic placement and utilization of artificial lighting fixtures. This type of lighting serves not only a functional purpose, such as enhancing visibility and security, but also an aesthetic one, creating a visually stunning and inviting atmosphere. The application of facade and landscape lighting involves a nuanced understanding of light placement, intensity, and color, as well as an appreciation for the unique architectural and environmental qualities of each space. The use of sophisticated lighting systems and technology, such as LED lighting, enables the creation of dynamic and intricate lighting designs that highlight and accentuate the defining features of a building's facade and its surrounding landscape. This results in an elevated aesthetic experience for both the inhabitants and visitors to the space.

3.15. Uninterrupted Power Supply (UPS) System

An Uninterrupted Power Supply (UPS) System is a type of electrical system that provides a reliable and consistent source of power to critical devices and equipment. This system operates by using batteries, generators, and other backup power sources to maintain a continuous supply of electrical energy in the event of an interruption or failure of the main power source. The UPS system is designed to provide a seamless transition from the primary power source to the backup power source, ensuring that there is no loss of power to the connected devices and equipment. The design of a UPS system typically involves the integration of advanced technology and sophisticated power electronics, such as inverters, to provide a high-quality output voltage and current, ensuring the reliable and efficient functioning of connected devices. The UPS system is an essential component of modern power infrastructure, playing a critical role in the maintenance of business continuity, data protection, and overall system reliability in various industries and applications.

detect and prevent potential hazards.

3.16. Earthing / Grounding Protection System

Earthing / Grounding protection system is a most essential and critical part of any power distribution system not only in terms of equipment's protection but also for human / public safety. This methodology involves earth conductivity enhancement compounds which absorbs moisture from the surroundings and increase the

conductivity of earthing conductor.

- Separate earth stations shall be provided for:
- Medium Voltage Switchgears.
- Transformer's Neutral.
- Transformer's Body.
- Generator's Neutral.
- Generator's Body.
- Main/Sub-Main Distribution panels with appropriate.
- Communication System.
- Lightning Protection System.
- Lift Panels.

Each DB shall be connected to the building earthing / grounding system using an isolated earth continuity conductor from sub-main floor distribution panel to the respective final distribution panel inside the building.

3.17. Building Lightning Protection System:

Instead of conventional air terminal, an Early Streamer Emission (ESE, latest generation) Lightning Arrestor shall be provided for lightning protection at roof top of the building. In conventional lightning protection system multiple metallic spherical spikes are to be mounted on the building perimeter at roof top. Exposed copper strips of appropriate gauge and width are laid on the roof perimeter which then goes down vertically up to the earth station at ground floor. Advance ESE lightning protection system has replaced all exposed installations. The arrestor has to be installed at roof top of the building connected with the grounding network with 1 or 2 concealed wires.

Aircraft warning lights shall be provided at the top of the building as per Civil Aviation requirements.

4. SOLAR SYSTEM

4.1. Solar Panel:

Solar energy refers to the energy that is generated from the sun's radiation. It is a renewable energy source that can be harnessed through various technologies such as photovoltaic (PV) cells, concentrated solar power (CSP), and solar thermal. Solar energy has become an increasingly important source of electricity generation in recent years, due to its potential to reduce greenhouse gas emissions and provide a sustainable energy source.

Solar Energy Basics: Solar energy is generated by the sun's radiation, which can be harnessed using various technologies. The amount of solar energy that reaches the Earth's surface is many times greater than the amount of energy that humans consume. Solar energy is a renewable energy source, as the sun will continue to radiate energy for billions of years.

Solar Photovoltaic (PV) Technology: Solar PV technology converts sunlight directly into electricity using photovoltaic cells. Photovoltaic cells are made up of semiconductor materials such as silicon, which absorbs sunlight and releases electrons that can be harnessed to generate electricity. Solar PV panels can be installed on rooftops or in large solar farms to generate electricity.

Concentrated Solar Power (CSP) Technology: CSP technology uses mirrors or lenses to concentrate sunlight onto a small area, which heats up a fluid such as water or oil. The heated fluid is then used to generate steam, which can be used to drive a turbine and generate electricity's technology is often used in large-scale power plants.

Solar Thermal Technology: Solar thermal technology uses sunlight to heat a fluid such as water or air, which is then used for heating or cooling. Solar thermal systems can be used for domestic hot water, space heating, and air conditioning.

Solar PV Technology: The efficiency of solar PV cells depends on the materials used, the design of the cells, and the quality of the manufacturing process. The most common type of solar PV cell is made from crystalline silicon, which is the same material used in computer chips. Other types of solar PV cells include thin-film cells made from materials such as cadmium telluride and copper indium gallium selenite.

Concentrated Solar Power (CSP) Technology: The efficiency of CSP technology depends on the concentration ratio of sunlight, the type of receiver used, and the efficiency of the heat transfer process. CSP systems can use either parabolic troughs, power towers, or dish/Stirling systems to concentrate sunlight onto a receiver. Molten salt is often used as the heat transfer fluid in CSP systems, as it can store heat for long periods of time.

Solar Thermal Technology: Solar thermal systems can be either passive or active. Passive solar thermal systems rely on natural heat flow and do not require any mechanical components. Active solar thermal systems use pumps or fans to circulate the fluid and control the temperature.

4.2. DC cable

DC cable technology refers to the development and use of cables that transmit direct current (DC) electrical energy. DC cables are used in a wide range of applications, including renewable energy systems, electric vehicles, and data centers. DC cable technology is critical in ensuring that the energy supply is stable, reliable, and efficient for the desired application.

DC Cable Basics: DC cables are used to transmit electrical energy in direct current (DC) form. They are used in a wide range of applications, including renewable energy systems and electric vehicles. DC cables can be insulated or uninsulated.

Types of DC Cables: There are several types of DC cables, including copper, aluminum, and fiber optic cables. Copper cables are commonly used in low-voltage applications, while aluminum cables are commonly used in high-voltage applications. Fiber optic cables are used for data transmission in data centers.

DC Cable Capacity and Efficiency: DC cable capacity is the amount of electrical energy that a cable can transmit. DC cable efficiency refers to the amount of energy that is lost during transmission. DC cable capacity and efficiency can be affected by several factors, including the type of cable, the distance of transmission, and the operating conditions.

DC Cable Construction: DC cables are typically constructed with a conductor, insulation, and a jacket. The conductor is typically made of copper or aluminum. The insulation is used to protect the conductor from external factors and can be made of materials such as polyethylene or polyvinyl chloride (PVC). The jacket is used to protect the insulation and can be made of materials such as PVC or cross-linked polyethylene (XLPE).

DC Cable Resistance and Voltage Drop: DC cables have resistance, which causes a voltage drop during transmission. The amount of voltage drop depends on the resistance of the cable and the amount of current flowing through it. DC cable resistance and voltage drop can be reduced by increasing the size of the cable or by using materials with lower resistance.

DC Cable Termination and Connection: DC cables can be terminated and connected using various methods, including crimping, soldering, and compression fittings. Proper termination and connection are critical in ensuring the safe and reliable operation of the system. DC cable termination and connection can also affect the efficiency of the system.

DC Cable Applications: DC cables are used in a wide range of applications, including renewable energy systems, electric vehicles, and data centers. Renewable energy systems use DC cables to transmit energy generated by solar panels or wind turbines to the inverter. Electric vehicles use DC cables to transmit energy from the battery to the electric motor. Data centers use DC cables for high-speed data transmission.

4.3. **Battery**

Battery technology refers to the development and use of rechargeable energy storage systems that convert chemical energy into electrical energy. Batteries are used in a wide range of applications, including portable electronics, electric vehicles, renewable energy systems, and backup power supplies. Battery technology is critical in ensuring that the energy supply is stable, reliable, and efficient for the desired application.

Battery Basics: Batteries are devices that store chemical energy and convert it into electrical energy. They are used to power a wide range of devices, from portable electronics to electric vehicles. Batteries can be rechargeable or non-rechargeable.

Types of Batteries: There are several types of batteries, including lead-acid, lithium-ion, nickel-cadmium, and nickel-metal hydride batteries. Lead-acid batteries are commonly used in backup power supplies and in vehicles. Lithium-ion batteries are commonly used in portable electronics and electric vehicles. Nickel-cadmium and nickel-metal hydride batteries are less common but are still used in certain applications.

Battery Capacity and Life: Battery capacity is the amount of electrical energy that a battery can store. Battery life refers to the time period that a battery can supply power before it needs to be recharged or replaced. Battery capacity and life can be affected by several factors, including the type of battery, the usage patterns, and the operating conditions.

Battery Chemistry: Batteries use various chemical reactions to store and release energy. Lead-acid batteries use a lead dioxide and lead reaction. Lithium-ion batteries use a lithium cobalt oxide or a lithium iron phosphate reaction. Nickel-cadmium batteries use a nickel oxide hydroxide and cadmium reaction. Nickel-metal hydride batteries use a nickel oxide hydroxide and metal hydride reaction.

Battery Charging and Discharging: Batteries can be charged and discharged using various methods, including constant voltage, constant current, and pulse charging. Charging a battery involves converting electrical energy into chemical energy, while discharging a battery involves converting chemical energy into electrical energy.

Battery Management Systems: Battery management systems (BMS) are used to monitor and control the charging and discharging of batteries. MS can help to improve the efficiency, performance, and safety of batteries. MS can also help to extend the life of batteries by preventing overcharging, over-discharging, and overheating.

Battery Applications: Batteries are used in a wide range of applications, including portable electronics, electric vehicles, renewable energy systems, and backup power supplies. Portable electronics use batteries to provide a mobile and convenient power source. Electric vehicles use batteries to power the electric motor and provide range. Renewable energy systems use batteries to store excess energy generated by solar panels or wind turbines. Backup power supplies use batteries to provide power in the event of a power outage.

4.4. **Inverter**

Inverter technology is a type of electronic technology that converts direct current (DC) to alternating current (AC). It is commonly used in a variety of applications, including solar energy systems, uninterruptible power supplies (UPS), electric vehicles, and home appliances. Inverter technology is critical in ensuring that the power supply is stable and efficient for the desired application.

Inverter Basics: Inverters are electronic devices that convert DC to Cathay are used to supply AC power to a range of electrical devices. Inverters are used in a wide range of applications, including solar energy systems, UPS, electric vehicles, and home appliances.

Types of Inverters: There are several types of inverters, including grid-tied, off-grid, and hybrid inverters. Grid-tied inverters are used in solar energy systems and are designed to feed excess power back into the electrical grid. Off-grid inverters are used in remote locations where there is no access to the electrical grid. Hybrid inverters can operate in both grid-tied and off-grid modes.

Benefits of Inverter Technology: Inverter technology provides a stable and efficient power supply for a range of applications. Inverters can help to reduce electricity costs and carbon emissions. Inverter technology can also help to reduce the overall size and weight of electrical equipment.

Inverter Components: Inverters consist of several components, including a DC source, an inverter circuit, a transformer, and an AC output circuit. The DC source can be a battery, a solar panel, or any other DC power source. The inverter circuit is responsible for converting the DC power to AC power. The transformer is used to step up or step down the voltage to the required level. The AC output circuit is responsible for delivering the AC power to the load.

Inverter Waveforms: Inverters can produce different types of waveforms, including square wave, modified sine wave, and pure sine wave. Square wave inverters are the simplest type of inverter and are not commonly used due to their poor quality of output. Modified sine wave inverters are more common and can produce a waveform that is close to a pure sine wave. Pure sine wave inverters produce a high-quality AC output that is similar to the AC power supplied by the electrical grid.

Inverter Efficiency: Inverter efficiency is a critical factor in determining the overall efficiency of the system. The efficiency of an inverter is typically measured as a percentage of the input power that is converted to output power. Inverter efficiency can be affected by several factors, including the type of inverter circuit used, the quality of the components, and the operating conditions.

Inverter Control: Inverters can be controlled using various methods, including pulse width modulation (PWM) and maximum power point tracking (MPPT). PWM is a common method used to control the output voltage of inverters by adjusting the width of the output pulses. MPPT is used in solar energy systems to maximize the power output of the solar panels by tracking the maximum power point of the solar panel.

Inverter Protection: Inverter protection is critical in ensuring the safety and reliability of the system. Inverters can be protected from overvoltage, under voltage, overcurrent, and

short-circuits using various protection circuits. Inverter protection can also be achieved by using fuses, circuit breakers, and surge suppressors.

Inverter Applications: Inverters are used in a wide range of applications, including solar energy systems, UPS, electric vehicles, and home appliances. Solar energy systems use inverters to convert DC power generated by the solar panels into AC power that can be used by the electrical grid. UPS systems use inverters to provide backup power in the event of a power outage. Electric vehicles use inverters to convert DC power from the battery into AC power that can be used by the electric motor. Home appliances, such as air conditioners, refrigerators, and washing machines, use inverters to provide stable and efficient power.

4.5. AC Cable

AC cable technology for solar energy systems refers to the development and use of cables that transmit alternating current (AC) electrical energy in solar power systems. AC cables are used to connect solar panels, inverters, and other system components, and play a critical role in ensuring that the energy supply is stable, reliable, and efficient for the desired application.

AC Cable Basics: AC cables are used to transmit electrical energy in alternating current (AC) form. They are used in a wide range of applications, including solar power systems and grid-tied systems. AC cables can be insulated or uninsulated.

Types of AC Cables: There are several types of AC cables, including copper and aluminum cables. Copper cables are commonly used in low-voltage applications, while aluminum cables are commonly used in high-voltage applications.

AC Cable Capacity and Efficiency: AC cable capacity is the amount of electrical energy that a cable can transmit. AC cable efficiency refers to the amount of energy that is lost during transmission. AC cable capacity and efficiency can be affected by several factors, including the type of cable, the distance of transmission, and the operating conditions.

AC Cable Construction: AC cables are typically constructed with a conductor, insulation, and a jacket. The conductor is typically made of copper or aluminum. The insulation is used to protect the conductor from external factors and can be made of materials such as polyethylene or cross-linked polyethylene (XLPE). The jacket is used to protect the insulation and can be made of materials such as PVC or XLPE.

AC Cable Resistance and Voltage Drop: AC cables have resistance, which causes a voltage drop during transmission. The amount of voltage drop depends on the resistance of the cable and the amount of current flowing through it. AC cable resistance and voltage drop can be reduced by increasing the size of the cable or by using materials with lower resistance.

AC Cable Termination and Connection: AC cables can be terminated and connected using various methods, including crimping, soldering, and compression fittings. Proper termination and connection are critical in ensuring the safe and reliable operation of the system. AC cable termination and connection can also affect the efficiency of the system.

AC Cable Applications in Solar Energy Systems: AC cables are used in solar energy systems to connect solar panels, inverters, and other system components. They are used to transmit AC energy from the solar panels to the inverter, where it is converted to DC energy. AC cables are also used to transmit AC energy from the inverter to the grid or to the load.

5. DIESEL GENERATORS

5.1. SUMMARY

Diesel engine generator sets. Fully imported. The country of manufacturing and shipment of the Generator shall be Europe, USA, Japan, China, Turkey.

Generator supplier shall be local authorized agent of the manufacturer. Authorization certificate is to be provided from manufacturer.

5.2. QUALITY ASSURANCE

Retain NFPA 99 in paragraph below for healthcare facilities.

Quality Standard: British Standard (BS5000, BS5514), IEC60034-1, ISO3046, ISO8528, AS2789, NFPA 37, NFPA 70, NFPA 99.

Emergency Power Supply System: NFPA 110

Safety Standard: ASME B15.1.

5.3. RATING

The diesel engine driven generating set shall have the following rating and electrical characteristics:

1. Generating Capacity (Prime Power Rating) : As indicated in the BOQ
2. Voltage : 400 Volts, $\pm 5\%$
3. System : 3 Phase, 4 Wire
4. Frequency : 50 Hz, $\pm 2\%$
5. Number Of revolutions : 1500 RPM

5.4. PROJECT CONDITIONS

Environmental Conditions: All material and equipment supplied and installed shall be designed, manufactured and tested to meet the following ambient conditions unless specifically stated otherwise for any material / equipment:

- a. Maximum outdoor ambient temperature : 48 degree C
- b. Minimum Indoor ambient temperature : 0 degree C
- c. Maximum relative humidity : 90 %
- d. Minimum relative humidity : 25 %
- e. Altitude : 20Meter

5.5. OPERATION DESCRIPTION

The A.C. diesel engine driven electric generating including base fuel tank set shall be arranged for electric starting by battery power, the set shall stay in stand-by position.

The generator shall have auto mains failure (AMF) system. It shall automatically start and supply power to the load within approximately 0 to 5 seconds of the complete cessation of mains supply failure on one or more phases, or when the voltage is reduced by 20% of nominal, and automatically shut down and re-transfer the load back to the mains supply to stabilize before retransfer of the load takes place, and shall be adjustable over the 1-10 minute range.

5.6. ALTERNATOR SPECIFICATIONS

- a. The alternator shall be prime power rated and be of steel construction. It shall be A.C. brushless type. The bearings shall be grease lubricated or roller bearings.
- b. The rotor shall consist of dynamically balanced salient pole revolving field. The poles shall be equipped with damper windings. The field coils shall be to withstand high centrifugal stresses without developing any damage. Rotor insulation shall conform to Class-H.
- c. The stator core shall be made from high grade laminated silicon steel and carefully tightened to prevent occurrence of magnetic vibrations. The stator windings shall be fully impregnated for tropical climates with high quality oil resistant varnish.
- d. The A.C. exciter shall have permanent magnets/AREP in its field ensuring positive voltage build-up. The rectification shall be affected by a suitably rated silicon diode assembly over-hung to the shaft. The rotating rectifier assembly shall be built to withstand vibration and centrifugal forces.
- e. The inherent characteristics of the alternator shall be such to maintain the output voltage under all conditions of load, power factor and temperature, within the limits of $\pm 5\%$ of nominal.
- f. The alternator shall have self contained excitation system with transistorized automatic voltage regulator. The automatic voltage regulator and control gear shall be mounted in a component box on the side of the machine using antivibration mounting. Electrical connections to the voltage regulator shall be taken through a multi-way plug and socket.
- g. The alternator shall be screen protected and drip proof (NEMA2, IP23). It shall have efficient cooling system using centrifugal fans. It shall be provided with a large terminal box for outgoing cable connections.

5.7. ALTERNATOR PROTECTION

Alternator protection shall be incorporated to shut down automatically the set with a visual cum-audio alarm of the following conditions:

Over load / Short circuit current
Over and under voltage.
Over and under frequency
Reverse power
Rotor ground fault protection
Excitation protection
Phase balance protection
Negative Sequence protection

5.8. DIESEL ENGINE SPECIFICATIONS

- a. The engine shall be prime rated 4 cylinder/ in-line, 4 stroke, direct injection, turbocharged air and charged air cooled induction, water cooled industrial diesel engine.

Technical Specifications

- b. The engine shall withstand a 10% overload for a period of 1 hour (in 12 hours) in accordance with BS 5514, ISO 3046, and AS2789).
- c. The engine speed should be 1500 rpm at 50 Hz.
- d. An engine driven pump shall circulate the lubricating oil under pressure and spin-on full flow filters with replaceable elements shall be fitted.
- e. An inline fuel injection pump and a diaphragm type lift pump with full filters with replaceable element and a fuel solenoid shall be provided. The fuel used shall be Class A2 Diesel.
- f. The air filter type should be dry replaceable element with restriction indicator.
- g. Governing shall be electronic type and conform to BS 649/1958.

5.9. ENGINE PROTECTION EQUIPMENTS

Engine protection equipment shall be incorporated to shut down automatically the set with a visual cum-audio alarm of the following conditions:

- a. Low lubricating oil pressure (Below a safe working value).
- b. High cooling water temperature
- c. Low coolant level
- d. Engine Over speed
- e. With fuel oil level low engine protection system shall develop visual cum-audio alarm.

5.10. GENSET CONTROL PANEL

The control panel shall be electronic solid state type. Automatic start Engine management and instrumentation system module in cubical is installed on individual bracket with anti-vibration isolator, with instruments and graphical icon in LCD display as follows.

- a. Generator running indicator.
- b. Voltage adjuster.
- c. Emergency stop button
- d. Selector Switch with key (STOP / RESET, AUTO, MANUAL).
- e. Manual start button.
- f. Battery voltage monitoring, protection and testing
- g. Common alarm indicator
- h. Data logging
- i. Scroll button for the display on LCD.
- j. Value display on LCD.



Technical Specifications

- ✓ Frequency / RPM.
 - ✓ AC voltage Line-Neutral.
 - ✓ AC voltage Line-Line.
 - ✓ AC line current.
 - ✓ Oil pressure.
 - ✓ Coolant temperature.
 - ✓ Engine hours run.
 - ✓ DC battery voltage.
 - ✓ Kilowatt-hours (kWhr).
 - ✓ Kilowatt (kW)
- k. Alarm indication with graphical symbol on LCD with audio and visual flashes.
- l. Status indicator.

5.11. MECHANICAL COUPLING

- a. The Diesel Engine and A.C. brushless Generator shall be coupled with each other by means of flexible coupling complete with all necessary control equipment mounted on a substantially fabricated type steel base.
- b. The generator end shield and the engine flywheel housing faces shall be fully machined with spigots concentric to their shafts. A fabricated steel coupling ring with both faces machined shall be flange mounted to the flywheel housing and generator end shield by steel bolts.
- c. A flexible coupling shall be fitted between the engine and generator to provide the drive and shall be suitable to absorb the transmissions of shock loads.
- d. The distortional flexibility shall be designed to match the distortional characteristics of the system to prevent resonant conditions.

5.12. MOUNTING DESCRIPTION

The combined engine-generator unit shall be bolted to a separate sub-frame which shall be attached to the main frame through 'Resilient Mountings' including vibration isolator so providing complete protection from the engine vibration to the control gear, and other set mounted components.

5.13. COOLING SYSTEM

- a. The diesel engine shall be radiator cooled.
- b. A thermostat shall pass the coolant, until a pre-determined operating temperature is reached.

- c. An immersion heater shall be incorporated in the cooling system.

5.14. STARTING SYSTEM

- a. The starting system shall consist of a heavy duty starter motor and starter switch, a set of 12 volt heavy duty lead acid starting maintenance free batteries of adequate capacity, all arranged for automatic electric starting.
- b. The starter motor shall automatically disengage when the engine shall fire. There shall be three automatic starting attempts before the starting batteries are, should the engine fail to start due to shortage of fuel, etc.
- c. Battery charging shall be automatic provided from a suitable single-phase full wave rectification static charger. Charger shall be complete with all necessary relays, cutouts, controls, switches and instruments for automatic charging of batteries.
- d. The batteries shall be housed in a cradle on the main base frame.

5.15. GENSET GROUNDING

The Genset frame shall be grounded at two points by two independent earth protected conductor and it is necessary to bond to a grounding electrode. The genset neutral and body earthing shall be done with PVC insulated cables and connect to grounding electrode. Earthing resistance shall be less than one ohm.

5.16. EXHAUST

A large and efficient critical acoustic type silencer to reduce noise level to a maximum of 25 dB, with a suitable length of flanged flexible exhaust pipe shall be installed.

5.17. FINISH

All sheet steel used shall be zinc coated.
The set shall be painted with good quality primer and finished with high gloss paint.

5.18. ACCESSORIES

The AC diesel engine driven electric generating set shall be supplied with the following accessories and manuals.

- a. One - Kit of engine tools.
- b. One - Set of holding down bolts.
- c. Three - sets of installation drawings.
- d. Three - sets of circuit diagram.
- e. Three - sets of engine maintenance book.
- f. Three - sets of spare parts manual.
- g. Three - sets of generating set instruction manual.

5.19. GENERATOR TESTS

A manufacturer's standard test report/certificate shall be submitted for factory tests at the

Technical Specifications

manufacturing facility.

- a. Operation of automatic starting, control sequence and all protection circuit/sensor.
- b. Prior to acceptance of installation, the equipment shall be subjected to an on-site test with full load for a minimum period of 8 hours, plus one hour at 110% load at manufacturer's facility.

The performance test which shall be carried out on site shall include the following as a minimum:

- a. Load test temperature rise

- ✓ 25 % load ½ hour
- ✓ 50 % load ½ hour
- ✓ 75% load ½ hour
- ✓ 100 % load 1hour
- ✓ 110 % load 1hour

All operating fluids (including fuel, oil, lubricants, coolant etc.) and load banks for the testing shall be provided by the contractor, who shall commission the genset, making all initial adjustment and setting required and test all the control and protection function and circuit. Three copies of the witnessed test report shall be submitted to the Employer.

The contractor shall have the kWh meters sealed and the installation approved by the electrical inspector.

5.20. INSTALLATION

- a. Generally:

The D/G Contractor shall install all equipment so as to avoid the transmission of vibration to the adjoining building.

- b. Erection:

The set must be installed, tested and commissioned at site by a registered and approved D/G Contractor and who has satisfactorily installed sufficient number of Diesel Generator Sets in Pakistan.

5.21. INSTALLATION

- **Shop Drawings:**

- I. Submit 3 copies of shop drawings for approval.
- II. Shop drawings shall be complete, as to be as-built drawings, not general outline drawings used for sales and guide layouts.

- **Interior wiring, terminals and interconnecting wiring,**

- I. Certified dimensions and weights,
- II. Submit a composite wiring diagram of the entire emergency transfer system showing all wiring between the engine starting panel, engine generator set and the automatic synchronization panel.

- **Wiring diagrams shall clearly show:**



Technical Specifications

- I. Main current conductors,
- II. Control conductors, with colour and/or number coding.
- III. Location of relays and apparatus.
- IV. Description of function, type and catalogue, of all components.

- a. **Alternator Control Panel:**

- b. **Submit a schematic line diagram showing:**

- I. Interlocks
- II. Protection
- III. Instruments.

- c. **Test Reports:**

Submit certified copies of data obtained during factory tests of the engine generator set.

- d. **Operation And Maintenance Data:**

- I. Submit 3 copies of a maintenance manual containing the following for all equipment:
- II. Manuals for the generator set.
- III. Detailed instruction books.
- IV. Operator's manuals.
- V. Maintenance schedules.
- VI. Parts catalogue.

5.22. SPARES

The contractor shall submit, in the format given below, a detailed itemized price list of manufacturer' recommended spares for the generator, engine and control panel for 1000 hours in the environmental condition.

5.23. Required Spare Parts

Type No.	Description	Qty Set	Rate (Rs)	Amount (Rs)

Technical Specifications

	<u>Engine:</u> Fuel filter Oil filter Air filter Water filter Fan belt Water-pump belt Alternator belt Rocker cover gasket Gasket <u>Alternator & Panel:</u> AVR Forward diodes Reverse diodes Fuses 2 amp Fuses 6/8 amp Fuses 10 amp	4 sets 4 sets 1 set 4 sets 1 set 1 set 1 set 2 sets 2 sets 1 set 3 set 3 set 5 Nos. 5 Nos. 5 Nos.		

5.24. Additional spare parts:

Supplier to list down the items as per manufacturer recommendation.

ELECTRICAL EQUIPMENT & COMPONENTS
LIST OF PREQUALIFIED MANUFACTURERS / SUPPLIERS "EDUCATION CITY"

IMPORTANT NOTES:

The Engineer has the right to select anyone of the manufacturer / supplier out of this approved list of manufacturer / supplier. This shall be binding on the Bidder / Contractor. Equipment / material offered must be in full compliance with Technical Specification of the Tender Documents.

Non Compliance will be subject to rejection.

The Contractor / bidder shall preferably, make the maximum use of materials, supplies and equipment indigenous to or produced in Pakistan and services available in Pakistan or operated in Pakistan provided such materials, supplies, equipment and services shall be of required standard.

The successful bidder will give the undertaking that which equipment / allied material as per the manufacturer list, he will provide before awarding the contract.

Change in Quoted Manufacturer (within the Approved List) may only be considered on exceptional circumstances with the prior approval of the Employer and Engineer.

Equipment and materials must be sourced exclusively from the approved suppliers listed below. In all instances, the Contractor is required to provide comprehensive technical specifications for the equipment and materials and secure approval from the Consultants before delivery to the construction site. In cases where the option of an 'Approved Equivalent' is indicated, it is at the discretion of the Consultants to accept any alternative proposal submitted by the Contractor.

Minimum "Product warranty of 1 year is required", and the warranty will commence upon the handover of the project to the client.

The contractor is required to submit the Technical Submittal to the consultants before placing orders. This submittal should include necessary documents, such as valid certifications from national and international authorities.

We have provided a General & Technical Specification to be applied to all electrical and allied equipment and components.

S#	DESCRIPTION	BRAND -1	BRAND -2	BRAND -3	BRAND -4
LV SYSTEM					
1	Generator	Perkins (UK)	Cummins (China)	FPT (Italy)	
2	LV Switchgear Panel	Babar Brothers (PAK)	Power Engineers (PAK)	Karimi Electromech System (PAK)	Hassan Engineering (PAK)
3	C.T, P.T, Relay & Auxiliary items	Schneider (France)	Siemens (Germany)	ABB (Germany/Italy)	SASI (Spain)
4	Digital Meters	Schneider (France)	Siemens (Germany)	Lovato (Canada)	INTER (Turkey)
5	LV- Circuit Breaker	Schneider (France)	ABB (Italy/Germany)	Legrand (France)	Terasaki (Japan/Malaysia)
6	Load Break Switch/Changeover & Isolator	Schneider (France)	Legrand (France)	Siemens (Germany)	SOCOMAC (France)
7	Pfi System	ABB (Italy/Germany)	Schneider (France)	RTR (Spain)	NOKIAN (Finland)
8	Magnetic Contactor	Schneider (France)	ABB (Italy/Germany)	TOGAMI (Japan)	TERRASAKI (Japan)
9	LV Power Cables	Fast Cable (PAK)	Pioneer Cable (PAK)	Allied Cable (PAK)	Pakistan Cable (PAK)
10	Busway (Cu/Al)	Pogliano (Italy)	EAE (Turkey)	Schneider (France)	Pioneer Cable (PAK)
11	LV ABC with IBC	Fast Cable (PAK)	Universal Cable (PAK)	or Eqv.	-
12	Wiring Cable	Fast Cable (PAK)	Universal Cable (PAK)	Allied Cable (PAK)	Pioneer Cable (PAK)
13	Term. Kit & Straight through Joint MV/LV	3M (USA)	Raychem (USA)	Elastimold	-
14	Lighting Fixtures (indoor/outdoor)	Osaka (China)	Philips (Netherland)	Britlite Egg. Products (China)	or Eqv.
15	Exit & Emergency Light fixtures	Orbix (China)	Menvier (UK)	Cooper (UK)	or Eqv.
16	Switches & Sockets	Legrand (France)	Clipsal (Australia)	MK (UK)	or Eqv.
17	Industrial Socket	PCE (Austria)	Gewiss (Italy)	Legrand (France)	or Eqv.
PROTECTION & SECURITY SYSTEM					
18	Earthing System	Dehn	Kingsmill	Furse	or Eqv.
SOLAR SYSTEM					
19	SOLAR PANEL	Jinko	Phono	or Eqv.	or Eqv.
20	INVERTER	Huawei	Foxes	Solis	or Eqv.
21	BATTERY	Narada	Pylontech	or Eqv.	or Eqv.
S#	DESCRIPTION	BRAND -1	BRAND -2	BRAND -3	BRAND -4
MISC WORK					
22	PVC/UPVC Conduits & Access.	Civic (PAK)	Jeddah Polymer (PAK)	Prince Pipe (PAK)	-
23	G.I Conduit	IIL (PAK)	Steelex (PAK)	or Eqv.	-
24	Cable Tray & MS Back Boxes	Hassan Engineering (PAK)	Babar Brothers (PAK)	Karimi Electromech System (PAK)	Power Engineers (PAK)
25	Street Light Pole	Babar Brothers (PAK)	Hassan Engineering (PAK)	Karimi Electromech System (PAK)	Power Engineers (PAK)
26	SLCP	Babar Brothers (PAK)	Power Engineers (PAK)	Karimi Electromech System (PAK)	Hassan Engineering (PAK)
27	FEEDER PILLAR	Babar Brothers (PAK)	Power Engineers (PAK)	Karimi Electromech System (PAK)	Hassan Engineering (PAK)