



**STANDARD SPECIFICATION
FOR
HOUSING PROJECTS - PART I
(HOUSES AND APARTMENTS)**

MAY 2010



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SECTION 1

GENERAL ITEMS

1.1 Quality of Houses

- a. The standard of construction shall be adequate for a minimum service life of twenty five years.
- b. Where materials or methods are not clearly defined in the project documents, the engineer shall assess contractor submittals for adequacy to required standards of construction
- c. Written submittal shall be provided to the Engineer for all materials, products or systems for his approval. No material, product or system shall be used until written approval is given by the Engineer.

1.2 Materials

- a) The following abbreviations for standard specifications are used in the Contract Documents :-

B.S.	British Standard Specification
B.S.I	British Standard Institution
C.P.	British Standard Code of Practice
A.S.T.M.	American Society for Testing and Materials.
A.A.S.H.T.O	American Association of State Highway and transportation official.
I.S.O	International Standards Organization.

The standard applicable shall be the standard current at the date of tender.

- b) The Contractor shall adhere strictly to all standard specifications, Codes of Practice, Building Regulations or similar which are referred to in the Contract Documents. If no standard is specified then the relevant British



Standard will be deemed to apply, but the Engineer may at his discretion accept materials in accordance with other standards specifications (e.g. ASTM) if the quality is equivalent or superior to the BS.

- c) The Contractor shall fully demonstrate in detailed documentation that he is complying with Cabinet Decree no. 21 – 1987 and that he has investigated all local manufactures of all products and materials listed in this specification. Preference must be given to Bahrain produced materials and products. In the event that the correct quality or cost margins are not met these shall be brought to attention of the Employer prior to rejection. The Employer reserves the right to direct Contractors to purchase locally produced materials rather than overseas materials where all other factors are equal.
- d) All overseas material manufactures shall comply with ISO 9000 requirements.

1.3 **Approval of Materials**

- a. Approval of materials, products or systems in accordance with clause 1.1(c) shall not, in any way, relieve the Contractor of full responsibility under the contract.
- b. Certain materials and components are specified on the Drawings using proprietary names in order to identify the standard and quality required by reference to an example. The Contractor may submit for written approval details of any alternative which meets the said standard and quality.



SECTION 2

EXCAVATIONS AND EARTHWORKS

MATERIALS

2.1 Topsoil

Only such soil will be taken as topsoil which, in a loosened state, contains mineral elements besides the normal inorganic components in adequate quantity to serve as a nutrient medium for vegetation when watered.

2.2 Fill Materials

a. Class 1:

Class 1 fill is a crusher run type material normally used as a road base. It shall be good, hard well-graded material screened and crushed as necessary to lie within the grading envelope given below when tested in accordance with BS 1377 Test 7. The fill material shall be non-plastic when tested in accordance with BS 1377 and the content of clay and friable particles when determined in accordance with ASTM C 142, shall not exceed 1% for any individual sieve size fraction. The total sulphate content as SO₃ of the material shall not exceed 1% and the total soluble salts shall not exceed 2%.

Grading Envelope for Class 1

<u>Sieve Size</u>	<u>% by Mass Passing</u>
50 mm	100
37.5 mm	95-100
20 mm	50-75
5 mm	25-50
0.6 mm	8-30
0.075 mm	0-10



b. Class 2

Class 2 fill is normally employed as a road sub-base material and shall be good, hard well-graded material, screened and crushed as necessary to lie within the grading envelope given below when tested in accordance with BS 1377 Test 7. The CBR of the material when tested in accordance with Clause 5.1.4 of BS 1377 at the density likely to exist in the field shall not be less than 30%. The liquid limit shall not be more than 25% and the plasticity index shall not exceed 6% when tested in accordance with BS 1377. The total soluble salts shall not exceed 2%.

Grading Envelope for Class 2

<u>Sieve Size</u>	<u>% by Mass Passing</u>
75 mm	100
37.5 mm	85-100
10 mm	45-100
5 mm	20-65
0.6 mm	8-45
0.075 mm	0-20

c. Class 3

Class 3 fill is desert fill type material and shall be a selected, graded, hard granular material free from clay and deleterious substances. The total sulphate content as SO₃ of the material shall not exceed 1% and the total soluble salts shall not exceed 2%. The grading of the fill shall lie within the grading envelope given below when tested in accordance with BS 1377 Test 7. Where the percentage passing the 0.075mm sieve is greater than 8%, the plasticity index shall not exceed 20% when tested in accordance with BS 1377.

Grading Envelope for Class 3

<u>Sieve Size</u>	<u>% by Mass Passing</u>
100 mm	100
5 mm	0-50
0.075 mm	0-20



d. **Class 4**

Class 4 fill is a dredged sand type material normally employed as common fill. The material shall be evenly graded and shall lie within the grading envelope given below when tested in accordance with BS 1377 Test 7. The material shall be non-plastic when tested in accordance with BS 1377. The total sulphate content as SO₃ of the material shall not exceed 1% and the total soluble salts shall not exceed 2%.

Grading Envelope for Class 4

<u>Sieve Size</u>	<u>% by Mass Passing</u>
5 mm	95-100
0.075 mm	0-8

e. **Class 5**

Class 5 fill is a single size-type material normally employed as a drainage blanket medium. The material shall be good hard rock screened and crushed to lie within the grading envelope shown below and shall be free from deleterious material.

Grading Envelope for Class 5

<u>Sieve Size</u>	<u>% by Mass Passing</u>
50 mm	100
37.5 mm	95-100
20 mm	0-5

f. **Class 6**

Class 6 fill is a crusher dust type material. It shall be good, hard rock screened and crushed to lie within the grading envelope shown below and free from natural sand, silt, clay and any other deleterious material. Class 6 fill shall also be non-plastic when tested in accordance with BS



1377 and shall not be susceptible to breakdown under moist conditions. The total sulphate content as SO₃ of the material shall not exceed 1% and the total soluble salts shall not exceed 2%.

Grading Envelope for Class 6

<u>Sieve Size</u>	<u>% by Mass Passing</u>
10 mm	100
5 mm	95-100

g. Class 7

Class 7 is a hardcore material. It shall be good stone, concrete, hard tiles or other approved material not exceeding 100mm gauge with not more than 1% passing a 20mm sieve. The fill shall not be susceptible to breakdown under moist conditions and shall not contain any deleterious materials. The total sulphate content as SO₃ of the material shall not exceed 1% and the total soluble salts shall not exceed 2%.

h. Class 8

Class 8 fill is a crushed aggregate material normally employed as a pipe bedding or pipe surround (note: it is not suitable for UPVC pipes). The material shall be hard, draining, clean, silt and clay free, and chemically stable stone in accordance with BS 882. It shall be screened and crushed to lie within the grading envelope given below when tested in accordance with BS 1377 Test 7. The permitted limits for the soluble chloride and soluble sulphate levels shall be those specified for concrete aggregates.



Grading Envelope for Class 8

Sieve Size mm	Percentage by Mass Passing Sieve	
	For pipes of Diameter 400 mm to 600 mm	For pipes of Diameter 600mm and above
20	100	-
14	85 - 100	100
10	0 - 50	85 - 100
5	0 - 10	0 - 25
2.36	-	0 - 5

j. **Class 9**

Class 9 fill material is normally employed as a pipe bedding for UPVC pipes. Unless noted otherwise, Class 9 fill shall comply with the requirements for Class 8 fill and shall be one of the following:

- i) Crushed aggregate in accordance with the grading for Class 8 fill except that the percentage passing a 10mm sieve shall be 100%.
- ii) Rounded (not crushed) aggregate.
- iii) Clean sand to BS 882 Table 5 Zone C.

2.3 Selected Excavated Material

Selected excavated material shall be deemed suitable for backfilling only if compliance with the Class 3 or Class 4 fill materials requirements is met. The material shall also be free from vegetable matter and other deleterious materials.



2.4 Agricultural Sand

Sweet sand shall comply with the requirements of Ministry of Housing specifications for landscaping. It shall be obtained from an approved location free from stones, chlorides and deleterious matters and shall be suitable for plant growth.

2.5 Sand Blinding

Sand blinding shall be a dredged sand, evenly graded and shall be within a grading envelope when tested in accordance with BS 1377 Test 7 as follows:

<u>Sieve Size</u>	<u>by Mass Passing</u>
5 mm	95-100
0.075 mm	0-8

WORKMANSHIP

2.6 Excavations

- a. The Contractor must ascertain the nature of the site. The contractor shall include for excavating in whatever type of soil encountered including rock as defined in clause 2.7, desert fill, hardcore, rubble, etc. and for removing all small isolated obstructions encountered and for filling voids with hard dry materials. All measurements shall be approved the Engineer
- b. Excavation shall be accurately cut to the lines and levels shown on the drawing or to such depths and dimensions as shall be determined by the Engineer.
- c. Should any excavation work be in excess of the dimensions shown, whether specified or authorized then the excess volume shall be filled in with approved Grade 20 concrete - Table 3.1 or hardcore as required by the Engineer. The whole cost of the filling excessive excavations shall be borne by the Contractor.
- d. If through the operations of the Contractor any excavated surface is softened or otherwise made unsuitable, the Contractor shall at his own



expense re-excavate to provide a firm foundation and fill up with hardcore fill or blinding concrete as directed the Engineer before the foundations or pipes are laid or any permanent work is commenced.

- e. The Contractor shall keep the excavations free from all water by means of pumping, bailing, or other suitable means.

2.7 **Rock Excavations**

- a. The following items, if they cannot be broken and removed by power excavating equipment such as bull-dozers, power shovels and back-actors and require the use of drills or rock-breakers and comply with Clause 2.7(b) of this Specification are hereby defined as rock excavation.

Note: The use of explosives for blasting is strictly prohibited.

- i) Rock or stone in original ledge
 - ii) Hard shale in original ledge
 - iii) Boulders within the foundations or trench limits exceeding 0.5 m^3 in volume
 - iv) Boulders on site, outside foundation or trench limits exceeding 1.0 m^3 in volume
 - v) Foundation stones or mass concrete greater than 1.0 m^3 in volume.
- b. Rock shall have a crushing strength of not less than 7.0 N/mm^2 when dry and not less than 4.0 N/mm^2 after submergence in water for twenty-four hours. This shall be determined on samples of $10 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm}$ cubes obtained from said materials. (Equivalent cores in lieu of the above cubes may be considered for testing at the discretion of the Engineer).
 - c. All other materials are classified as 'General Excavation' as far as removal of the material to be excavated is concerned. Removal of paving foundations is classified as general excavation.
 - d. All bottoms of rock foundation shall be carefully examined, loose or broken rock shall be removed to solid bearing, and the rock surface leveled, or shelved to a slope not exceeding 8% or as directed.



2.8 Support to Earthwork Excavations

- a. The Contractor shall allow for upholding the sides of excavations by means of planking and strutting or other suitable means and removing these on completion and shall bear the full responsibility for the safety of his work-people and for damage to adjoining property due to neglect on his part to take to the correct precautions.
- b. Any falls due to lack of proper support shall be made good at the Contractor's expense.
- c. The Contractor shall furnish, put in place, and maintain such sheeting, bracing, etc. as may be necessary to support the sides of the excavation and to prevent any movement of earth which could in any way diminish the width of the excavation to less than that necessary for proper construction, or could otherwise cause injury to persons, or delay the work, or endanger adjacent structures. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor.
- d. Wherever the depth of excavation below natural ground level is greater than 3 metres, or wherever applicable the Contractor shall present to the Engineer for his approval, construction drawings indicating details of sheeting, , method of dewatering, etc as required.
- e. Wherever possible sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting, care shall be taken to avoid trimming behind the face along which the sheeting shall be driven.
- f. The Contractor shall leave in place to be embedded in the backfill or concrete, all sheeting, bracing etc. which is indicated on the drawings to be so left in place or as may be ordered by the Engineer. He also shall leave in place any and all other sheeting, bracing etc. which the Engineer may direct him in writing to leave in place, at any time during the progress of the work, for the purpose of preventing injury to structures or property.
- g. The Engineer may direct that sheeting and bracing be cut off at any specified elevation.



- h. All sheeting and bracing not to be left in place shall be carefully removed in such a manner as not to endanger the construction or other structures. All voids left caused by the withdrawal of sheeting shall be backfilled immediately with approved material and compacted by ramming with tools specifically adapted to that purpose, by watering or by other means as may be directed.

2.9 **Preparation of Footing Excavations**

The last 150mm of soil above formation level shall be excavated manually. The formation shall be compacted to a 95% of the maximum dry density in accordance with BS 1377 Test 13 or 14. Any over excavation shall be filled in with Grade 20concrete. Soft spots shall be excavated and filled in with Grade 20concrete.

2.10 **Other Excavation**

The formation shall be compacted to 95% of the maximum dry density in accordance with BS 1377 Test 13 or 14. Any over excavation shall be filled in with an approved desert fill as described under 'Filling'.

2.11 **Approval of Excavations**

The bottom of all excavations are to examined and approved by the Engineer before any further work is carried out. The Contractor shall give the Engineer at least 24 hours notice that the bottoms of excavations are ready for inspection and measurement.

2.12 **Disposal**

The Contractor must dispose of the surplus excavated material at a pit to be found by the Contractor or if prior approval is obtained from the Engineer the surplus excavated material may be spread and leveled in areas as directed.



2.13 **Backfilling**

Excavations shall be filled in after foundations have been approved by the Engineer with selected excavated material or with other approved material. Backfill shall be well compacted in 150mm layers.

2.14 **Filling**

- a. When working with Class 3 fill, Class 7 fill and similar materials, Contractor shall include for all necessary retaining boards.
- b. Filling generally under slabs shall consist of Class 3 fill or other approved fill laid in layers not exceeding 150mm compacted thickness, each layer being well watered and compacted to 95% of maximum dry density as determined in accordance with BS 1377, Test 13.
- c. Excavated areas around sub-structures shall be backfilled with approved material in horizontal successive layers not exceeding 150mm compacted thickness to the required levels. Care shall be taken to avoid any damage to structural concrete. Any damages to structural concrete shall be reported to the Engineer's attention. The Contractor shall at his own expense make good to such damages. Instructions from the Engineers must be obtained before carrying out any remedial action.
- d. All filling shall be compacted to at least 95% of the maximum dry density, as determined in accordance with the procedures given in BS 1377 Test 13 or 14. Each compacted layer shall be tested and approved in writing by the Engineer prior to the laying of the subsequent layer. The above operation shall be continued until the fill layers reach the required levels to 95% compaction.
- e. Where Class 7 fill is specified, it shall be laid in a layer not exceeding 150mm compacted thickness. If Class 7 is to receive a subsequent layer of concrete or damp proof course, it shall be blended with crusher dust and shall be vibrated until all lean and empty pockets are eliminated.



SECTION 3

CONCRETE WORK

3.1 General

- a. All materials and workmanship shall comply with the relevant British or ASTM Standards or Codes of Practice except as amended herein and shall apply equally to in-situ and precast concrete.
- b. The Contractor shall submit to the Engineer samples of all materials proposed to be used for the works, together with a list of suppliers to be employed. The Engineer's consent in writing shall be obtained to all such samples and sources of supply before concreting work is put in hand. No changes shall subsequently be made without the Engineer's approval. The Engineer shall have access to all sources of supply for the purpose of inspecting and taking samples.
- c. Concrete mixes indicated assume no adverse ground conditions or impure constituents in the concrete. All relevant tests shall be carried out prior to construction and the results presented to the Engineer for approval. Precautions and measures shall be taken where necessary under further relevant specification prior to any works proceeding.

MATERIALS

3.2 Cement

- a. All cement for work above ground slab level shall be 'Ordinary Portland Cement' of an approved brand and complying with BS 12 or ASTM-C150-Type I. All cement for work below ground level or in contact with soil shall be 'Sulphate Resistant Portland Cement' complying with BS 4027 or ASTM-C150-Type V. All cement shall be of a brand approved by the Engineer. In addition all cement used in the works shall be low alkali cement containing less than 0.6% acid soluble alkali (expressed as $\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$), when tested in accordance with BS 4550. Cement shall be delivered in manufacturer's sealed branded bags or barrels, each consignment accompanied by the manufacturer's test certificates. Damaged bags or barrels and any



cement the Engineer considers unsatisfactory shall be rejected. Each bag shall be used on the day of opening. Bags opened on the previous day shall be rejected. All rejected cement including that which has become affected by damp conditions is to be removed from site immediately. Cement bags shall have a coding system for identifying date of manufacture.

- b. All cement shall be stored in a suitable weatherproof building or silo. The building shall be painted a light color. Bagged cement is to be stored off the ground and it shall be used up in the order in which it is delivered to site.
- c. Different grades of cements shall be stored in separate areas. Cement temperature shall not exceed 50° C when used.
- d. If cement has been held in store for 3 months or more it shall be tested to satisfy the relevant BS or ASTM standard. No cement shall be used after 6 months from its manufacturing date.
- e. Each consignment of cement delivered to the site must be accompanied by a certificate showing the place and date of manufacture and the results of standard tests carried out on the bulk supply from which the cement was obtained.
- f. Notwithstanding the above requirements and tests, the Engineer may reject any cement which in his opinion is unsatisfactory for any reason whatsoever.

3.3 Aggregates Generally

Aggregates for concrete shall comply with BS 882 except as amended herein. The aggregates used in any concrete mix shall not cause damage or weakening of the concrete and shall be thoroughly washed in an approved washing plant and be clean and free from deleterious material.

3.4 Coarse Aggregates

- a. Coarse aggregates for concrete shall be crushed, hard durable stone with at least 90% of the particles having one or more fractured faces and free from soft substances or organic matters.



- b. The maximum permitted content of chlorides and sulphates are 0.03% by weight of aggregate (as acid soluble Cl) and 0.4% by weight of aggregate (as acid soluble SO₃) respectively.
- c. The flakiness index shall not exceed 30%
- d. Coarse aggregate shall contain not more than 1% by weight of friable particles.
- e. Unless otherwise approved by the Engineer coarse aggregate for use in all grades of concrete shall be provided for batching as single-sized aggregate of 20mm and 10mm nominal size proportioned in such ratio as to give a uniform gradation.
- f. Material finer than 75 micron sieve when determined in accordance with BS 812 part 103 shall not exceed 1%.

3.5 Fine Aggregates

- a. Sand for concrete shall comply with BS 882. For site-mixed concrete it shall have a grading within the limits of grading M. It shall be washed sand and shall not contain more than 3% voided shells and free of soft substances or vegetable matter.
- b. The maximum permitted concentration of chlorides and sulphates expressed as percentage by weight of dry sand are 0.06% (as acid soluble Cl-) and 0.4% (as acid soluble SO₃) respectively.
- c. The blending of crushed stone fines may be permitted provided that the blended product meets all the requirements for fine aggregate.
- d. Material finer than 75 micron sieve when determined in accordance with BS 812 part 103 shall not exceed 3%.

3.6 Storage of Aggregates

Aggregates shall be stored and handled only on approved impervious free draining platforms with concrete block walls separating different grades and a concrete base shall be provided for all storage areas. Stockpiles shall be built in 1.50m (maximum) layers and segregation of the aggregates



prevented. All aggregates which have become segregated shall be removed. All aggregates stored on site shall be covered with approved shading devices against direct sunlight until required for mixing. Aggregates which have become contaminated whilst stored on site shall be removed. Aggregates may be sprayed with clean cold water complying with Clause 3.7(b) prior to the mixing.

3.7 Water

- a. Water for use in the washing of aggregate, curing, and in the production of concrete and mortar, shall be obtained from an approved source and shall be of such a quality as not to affect (1) the setting time, strength and durability of the concrete or mortar (2) the appearance of hardened concrete or mortar by discoloration of efflorescence and (3) the reinforcement at any age of the concrete or mortar.
- b. Water shall be clean, demineralized, blended or unblended, with a pH between 6.5 and 8.0 and shall be tested in accordance with BS 3148. The following limits shall not be exceeded.

Total dissolved solids (TDS)	not greater than	2000	ppm
Suspended solids (TSS)	" " "	2000	ppm
Chloride as NaCl	" " "	800	ppm
Chloride as Cl-	" " "	500	ppm
Sulphates as SO ₃	" " "	1000	ppm
Alkali HCO ₃ /CO ₃	" " "	1000	ppm

- c. Water shall be stored in approved, clean, covered containers painted white and are protected from sun, wind and dust and from contamination from any other source. Pipework for water shall, wherever possible, be protected from the sun and insulated. Crushed ice may be used to bring the water temperature below 32° C but with the strict supervision of the Engineer only.

3.8 Removal of Rejected Materials from Site

Materials rejected by the Engineer shall be removed from site within 48 hours of written notice of such rejection.



3.9 Admixtures

- a. An admixture is a material other than water, aggregate and hydraulic cement that is used as an ingredient of concrete or mortar and is added to the batch immediately before or during its mixing.
- b. Admixtures to be used in concrete shall be subject to prior approval by the Engineer in writing and shall comply with BS 5075 or ASTM C494-C260.
- c. Only liquid admixtures will be permitted. They shall be chloride free and shall not contain other substances which adversely affect the durability and performance of the concrete. Admixtures that excessively retard or accelerate the setting time of concrete will not be permitted.
- d. The following information must be submitted to the Engineer for approval purposes:
 - i) The brand name, the manufacturer's name and address together with a copy of the manufacturer's recommendations for the admixture.
 - ii) The typical dosage and detrimental effects of under dosage and over dosage.
 - iii) The chemical type(s) of the main active ingredients in the admixture.
 - iv) Whether or not the admixture leads to air entertainment when used at the manufacturer's recommended dosage.
 - v) Confirmation that the admixture is chloride free.
 - vi) The length of time and conditions under which the admixtures should be stored.
 - vii) Special measuring devices or equipment whenever needed.
- e. The suitability and effectiveness of any admixture shall be verified by trial mixes and compared with concrete of the same class but containing no admixture (control mix) to determine the effects of the admixture especially regarding workability, strength, setting time and density.



- f. When more than one admixture is to be used simultaneously in the concrete, the compatibility of the various admixtures shall have been ascertained by various standard tests and certified by the manufacturers.

3.10 **Reinforcing Steel**

- a. Reinforcement shall comply with the requirements of BS 4449, "Hot rolled steel bars for the reinforcement of concrete", BS 4449 "Cold worked steel bars for the reinforcement of concrete", ASTM A615 or BS 4483 " Steel mesh fabric." High tensile bars shall be round deformed bars or equivalent. Reinforcement shall be cut and bent in accordance with the relevant standard for each manufacturer.
- b. All reinforcement shall be clean and free from materials that may cause corrosion of the reinforcement or the disintegration of the concrete and from pitting, seams, loose rust, mill scale, paint, oil, grease and other material that may impair the bond between the concrete and the reinforcement.
- c. Sheets of mesh fabric shall be flat unless specified as bent and any tendency to curve or twist shall be corrected by the contractor before fixing. Mesh fabric shall not be supplied in rolls.
- d. The Contractor shall furnish the Engineer with manufacturer's certificates for the reinforcing steel intended for use, including test results of the physical and chemical properties as in the relevant standard, all prior to use in the works.
- e. Reinforcement shall be stored on properly constructed racks at least 150mm above ground level. The storage, cutting and bending of steel reinforcement shall be carried out under cover, on an approved free draining platform. The method of storing shall be such as to prevent contamination or damage by weather or accident. All steel reinforcement shall be protected from humidity and salt laden dews when stored.
- f. If necessary, steel shall be tested in accordance with the requirements of the standard/s to which it has been manufactured.



WORKMANSHIP

3.11 Reinforcement

- a. Dirt, rust, concrete, scale, paint, oil, grease, salts etc. shall be removed from the reinforcement by grit blasting or other approved technique.
- b. Reinforcement shall be bent when cold by hand or by using an approved hand or power operated bending machine. When bending the reinforcement should be subjected to a constant even load and not an impact load.
- c. Welding of reinforcement will be allowed only when required by the drawings and with specific written permission by the Engineer.
- d. Bar types, sizes and placement shall be as shown on the drawings. Bending dimensions shall be in accordance with BS 4466.

3.12 Fixing Reinforcement

- a. Bars in contact shall be firmly secured to each other with approved binding wire or proprietary clips of a type approved by the Engineer. Binding wires shall be 1.1-1.3 mm diameter soft annealed iron wire free from rust or other contaminants. The reinforcement shall be fixed accurately and securely in position so that the reinforcement is in the correct position in relation to the formwork to give the specified concrete cover and will not be displaced due to trafficking around site or during the placing and compaction of the concrete or any related operations.
- b. The correct cover shall be maintained by the use of plastic spacers or other approved means. Concrete spacing blocks, if approved for use, shall be machine pressed well compacted and water cured for a minimum of seven days after casting and shall have a 10 minute absorption of less than 2.5% by weight. Concrete spacers shall be comparable in strength, durability and appearance to the surrounding concrete. Any wire cast into the spacer blocks shall be positioned well away from the exposed surface and shall be galvanized. Spacers fixed to parallel reinforcement bars shall not be located in a line across a section. Timber, stone or metal spacers are not permitted.



- c. The top reinforcement in slabs shall be rigidly supported by mild steel chairs from the bottom reinforcement. Plastic coated or galvanized steel chairs shall be used where in contact with exposed concrete surfaces. Chair spacing shall be at 1.5m in both directions or less if required for working loads.
- d. Starter bars to columns and walls must be securely fixed to the reinforcement in the parent concrete and accurately located to maintain the specified cover. Reinforcement embedded in hardened concrete shall not be bent.
- e. Reinforcement cages assembled before fixing shall be protected against the weather and shall be stored and transported carefully so that no distortion or contamination may occur.
- f. Concrete shall be placed within 1 day of fixing reinforcement and the reinforcement shall be protected with plastic sheeting or tarpaulin in the interim period.

3.13 **Bending Schedules**

- a. The Contractor shall if so instructed, prepare for his own use bar bending schedules from the information shown on the drawings and in Ministry of Housing, specifications. These schedules shall be submitted to the Engineer for approval, which shall in no way relieve the Contractor of his responsibility for the correctness of such schedules.
- b. Lapping of bars shall not be permitted except where shown and as indicated on the drawings or approved by the Engineer. Where such laps are approved, no additional payment will be made for extra steel required. Laps shall be as directed by the Engineer.

3.14 **Concrete Mix**

- a. Concrete Grades - Table 3.1
- b. The concrete shall be capable of being transported and readily compacted by the approved methods to a dense impermeable mass without segregation, bleeding or plastic cracking. Subsequently, the concrete shall be durable and free from crazing, thermal cracks, drying shrinkage cracks, or any other



cracks in excess of the design crack width. The slump shall be kept to the minimum approved for placing and compacting requirements.

- c. Concrete mixes shall have the minimum cement content necessary to meet the specified water cement ratio, workability and compressive strength requirements as shown in Table 3.2. The maximum cement content should not exceed 500 kg per cubic meter.
- d. The mix proportions shall be adjusted to achieve the maximum density from the materials in use. (With imported aggregate and dredged sand this density is normally greater than 2450 kg/m³ for mixes grade 45 and 30)
- e. In-situ concrete shall be dense and well compacted to a minimum of 98% of the density of the relevant test cubes.
- f. The total chloride content of concrete containing embedded steel shall not exceed the values given in the following Table 3-1) when determined as nitric acid soluble chloride by the Volhard Titration Method.
- g) The total sulphate content of the mix expressed as percentage by weight of cement shall not exceed 5.0% (acid soluble SO₃).

Table 3-1

Type of Concrete	Maximum Total Chloride Expressed as % of Chloride Ion by Weight of Cement
Pre-stressed Concrete	0.2
Concrete made with Cement Complying with BS.4027	0.2
Concrete made with Cement complying with BS.12 and having C3A contents as below: Less than 7% 7% or more	0.2 0.4



TABLE 3.2 - CONCRETE GRADES

Concrete Grade	Nominal max size of Aggregate (mm)	Minimum Cement Content** (kg/m ³)	Slump (mm)		Characteristic Strength N/mm ²	Maximum Water - cement ratio
			A	B		
45	40*	370	25	75	45	0.45
	20	370	25	75		
35	20	330	25	75	35	0.5
	10	360	25	50		
20	20	260	25	75	20	0.6
	10	290	25	50		
Blinding Concrete		220				

NOTE: SLUMP : Col. A: Specified slump where no politicizing / water reducing admixture is used.

Col.B: Specified slump where politicizing /water reducing admixture is used.

* Concrete with 40 mm aggregate subject to Engineer's approval and to be used in mass concreting

** Maximum cement content 500 kg/m³ as per Clause 3.14c.



3.15 Mixed Concrete

- a. Only ready-mixed concrete shall be used for substructure and superstructure elements and for other elements where the required quantity is more than half a cubic meter. Engineer approval for compliance with Clause 3.14. has to be obtained.
- b. The name and address of the supplier is to be submitted to the Engineer and acceptance of the use of such supplier shall be obtained prior to placing the order. Notwithstanding any such authorization by the Engineer the Contractor shall take full responsibility for the ready-mixed concrete complying with the requirements of the Specification.
- c. The concreting materials shall comply with the requirements of this Specification and shall be tested in accordance with the Engineer's instructions. The cost of such testing will be the responsibility of the Contractor. Test cubes shall be taken on site by the Contractor.
- d. The Contractor is to ensure that a record is kept on the exact time when the concreting materials are mixed.
- e. Ready-mixed concrete shall be plant batched and mixed; truck mixed concrete will not be accepted. The concrete shall be carried in purpose-made agitators, operating continuously. The concrete shall be placed in it's final position within 90 minutes of the time when the cement first came into contact with water or wet aggregates.
- f. Delivery notes shall record the following information :
 - (i) Cement content, type and grade of concrete.
 - (ii) Design slump
 - (iii) Temperature at mixing
 - (iv) Additives (if any).
 - (v) Mix code number
 - (vi) Time and date of mixing.
 - (vii) Time and date and of truck arrival.
 - (viii) Registration number of truck and name of depot.
 - (ix) Time when concrete placed in position.
- g. The following additional information shall also be recorded by the Contractor who shall submit to the Engineer a copy of the signed



agreement, together with the mix designs, specifications and all other documents relating to the supply of concrete.

- i) Mix grades and position in the structure where the concrete is placed.
 - ii) Whether test cubes were taken from this delivery.
 - iii) Actual slump and details of additives.
- h. If the use of ready-mixed concrete has been approved by the Engineer, the Contractor shall submit to the Engineer a copy of the signed agreement, together with the mix designs, specifications and all other documents relating to the supply of concrete.
- i. Ready-mixed concrete shall comply in all respects with BS 5328.
- j. Admixtures used in ready-mixed concrete shall comply in all respects with BS 5075.
- k. Where small amount of non-structural concrete not exceeding one half a cubic meter is required, site mixing may be allowed. However, the contractor must submit a formal request along with material approval certificate “MAC”. Mix design and batching details for the desired grade shall also be submitted for approval.

3.16 **Sampling Testing and Compliance**

- a. For assessment of strength, a sample shall be taken from a randomly selected batch of concrete by taking a number of increments in accordance with BS 1881. The samples, whenever practicable, shall be taken at the point of discharge from the mixer or in the case of ready-mixed concrete, the point of discharge from the delivery vehicle. Four test cubes from each sample shall be prepared and cured in accordance with BS 1881. The placing of concrete shall not begin until all equipment necessary for sampling/testing are available and are acceptable to the Engineer. Equipment shall be in good working condition and shall be suitable for the intended purpose.
- b. The test cubes shall be cured in accordance with BS 1881. Two cubes will be crushed at 7 days and used for early assessment of the concrete as a guide only.



- c. One sample (of four test cubes) shall be taken for each thirty cubic meters of concrete or each day's concreting whichever is the smaller quantity. The test cubes shall be prepared by the contractor under the supervision of the Engineer.
- d. The test cubes shall be stored under water on site in cool conditions for a period of not less than three days or more than six days. The test cubes shall be delivered to, and tested by, a laboratory approved by the Engineer. Certified copies of the test results shall be supplied to the Engineer. Test machines used by the private laboratories shall be verified in accordance with BS 1610 at the intervals stipulated. Certificates of calibration are to be made available to the Engineer.
- e. For ready-mixed concrete, compliance with the characteristic strength will be assessed in accordance with the requirements of BS 8110 and BS 5328.
- f. All concrete of any given mix, poured after the taking of a sample and prior to taking the next sample, shall be represented by the former sample.
- g. The cost of taking and testing concrete samples and materials required to ensure compliance with this specification shall be borne solely by the Contractor.
- h. Should the concrete supplied not comply with the characteristic strength requirements, the Engineer may instruct the removal and replacement of the concrete or other remedial action to be taken. Any such removal or remedial action will be carried out at the Contractor's own expense and payment will not be made for such elements until the removal and replacement or remedial action is completed, to the satisfaction of the Engineer.

3.17 **Records**

- a. The Contractor shall also keep a complete record of the work of concreting showing the time and the date of placing the concrete in each portion of the work. The records shall be available for inspection at any time by the Engineer.



- b. The following information shall be recorded for each set of cubes and shall be supplied to the testing laboratory and to the Engineer :
 - (i) Grade of mix, cement content and type
 - (ii) Origin
 - (iii) Slump and quantity
 - (iv) Temperature of concrete, if measured.
 - (v) Mixing date.
 - (vi) Exact location in structure of concrete.
 - (vii) Cube identification marks.
 - (viii) Supervising officer

- c. All cubes shall be clearly marked prior to leaving site. No cube shall leave the site unless the documentation complying with the above has been supplied to the Engineer.

- d. If instructed by the Engineer the temperature of the concrete sample shall be determined in the following manner: Within two minutes of taking the concrete sample, a type A 100mm immersion thermometer having a range of -5 degrees to 110°C graduated at each 1°C and complying with BS 1704 or other approved temperature measuring device shall used. The thermometer shall be inserted in the sample at a depth of at least 100mm. When steady conditions have been maintained for one minute the temperature shall be recorded to the nearest 1 °C. Should the temperature exceed 32 °C, concreting shall be suspended until measures have been taken to reduce the concrete temperature.

3.18 Transport and Placing of Concrete

- a. The Contractor shall notify the Engineer in writing 48 hours before placing concrete, stating the times of placement and shall not commence pouring operations without Engineer's written approval of excavations, formwork, reinforcement, arrangements for plant and materials on site, installation of accessories, etc. Any concrete placed before obtaining such approval shall be rejected.

- b. The formwork or area of disposition shall be cleaned as specified. Constructional materials required, or which may be required, during the concreting work and for curing shall be on site and fully prepared before concreting commences. All accessories shall be installed and formwork for holes, chases etc., shall be provided as specified.



Only after all these preparations have been completed, shall the Engineer's written approval to place concrete be given.

- c. Concrete shall be transported, placed and spread by approved means and in such a way as to prevent segregation. Concrete not placed within 90 minutes of adding water to the mix or before starting its initial set shall be rejected, unless an approved retarding admixture is used.
- d. Concrete shall be transported and compacted into a dense impermeable mass without segregation or bleeding or cracking to ensure that when hard it is durable, uncracked and uncrazed.
- e. Except where otherwise agreed by the Engineer, concrete shall be deposited in horizontal layers to compacted depth not exceeding 500mm where internal vibrators are used or 300mm in all other cases. Concrete shall be deposited as near as possible to its final position to avoid re-handling.
- f. Unless otherwise agreed by the Engineer concrete shall not be dropped into place from a height exceeding 2 meters. When trunking or chutes are used they shall be kept clean and used in such a way as to avoid segregation.
- g. Concrete shall be deposited continuously. No concrete shall be placed against concrete which has hardened sufficiently to cause seams, planes of weakness or cold joints.
- h. If for unforeseen reasons it is necessary to stop concreting before completion of the pour then construction joints as specified shall be formed and further concreting shall be suspended for at least twenty-four hours unless otherwise approved in writing by the Engineer.
- j. Cutting and chasing of hardened concrete shall not be permitted without the Engineer's approval. The Contractor shall provide openings, mortises, chases, sleeves etc., and shall fix bolts, anchors etc. in concrete as work proceeds and shall support embedded items against displacement. Embedded hollow items shall be blocked with readily removable materials to prevent concrete ingress.
- k. The Contractor shall provide adequate construction and/or expansion joints. Engineer's approval shall be obtained for the size and locations



of these joints. When reinforcement is continued over expansion joints, the Contractor shall use approved sleeve pieces.

- l. The Contractor shall clean and wet and then fill tie holes solid with specially prepared patching mortar. When required by the Engineer honeycombed and other defective concrete shall be cut back to sound concrete with perpendicular or slightly under-cut edges and shall be prepared to the Engineer's approval.
- m. The Engineer will reject any concrete which he considers to have been inadequately mixed or in which the ingredients have segregated or which is no longer capable of being effectively placed or compacted.
- n. All receptacles used for the transport and deposition of the concrete shall be kept clean and thoroughly washed out after stopping work at the end of each shift.
- p. The Contractor shall obtain the Engineer's permission before concreting in air shade temperatures which exceed 35° C, and shall take appropriate precautions to ensure that concrete when placed does not exceed 32° C and is protected from drying winds.
- q. No concreting shall be carried out in rain. The remixing or retempering of stiffened concrete is not permitted.

3.19 **Compaction**

- a. Concrete must be carefully and thoroughly compacted during placing to ensure that it completely surrounds the reinforcement, fills the formwork and excludes voids.
- b. All concrete shall be compacted by using internal vibrators. The size and type of vibrator must be approved by the Engineer and they shall be used by operatives experienced in their use. Concrete is to be vibrated for the minimum time necessary for thorough consolidation, and the Contractor shall ensure that excessive vibration leading to segregation, is avoided. Care must be taken to ensure that the vibrator does not touch the reinforcement or formwork. Additional compactive effort, applied by the use of external vibrators, may be required by the Engineer.



- c. The Engineer shall approve all vibrator operations and all vibrators shall be tested prior to concreting.
- d. Internal vibrators shall be of the immersion type with a frequency of not less than 3000 vibrations per minute, and sufficient amplitude to consolidate the concrete effectively. The Contractor shall provide at least 50 percent duplication of all vibration equipment as standby during any period of concreting.
- e. Vibrators shall be inserted and withdrawn at points 400mm to 700mm apart. At each insertion, the duration shall be sufficient to consolidate the concrete, but not long enough to cause segregation. The duration shall be generally from five to fifteen seconds. They shall be withdrawn slowly at a speed not greater than 75mm per second.
- f. Vibrators shall not be employed to move concrete within the formwork. Their use shall be continued only as long as it is required for the concrete to become uniformly plastic and free from air bubbles.

3.20 Curing

- a. Freshly deposited concrete shall be protected from premature drying and excessively hot or cold temperatures and shall be maintained with minimal moisture loss at a relatively constant temperature for the proper hydration of the cement and hardening of the concrete.
- b. The materials and methods for curing shall be subject to approval. Concrete surfaces not in contact with forms shall be cured immediately after the finishing operations by one of the following materials or methods:
 - i) Ponding, continuous sprinkling, or absorptive mat or fabric kept continuously wet with water which complies with the requirements of Clause 3.7.
 - ii) Polythene membrane shall be laid direct onto damp (not wet) concrete in unbroken sheets with substantial close fitted lap joints. Sheets shall be weighed-down with timbers or other suitable material to prevent dry winds blowing under the membrane.



- iii) Spray applied membrane and compounds which shall be of approved manufacture and type and be of the maximum retentive type. Curing compounds used shall have reflective properties; they shall be applied in accordance with the recommendations of the manufacturer and shall not be used on any surfaces against which additional concrete or other finishing materials are to be bonded and shall not adversely affect the concrete.
- c. Curing shall be continued for a period of at least seven days when methods (i) and (ii) above are used. Rapid drying at the end of the curing period shall be prevented.
- d. The Engineer may instruct in hot, dry weather or as deemed necessary in judgment that a combination of the above methods shall be used.
- e. Exposed horizontal surfaces of slabs in hot, windy weather may require additional protection between the initial compaction and the final finishing stages to ensure that the concrete is not exposed for more than twenty (20) minutes after placing.
- f. Formwork exposed to direct sunlight during the curing period shall be shaded.
- g. Steel forms heated by the sun and all wood forms on contact with the concrete during the curing period shall be kept wet. If forms are to be moved during the curing period one of the above curing materials or methods shall be employed immediately. Such curing shall continue for the remainder of the curing period. Concrete surfaces cured by the liquid membrane or waterproof paper where permitted shall be adequately prepared before application of any finishes.
- h. The use of any of these methods of curing shall be subject to the requirements of the Engineer for achieving a satisfactory curing result. Any method not giving satisfactory results shall be discontinued and another method as directed by the Engineer be applied instead.
- i.



FORMWORK

3.21 General

- a. The design of formwork and its construction shall be the sole responsibility of the Contractor. It shall include all moulds for forming the concrete and all temporary construction for the proper execution of the work. The design shall be submitted to the Engineer for approval before construction work commences.
- b. Formwork shall be fixed in perfect lines, grades and dimensions, with no crevices at joints. It shall be securely braced, supported and wedged so as to retain its position without displacement or deflection during the placing and compaction of concrete. All joints shall be either horizontal or vertical, unless otherwise required.
- c. In long spans, the anticipated deflection due to the effect of self-weight shall be accurately computed by the Contractor and taken into account in the design of formwork such that the finished concrete member shall have true surfaces conforming to lines, planes and elevations shown in drawings. If adequate foundations for shores are not secured, trussed supports shall be provided by the Contractor.
- d. Metal ties or anchors within the form shall be so constructed as to permit their removal to a depth of at least 30mm from the face without injury to the concrete. All fittings for metal ties shall be of such design that, upon their removal the cavities which are left will be of the smallest possible size. Spreader cores or ties shall not exceed 25mm diameter. The cavities shall be filled with cement mortar and the surface left sound, smooth, even and uniform in color.
- e. The maximum tolerances within which concrete work shall be constructed are as follows:-
 - i) All setting out dimensions $\pm 6\text{mm}$
 - ii) Sections of concrete members $\pm 3\text{mm}$
 - iii) Surface levels of floor slabs $\pm 6\text{mm}$



- f. Any rectification of work not constructed within the tolerances set out in item 3.21(e) above, shall be entirely the responsibility of the contractor shall be rectified at his expense.
- g. All forms in contact with concrete shall be coated with an approved, non-staining, proprietary release agent, before reinforcement is placed. The release agent shall be carefully applied in such a manner that there is not contamination of reinforcement or previously placed concrete. The release agent shall be effective, even after exposure to high temperatures, sun and wind.
- h. Temporary access openings shall be provided at the base of column forms, wall forms and other points where necessary, to facilitate cleaning before the concrete is placed.
- j. Before any concrete is placed forms shall be properly cleaned by washing out with water and/or air under pressure to remove sawdust, shavings, metal and other foreign matter. All water shall then be drained and mopped out from the formwork. In no case shall concrete be placed in the forms until such forms have been approved by the Engineer. Such approval shall not relieve the Contractor of his responsibility for the formwork.
- k. Details of any fixtures to be cast into the concrete shall be to the approval of the Engineer. No fixtures shall be attached to the concrete by shot-firing without prior permission of the Engineer. Notwithstanding any such authorization the Contractor shall take full responsibility for any such damage to the structure and make good to the satisfaction of the Engineer.
- l. Details of any openings, holes, chases, etc. required to be formed or cut in the structure shall be approved by the Engineer prior to the work being carried out on site.
- m. The formwork used for the concrete shall be of grades 1 or 2 as specified on the drawings and shall comply in all respects with clauses 3.22 and 3.23 respectively.



3.22 **Formwork Grade 1 (Sawn Formwork)**

Formwork Grade 1 where shown on the drawings shall be constructed of sawn boards, suitably treated plywood, sheet metal panels or other suitable material.

3.23 **Formwork Grade 2 (Lined Formwork)**

- a. Formwork Grade 2 is to produce a uniform smooth finish of high quality, with even, true and clean arises for exposed concrete. The finished concrete surface shall have, if any, minor blemishes and there shall be no staining or discoloration from release agents, formwork material or other sources. The forms shall be designed to have as few joints as possible and shall be arranged in a uniform pattern. Wherever possible joints between sheets shall be arranged to coincide with architectural features such as openings or changes of plane.
- b. The formwork shall have an impermeable form face. Immediately after striking the formwork all surface fins and other superfluous projections shall be removed and the purpose made holes for internal ties shall be made good with specially prepared cement and fine aggregate mortar. Color matching for the making good materials shall be accurate.

3.24 **Re-use of Formwork**

Care should be taken, when re-using formwork, that its surface shall be smooth and clean and that it shall be free from warping, twisting or other deformation. Any formwork, which has in the opinion of the Engineer, deteriorated sufficiently to render it unsuitable for the work shall be rejected and must be removed from the site within 48 hours or must be broken up at once, and new formwork to be provided at the Contractor's expense.

3.25 **Stripping of Formwork**

- a. Formwork shall be removed in such a manner as not to cause any damage to or overstress in the concrete. Formwork shall not be removed before the concrete has sufficiently set and hardened. The minimum periods which shall elapse between placing the concrete and the removal of formwork for the various parts of the structure shall be as given in 3.25(b) below. These minimum requirements shall not



relieve the Contractor of the obligation to delay the removal of forms if the concrete has not attained its specified working strength. The Engineer may, at his discretion vary the listed minimum periods.

- b. The following striking time, given in days (24 hours) are the absolute minimum that will be permitted:
- | | |
|--|---------|
| i) Beam sides | 2 days |
| ii) Slabs and beams soffits | 10 days |
| iii) Side of walls, foundations and columns. | 2 days |
| iv) Beam props | 16 days |
- c. When shores and other vertical supports are so arranged that the non-load carrying form facing material may be removed without loosening or disturbing the shores and supports, the facing material may be removed at an earlier stage if permitted.
- d. Loads shall not be placed on concrete before the following periods after casting (or as otherwise agreed in writing by the Engineer).
- | | |
|-------------------------------|---------|
| i) Columns, beams, slabs etc. | 14 days |
| ii) Foundations | 7 days |

TOLERANCES - GENERAL

3.26 Setting Out

- a. The following tolerances apply to the general setting out of the building. Measurements shall in all cases be carried out with steel tapes or bands. Tape tensioners shall be used to tension the tapes for horizontal measurements. Corrections must be made for the slope of the ground where applicable.
- b. Levels and theodolites shall be used where necessary to check levels, plumpness and square ness of the structure.
- | |
|---|
| i) All setting out dimensions at ground floor with respect to one datum each way, $\pm 5\text{mm}$ per 30 meters. |
| ii) Storey height, between floor datums, - 0 + 5mm. |



- iii) Plan position of datum points in relation to setting out at ground floor, $(5\text{mm} + N \times 0.8\text{mm})$ where N equals the number of stories.
- iv) Setting out on upper floors with respect to datums defined in item (iii) each way, $\pm 5\text{mm}$ per 30 meters.

3.27 **Elements of Construction**

- a. The following tolerances shall be accurately used for the fitting together of the various components in the building such that the final appearance and function of the structure are not affected. They will not be enforced in positions where these factors are unimportant. However, all work shall be constructed accurately to the dimensions shown to the satisfaction of the Engineer.
- b. The tolerances on the elements of construction shall only be additive within the limits allowed, i.e. errors in plumb of columns or walls etc. shall be corrected on successive lifts.
 - i) Levels of Beams and Slabs: Soffit levels to be within 3mm of the true position taking the specified cambers into account.
 - ii) Plumb of vertical members: $\pm 5\text{mm}$ per storey.
 - iii) Sections of In-situ Concrete Members: $\pm 3\text{mm}$.
 - iv) Flatness of surface other than those to be cambered, measured from a line stretched between any two points of the surface:
 - Up to 3 meters long $\pm 1.5\text{mm}$
 - Up to 6 meters long $\pm 3.0\text{mm}$
 - Up to 9 meters long $\pm 4.5\text{mm}$
 - Up to 12 meters long $\pm 6.0\text{mm}$
 - v) Clear distances between adjacent columns and walls at any level where accuracy required for doors, windows etc.: $\pm 5\text{mm}$.



JOINTS IN THE CONCRETE

3.28 Construction Joints

- a. The Contractor shall submit to the Engineer for discussion and approval a marked up drawing showing proposed positions of construction joints at least 7 days before work commences.
- b. Construction joints shall be formed in either horizontal or vertical planes and located in the work to suit working stresses. They shall be so located and the quantity of concrete placed at any one time shall be so limited in size and shape as to minimize shrinkage and temperature effects. All reinforcing steel and welded wire fabric shall be continued across construction joints except where shown on the drawings. Keys and inclined dowels shall be provided as directed by the Engineer. Longitudinal keys, at least 50mm deep, shall be provided in all joints in the walls and between walls and slabs or footings. The surface of the concrete at all joints shall be straight and shall be thoroughly cleaned with water and air under pressure to expose aggregate. The cleaned surfaces shall be well wetted and cement grout wash applied; laying shall commence before the grout has set. Approved water stops shall be provided in joints subject to water pressure.

3.29 Water Bars

- a) Water bars shall comply with the requirements of BS 2571 or ASTM specification D-412 / D-624/746. They shall be manufactured of extruded PVC or of nitrile rubber. Water bars shall be of the types and general shapes indicated on the drawings. They shall be obtained from reputable manufacturers and shall be to the latest shapes and forms generally adopted in the industry. Water bars shall comply with the following requirements of Table 3-3.

**Table 3.3 Water Bar Characteristics at 25°C**

Property	Rubber (BS 903)	PVC (BS 2782)
Density	1100 kg/m ³	1300 kg/m ³
Hardness	60-65 I.R.H.D.	70-75 I.R.H.D.
Softness Number	-	42-52
Tensile Strength	Not less than 20 N/mm ²	Not less than 15 N/mm ²
Elongation at Break Point	Not less than 450%	Not less than 285%
Water Absorption (48 hours immersion)	Not exceeding 5%	Not exceeding 0.7%
Web thickness	10 mm	10 mm
Center Bulb Dimension	18 mm	18 mm

- b) Where water bars are indicated on the drawing the Contractor shall submit to the Engineer a layout drawing and a detailed drawing showing junction pieces etc. for the Engineer's approval.
- c) Rubber and PVC water bars shall be suitable for storage, handling, installation and service within a range of 15°C to 50°C.
- d) Water bars and water stops shall include means, such as eyelets or reinforced nailing flanges, to facilitate their accurate fixing within the structure.

3.30 Expansion Joints

- a. Expansion joints shall be formed in the positions and in conformity with the details shown on the drawings. In no case shall the reinforcement or other embedded metal items run continuously through an expansion joint unless sleeves are provided as approved by the Engineer.
- b. Expansion joints shall be filled with joint filler strips cut back and pointed with joint sealer all as specified in clause 3.31.



3.31 **Expansion Joint Filler**

Filler strips at expansion joint shall be approved by the Engineer and have the following characteristics:-

- a) Cellular structure, non-staining, compressible without extending and elastic to the extent that after compression it recovers and will continue to do so for an indefinite number of cycles. The joint filler shall also be resistant to damage, handling and shall not be extruded from joints when movements occurs. Joint fillers shall have the characteristics detailed in table 5 of BS 6093 and shall be but not restricted to the types given in Clause 3.32.
- b) Compressible pre-formed expansion joint filler shall be cork or 15-20% bitumen impregnated fiber boarding of the thickness specified within a tolerance of +/- 1.5mm and of such a width that it complies with the specified joint details.

3.32 **Joint Sealing Compound**

Joint sealing compounds shall be approved by the Engineer. In all cases, they shall be carefully selected as appropriate for their climatic and environmental exposure. The Contractor must supply to the Engineer copies of written recommendation(s) and guarantee(s) from the manufacturer as to the suitability of the product(s) for each individual structure and for the methods of installation.

- a) Bituminised foamed polyurethane sealing strip shall be 9mm thick uncompressed. It shall compress to 25% of its original thickness under a force of 0.045 N/mm².
- b) Hot poured joint sealants shall comply with the requirements of BS 2499 for Ordinary Type A1 sealants.
- c) Cold poured polymer based joint sealants shall comply with the requirements of BS 5212 for Normal Type N sealants.
- d) Two-part polysulphide based sealants shall comply with the relevant requirements of BS 4254. Pouring grade shall be applied to horizontal upward facing joints and gun grade to joints of any other aspect of inclination. Other two-parts polymer based sealants of gun or



- iii) Minimum puncture resistance 200N (ASTM E154)
- iv) Minimum tensile strength 200N/50mm (BS2782)
- v) Maximum water absorption 0.3% (ASTM D5700)

The material shall have a solar shield where exposed above ground level.

PRECAST CONCRETE

3.35 General

- a. All materials and workmanship are to be in accordance with BS 8110.
- b. Moulds for precast concrete lintels, window surrounds and cells are to be constructed to the correct size and shapes shall be of metal or stout timber and properly formed together including all fillets, blockings, and dovetail fixing blocks cast in. Units which are to be plastered shall be formed with a suitably keyed face.
- c. Precast concrete units which are removed from their moulds before full curing has taken place shall be stacked in a manner to facilitate the continuity of the curing process.
- d. All precast concrete units shall be stacked on suitable bearers in such a manner as to prevent damage. All units shall be clearly marked to show which is the top side, and care must be taken to ensure that they are fixed in the correct position.

PRECAST WALLS, SUSPENDED FLOOR AND ROOF SLABS

3.36 General

- a. The Contractor may at no extra cost to the contract propose the use of factory produced precast reinforced, prestressed or post tensioned concrete elements. Only MOH approved factories will be accepted as a source of supply. This shall not relieve the Contractor of his responsibilities and duties under the contract.



- b. Damaged or factory-repaired precast elements will not be accepted.

3.37 Design

- a. Any proposal for precast structural concrete element shall include full design details with all relevant calculations to demonstrate that the design of the elements and their incorporation into the structure comply in all respects with the requirements of BS 8110 with particular reference, to BS 8110 Clauses 3.1.2.2 (stability) and 5.1.2.4 (stability).
- b. The design of the slabs shall be in conformity with CP3 and BS 8110. The deflection of the slabs shall not be greater than (span divided by 250). The minimum bearing of the slab in the span direction shall be 75mm on the support. The Contractor shall ensure that the design incorporates the intent of BS 8110 Clause 2.2.2.1 (structural stability) in that if a local failure occurs within a structure for any reason that the collapse mechanism should be regressive and not progressive and that the extent of the damage is not disproportionate to the cause.

3.38 Concrete

- a. For **reinforced concrete slabs**, the concrete and its constituent materials shall comply with the requirements herein, except that the cement shall be ordinary Portland cement from an approved source and shall comply with the requirements of BS 12 or ASTM C150 Type 1 and the Tricalcium Aluminates content (C3A) shall be greater than 7%.
- b. For **prestressed extruded/slip-formed** concrete slabs, the concrete and its constituent materials shall comply with the requirements herein, including those in Clause 3.38(a) above, except as modified below :
 - i) When tested in accordance with BS 1881 by tests on fully compacted cubes, the characteristic compressive strength at 28 days shall not be less than 75N/mm².
 - ii) the minimum cement content excluding any mineral additions added to the concrete at the time of batching shall not be less than 350kg/m³.



- iii) mineral additions which will reduce the porosity and permeability and otherwise enhance the durability of the concrete may be proposed for approval by the Engineer. Any such proposals shall include supporting technical evidence including the results of full scale local trials to demonstrate that the effects of the addition on the performance and properties of the concrete in both the fresh and hardened states are beneficial.
 - iv) the maximum free-water/cement ratio shall not exceed 0.35.
 - v) the characteristic (5%) minimum saturated density of the cubes at 28 days determined in accordance with BS 1881 : Part 114 : Clause 9, should not be less than 98% of the calculated theoretical maximum density at zero air voids or at the mean entrained air content where the concrete actually contains entrained air.
 - vi) the characteristic (5%) minimum saturated density of specimens sawn from slabs aged not less than 7 days and determined in accordance with BS 1881 : Part 114 : 1983, Clause 9, should not be less than 97% of the calculated theoretical maximum density at zero air voids or at the mean entrained air content where the concrete actually contains entrained air.
- c) Prestressing strands shall comply in respect of chemical and physical properties with BS 5896.

3.39 **Prestressing Strand Protection**

Strands for prestressing shall be fully protected from damage and corrosive influences at all stages from manufacture to embodiment in precast units.

Strands shall be stored in clean, dry, enclosed spaces on concrete hardstandings and shall not be unwrapped until immediately prior to being required for use. After removal of the manufacturer's protective wrappings the strands shall be inspected for freedom from damage and corrosion. It shall then be fully protected from rain, contamination by wind-blown sand and dust and from dewfall at all times up to embodiment, including the period between tensioning and concreting. The strands draw-off frame shall be on a clean concrete hardstandings and shall be protected by a purpose made cover or enclosed space at all times. Care shall be taken to avoid any



mechanical damage and to reject any damaged or corroded lengths. Welding or grit-blasting operations shall not be carried out near to any strand.

3.40 **Prestressed Floor Units ; Curing and Protection**

The units shall be wet cured using demineralized water as specified in Clause 3.7. Special attention shall be paid to ensure that the entire soffit area remains damp. Units shall be cured of a period of 7 days minimum, unless it can be shown, by means of research evidence from a recognized institution or by standard code of practice, that sufficient degree of hydration can be achieved in a lesser period. Subsequently units shall be protected from salt contamination by saline ground and atmospheric conditions.

3.41 **Prestressed Floor Units ; Stacking and Handling**

Units shall be stacked and handled to avoid damage and any torsional or transverse bending stresses. The maximum number of units in a vertical stack shall not exceed twenty.

3.42 **Porosity**

When tested in accordance with ASTM 642, the average pore space expressed as percentage of permeable pores at strand locations shall not exceed 10%. Permeable pores at any individual strand location shall not exceed 12%.

3.43 **Working Drawings**

- a. The Contractor shall prepare and submit for approval by the Engineer full working drawings.
- b. These drawings are to be submitted to the Engineer for approval not less than 60 days prior to commencement of work.
- b. Drawings returned to the Contractor for alterations or amendments should be re-submitted for approval of the Engineer.



3.44 As Fitted Drawings

After completion of the works and after obtaining partial approval, the Contractor shall submit to the Engineer 'As-fitted drawings' for record purposes.

PRECAST STAIRSCASE

3.45 General

Stair-case shall be as specified in the drawings. The Contractor may at no extra cost to the contract submit full design proposals with calculations for precast in lieu of an in-situ concrete stair-case.

It is at the sole discretion of the Engineer if such a proposal is accepted. If rejected then the Contractor must execute the works entirely as shown on the Contract Drawings.

3.46 Working Drawings

- a. The Contractor shall prepare and submit for approval by the Engineer full working drawings.
- b. These drawings are to be submitted to the Engineer for approval not less than 60 days prior to commencement of work.
- c. Drawings returned to the Contractor for alterations or amendments should be re-submitted for approval of the Engineer.



SECTION 4

MASONRY

MATERIALS

4.1 Cement

Cement for masonry works below ground floor level and for the manufacture of bricks and blocks shall be Sulphate Resistant Cement complying with BS 4027 or ASTM C150 Type V. Cement for masonry works above ground floor level shall be Portland Cement complying with BS 12. All cements shall be “low alkali” having a total acid soluble alkali content ($\text{Na}_2\text{O}+0.685 \text{K}_2\text{O}$) of not more than 0.06% as determined in accordance with BS 4550.

4.2 Aggregates

Aggregates used for the manufacture of blocks or bricks in contact with soil or ground water (ie. below damp proof course or within 350 mm above the finished ground level in walls without damp proof course) shall comply with the requirements for aggregates for concrete. Aggregates shall be hard, strong and durable and shall contain no harmful materials or that will adversely affect the strength or the durability of the blocks.

Coarse aggregates for the manufacture of blocks or bricks to be used in superstructures may be that obtained from the Askar/Hafeera quarries in Bahrain. However, no variation to any Clause of the Specification will be permitted or considered when these aggregates are used. Blocks manufactured with different aggregates are to be stacked in separate and clearly defined stacks on site.

4.3 Sand for Mortar

- a. Sand for mortar shall comply with the requirements of BS 1200.
- c. The grading of sands for general purpose masonry mortars and reinforced brickwork or blockwork mortars shall be within the limits of Table 1 of BS 1200.



- c. The clay/silt content, when determined in accordance with BS 812 shall not exceed 3%.
- d. The chloride and sulphate contents shall not exceed the limits given for aggregates for concrete.

4.4 **Water**

Water used for the manufacture of bricks or blocks, curing mortar and wetting down shall comply with the requirements of clause 3.7 water mixing and curing of concrete.

4.5 **Admixtures**

- a) Mortar plasticisers shall comply with the requirements of BS 4887.
- b) Admixtures used in the manufacture of bricks and blocks shall comply with the requirements of BS 5075 and shall be used in the proportions recommended by the manufacturer. Additives shall in no way adversely affect the mortar durability or contain chemicals which are harmful to other building materials. The addition of gypsum to cement on site is strictly forbidden.
- c) The use of calcium chloride as an accelerator shall not be permitted.

4.6 **Lime**

Lime for use in mortar shall be non-hydraulic or semi- hydraulic lime and shall comply with BS 890. Lime for use in block manufacture shall comply with BS 890.

4.7 **Damp Proof Courses**

Flexible damp proof course materials shall comply with BS 743 where applicable and with the following requirements and shall be the type as shown in the drawings or as directed by the Engineer.



Type 1: Bituminous damp-proof course materials with asbestos base complying with BS 6398.

Type 2: Black Polyethylene damp-proof course material complying with BS 6515.

Type 3: Pitch polymer damp-proof course material having a minimum thickness of 1.27mm and a minimum weight of 1.45 kg/m².

4.8 **Accessories**

a. **Wall ties**

Wall ties shall be of austenitic stainless steel conforming to BS 970 Part 4. Ties for cavity walls shall comply with BS 1243. All ties shall be of sufficient length to permit ends bedded into masonry joints to extend not less than 50 mm into the leaf.

b. **Anchor Slots**

Anchor slots shall be of austenitic stainless steel suitable for casting into reinforced concrete at the locations to receive masonry anchors. The slots shall be dovetailed in section and shall be provided with polystyrene fill.

c. **Masonry Anchors**

Unless otherwise detailed on the drawings, masonry wall anchors shall be as described in 4.8.(b), but shall be flat with dovetail ends and shall be compatible with the anchor slots. All anchors shall be of sufficient length to be solidly bedded not less than 150 mm into mortar joints.

d. **Joint Reinforcement**

Joint reinforcement and all accessories shall be austenitic stainless steel. The width of the reinforcement shall be such to provide a minimum 25mm cover to the reinforcement when bedded in the wall.



4.9 **Expanded Metal**

When specified, expanded metal for internal and external use shall be grade Z450 Galvanized steel or complying with BS 1369 or stainless steel. Mass per square meter shall not be less than 1.61 kg for galvanized steel and 1.09 for stainless steel.

4.10 **Pre-formed Joint Filler**

Compressible pre-formed expansion joint filler shall be cork or 15-20% bitumen impregnated fibre boarding of the thickness specified within a tolerance of +/- 1.5mm complying with BS 6093 and of such a width that it complies with the specified joint details.

4.11 **Joint Sealer**

Joint Sealer shall be a two part polysulphide liquid sealant complying with BS 4254 and applied in accordance with the manufacturer's recommendations. The Engineer's approval in writing shall be given before incorporation in the works.

4.12 **Precast Blocks**

- a. Precast solid and hollow blocks shall comply with the requirements of BS 6073. The thickness of each external wall of the hollow blocks shall be at least 17.5% of the block thickness.
- b. Polystyrene sandwiched masonry insulation blocks shall comply with the requirements of BS 6073.
- c. Other insulation systems shall be subject to Engineer approval.
- d. The U-Value for any insulation system including internal and external finishes shall not exceed the $0.75 \text{ W/m}^2\text{C}^\circ$ when calculated in accordance with ISO 6946
- e. Nominal characteristic strength for blocks shall be 7 N/mm^2 . Blocks shall comply with the following requirements when tested in accordance with BS 6073:



1. Minimum average compressive strength shall not be less than 7 N/mm².
 2. Compressive strength of lowest individual block shall not be less than 5.6 N/mm².
- f. Polystyrene used in insulation blocks shall have the following characteristics:
- | | |
|---------|------------------------|
| Density | ≥ 24 kg/m ³ |
| C-Value | ≤ 0.0033 W/mC° |

WORKMANSHIP

4.13 Cement Mortar

- a. Cement and sand mortar shall be mortar designation (ii) in accordance with BS 5628 table 1. It shall be (1:4) cement : sand with plasticizer. When testing is required, it should be in accordance with A. 1 of BS 5628 : Part 1.
- b. Sulphate resistant cement shall be used below top of the ground floor slab or damp proof course level and ordinary Portland Cement above ground floor slab.
- c. Mortar shall be machine mixed, mixed dry and then with added water until the correct consistency and uniform distribution of materials is obtained.
- e. For small quantities, hand mixing may be permitted by the Engineer. The ingredients shall be mixed on a clean, dry and watertight platform. Water shall be added until the correct consistency and uniform distribution of materials is obtained.
- f. Unless retarding agents are incorporated in the mortar mix, mortar shall be used within 30 minutes of the addition of water, any mortar not then used shall be discarded.
- g. Retarding agents may be used only with the written approval of the Engineer. Where retarding agents are incorporated into the mix, the Engineer shall reject any mortars which becomes unworkable or is



being used more than two hours after the addition of water. Retarded mortars shall be protected by polythene sheeting or other effective means approved by the Engineer to prevent excessive evaporation of the mixing water. Retarded mortars shall be used within 30 minutes of being first removed from its protection.

4.14 **Blockwork**

- a. All blockwork shall be set out and built to the respective dimensions, thicknesses and heights shown on the drawings.
- b. All blockwork shall be thoroughly wetted before laying to adjust suction on the faces in contact with the mortar. The water used for this purpose shall be demineralised water as described in "Concrete Work".
- c. Blockwork shall be carried up in a uniform manner, no one portion being raised more than 1.00 m above another at one time unless special circumstances render this impracticable. All perpends, quoins etc., shall be kept strictly true and square and the whole properly bonded together. The maximum height which is to be built in one day is 1.50 m.
- d. All joints between blocks shall be solidly filled to a general thickness of 10 mm and at no point more than 15 mm. All cross joints shall be filled by well buttering the end of the blocks and then pushing it into position against its neighbour.
- f. Fair-faced joints are to be half-round, recessed (bucket-handle or hosepipe) and of average thickness 10 mm.
- e. Block walls shall be built in stretcher bond. Intersections of block walls shall be properly bonded in alternate courses where possible. In other cases galvanized expanded metal ties (100 x 400 mm) are required in alternate courses.
- f. Generally blockwork where exposed shall be flush jointed as the work proceeds. Joints and beds must be filled with mortar except those which are to receive external or internal plastering which shall be raked out not exceeding 5 mm deep using a key with shoulder to prevent deeper raking.



- g. All hollow blocks shall be filled at sides of openings and intersections with concrete mix having a compressive strength at 28 days of not less than that of the block.
- h. Provide a solid or pre-filled course of blockwork at sill level of openings and under bearing of all in-situ concrete.
- j. Generally the design of blockwork shall be in accordance with BS 5628.
- k. All cutting of blocks is to be by machine; hand cutting will not be permitted.

4.15 **Damp Proof Courses**

- a. On walls the damp proof course shall be lapped at least 100 mm at joints and angles and be bedded on and covered with a bed of mortar.
- b. Below concrete floors the damp proof membrane shall be continuous throughout the whole floor area and shall be seated to the damp course in ever adjoining wall or other part of the structure.

4.16 **Bedding Frames**

All door openings shall have ties and lugs built in where required and at completion, point frame with gun grade mastic tested to BS 3712 on exposed sides. Where the frames are built in they shall be bedded in the same mortar as that used for the walling.

4.17 **Labours**

The Contractor shall perform all labours necessary for the proper completion of the walling, including making good to finishes for all work. Sleeves, chases and holes shall as far as possible be provided during the erection of the blockwork. Chasing of completed walls or the formation of holes shall only be carried out with the approval of the Engineer and then only with a proper tool designed to cleanly cut the blocks. The Contractor must demonstrate in trials the machine's ability to cut acceptable chases. Walls shall be allowed to set thoroughly hard before cutting or chasing in fixings. No horizontal or diagonal chases will be permitted.



SECTION 5

WATER PROOFING SYSTEMS

5.1 GENERAL

- a. The Contractor shall submit to the Engineer for his approval complete details of the proposed waterproofing system specified in the drawings. The submittal shall include specifications, technical literature, safety measures, samples and detailed drawings showing the following :
 - Complete roof plan indicating the expansion joints in the screed and the type of mastic to be used.
 - Vertical upstand areas.
 - Water spout areas.
 - The water tank area.
 - Layout of slopes and cross falls with levels.
- b. The submittal shall also include a comprehensive method statement describing the procedure for detection and repairing techniques in case failure occurs in the water proofing system
- c. The water proofing system shall be applied by specialized experienced subcontractors (minimum five years experience) who possess purposed-build machines and specially trained applicators. Verification of the above shall be submitted for approval.
- d. The final approval of the water proofing system will be granted only after a sample house waterproofing is done which shall fully demonstrate the method of application and required workmanship for the satisfaction of the Engineer.
- e. The entire roofing system shall be guaranteed for **a minimum period of ten years** against any defects. The Contractor will be required to complete the form of guarantee as detailed in the Appendix of the tender book.
- f- A water test shall be carried out after the application of the waterproofing system by flooding the roof with 100mm deep at upstands and not less than 25mm deep at the highest point) for a period of 24 hours. Repair any leaks and repeat the test until a watertight system is attained. A further test shall be done before the end of the Defects Liability Period.



- g- The Contractor shall ensure that all works on site are carried out safely in accordance with manufacture's instruction and legal / statutory requirements. The Contractor shall ensure that all personnel engaged in waterproofing wear appropriate clothing. All necessary precautions shall be taken to avoid the risk of fire during the installation of waterproofing system.
- h- Generally reflective aluminum coatings shall not be used unless written permission from the Engineer is obtained.
- j- During installation of the roofing system the Contractor shall ensure that damage to laid surfaces is avoided. Foot traffic during roofing operations shall be kept to a minimum and temporary protection shall be provided as required.

5.2 SPRAYED POLYURETHANE ROOF WATER PROOFING SYSTEM

5.2.1 General

- a. The roof waterproofing system shall be as follows:

Layer 1: Sprayed foam of polyurethane complying to BS 5241-part 1 applied to provide a maximum thermal transmittance value of $0.60 \text{ W/m}^2 \cdot ^\circ\text{C}$ and with a thickness not less than 35mm(50mm for apartments)

Layer 2: Liquid protective membrane applied to a minimum dry film thickness of 800 microns.

Layer 3: A protection layer of 100 grams per square meter (gsm) of geotextile.

Layer 4: Grade 20 concrete protective screed applied to slope with a minimum thickness of 50 mm and slope not less than 1:80.



5.2.2 Materials

a. **Polyurethane Foam**

The polyurethane foam shall be sprayed to a minimum thickness of 35 mm. The basic component of the polyurethane foam shall be polyol resin and isocyanate liquid which are pumped under pressure in metered amounts. The blowing agent in the polyol resin shall be environmentally friendly, meeting the requirements of environmental local authorities. During spraying operation, the temperatures, pressures, and volumes of mixing shall be properly controlled as per manufacturer's recommendation to achieve the required physical properties listed in table 5-1.

Table 5-1

Physical Property	Test Requirement	Test Method
Minimum Core Density	36 Kg/m ³	
Minimum Compressive Strength	2.0 Kg/cm ²	Method 3 of BS 4370 part 1
Maximum Thermal Conductivity (Initial Value)	0.018 W/mk	Method 7 of BS 4370 Part 2
Maximum Water Absorption (By Volume)	6.5 %	Appendix B of BS 5241 Part 1
Minimum Closed Cell Content (By Volume)	90 %	Method 10 of BS 4370 Part 2

The containers for the raw materials of the sprayed PU foam shall have the manufacturer's name, product identification and shelf life clearly printed.

The waterproofing system materials quality shall be checked on a regular basis. Initially test specimens should be taken from every 100 m². Once satisfactory standard has been established the area per test shall be increased to 500 m².



b. Protective waterproofing Coating

The protective waterproofing coating shall be cold liquid applied to form a seamless membrane. The coating shall be a one component moisture curing based on polyurethane elastomer. The finished surface shall provide an elastomeric, flexible membrane that is free from pin-holes, blisters and any other defect. All coating components shall be compatible with the foam to avoid any chemical reaction. The finished membrane shall have a minimum elongation of 300% and a recovery of 90%. The minimum dry film thickness shall not be less than 800 microns.

c. Geotextile Sheet :

A layer of 100 gsm of non woven needle punched geotextile sheet. The sheet shall be made from continuous thermally bonded polypropylene filaments.

d. Protective Screed

The screed concrete shall be grade 20 complying with clause 3.14 of section 3 of this specification. Joints and expansion joints in the screed shall be treated with approved sealant.

e. Coating for exposed areas

Whenever coating is required to be used in exposed areas, the coating shall be especially formulated to resist the effect of sun light and provide waterproofing properties. The coating applied shall be cold liquid applied and shall form a seamless membrane after application. The coating shall be based on polyurethane and the ultimate elongation of the finished product shall not be less than 120%.

5.2.3 Workmanship

a. Surface Preparation

Before application of foam the roof slab shall be dry and cleaned to remove loose particles, dust, laitance, efflorescence, etc. Surfaces must be approved by the Engineer prior to application including fillet



application. No other activity shall be permitted on the roof during the application of polyurethane foam. The end levels of application shall be marked from datum.

b. Polyurethane Foam application

Spraying shall be carried out when the weather is within the following conditions unless approved by the engineer :

- Wind speed is not excessive to disrupt the spraying operation and cause damages to the adjacent properties.
- Relative humidity is not in excess of 90%
- Temperature within the manufacturer allowable limits
- No rain or imminent rain condition.

The foam shall be applied in layers as recommended by the supplier such that the total specified minimum thickness is built up in layers and the cells of the PU foam are vertical. The first coat or layer (Flash coat) shall be thinner than the subsequent layers. The time required between one layer and the other shall not be less than 2 minutes and not greater than 15 minutes. The finished surface shall be even and smooth without pinholes, discontinuities or undulations.

c. Protective Membrane Application

The liquid protective membrane shall be applied in accordance with the manufacturer's recommendations. The membrane shall be applied to the PU foam as soon as possible but not before the foam is completely dry (follow manufacturers specifications). Particular attention shall be given to locations where it is likely to have failures such as water spouts, upstands, edges, ... etc. The finished surface of the membrane shall be free from pin holes and it shall not have any uncurled areas or any other observable defects.

d. Geotextile Sheet layer

The Geotextile sheet shall be placed directly over the coating when the coating is dry. The sheet shall be placed after conducting the flood test. Adequate time shall be given for the coating to cure as recommended by the manufacturer. Overlaps in the geotextile sheet



shall be at least 200mm and all joints shall be sealed by the approved waterproof coating.

e. **Roof Screed**

Screed shall be laid to the thickness and falls shown on the approved detailed drawings to a minimum thickness of 50mm and shall be kept wet and protected and cured in accordance with BS 8110. Care shall be taken to ensure that screeds are level at abutments with walls etc. The screed shall be constructed to a slope not less than 1:80 and finished evenly.

5.3 **MEMBRANE ROOF WATERPROOFING SYSTEMS**

5.3.1 **General**

a. Membrane roof waterproofing system shall be as follows:

Layer 1 : Screed laid to a minimum thickness of 50mm with a minimum slope of 1:80

Layer 2 : Primer

Layer 3 : Two layers of roof sheet membrane

Layer 4 : Insulation material

Layer 5 : Filter layer

Layer 6 : Topping

5.3.2 **Materials**

a. **Roof Screed**

Screed shall be laid to the thickness and falls as shown on the approved detailed drawings and shall be kept wet and protected and cured as specified in BS 8110. Care shall be taken to ensure that screeds are level at abutments with walls etc. The screed shall be constructed to a slope not less than 1:80



b. Primer

A solvent based bitumen primer is required to be applied to reduce the porosity of the substrate. The primer should have the following characteristics when tested in accordance with BS 2000 : part 72 : 1988

- i) Minimum volatile solvent content 40% by mass.
- ii) Maximum viscosity (STV at 25 °C, 4mm orifice): 10s.

c. Waterproofing Sheet

The waterproofing sheets shall be 4mm thick membrane. The carrier shall be 180g/m² polyester and the coating shall be bitumen modified by 7-13% of an approved Styrene Butadiene Styrene (SBS). The bitumen sheet shall comply with the following typical requirements when tested according to the stated standard:

<u>Property</u>	<u>Requirement</u>	<u>Standard</u>
Longitudinal tensile strength BS2576	800	N/50mm
Transverse tensile strength BS2576	600	N/50mm
Longitudinal tear resistance BS747	220	N
Transverse tear resistance BS747	270	N
Longitudinal elongation BS2576	50	%
Transverse elongation BS2576	55	%
Burst strength BS3137	2400	kPa
Low temperature flexibility BS747	-15	°C

Waterproofing sheets must be covered with minerals whenever they are exposed to the surface and allowance must be made for locations of sheets overlaps. However, if used as a bottom layer or in an inverted cold deck roof system, no mineral surface is necessary.



d. **Insulation Material**

The insulation material shall be one of the closed cell type materials listed below in table 5.2.

Table 5-2

Material	Relevant Standard	Density (kg/m³)	Thermal conductivity (W/mk)	Compressive strength (kPa) (@ 10% deflection)
Rigid Urethane Boards	BS4841 Part 3	32-48	0.022 - 0.025	175 – 205
Expanded Polystyrene	BS3837	25	0.033	110 – 150

The minimum thickness of boards provided shall not be less than 50mm.

e. **Filter layer**

A non woven polyester layer shall be placed below the topping layer (gravel, ...etc.) to stop fines passing through insulation layer and to protect the waterproofing system. The polyester shall have a minimum weight of 150g/m².

f. **Topping Material**

The topping material shall be as shown in the drawings and shall comply with the relevant clause of this specification.

5.3.3 Workmanship

a. **Roof Screed**

Screed shall be laid to the thickness and falls as shown on the approved detailed drawings to a minimum thickness of 50mm and shall be kept wet and protected and cured in accordance with BS 8110. Care



shall be taken to ensure that screeds are level at abutments with walls etc. The screed shall be constructed to a slope not less than 1:80

b. Surface Preparation

The roof slab shall be cleaned and any loose particles shall be removed. The surface shall also be free from any dust, laitance, efflorescence, dampness, etc. The surface shall be primed to seal any pores and to make it compatible with the successive waterproofing layer.

c. Roof waterproofing sheets

The roof waterproofing sheets shall be torch-applied and fully adhered to the roof surface. During torching, the applicator shall insure that the coating has been adequately molten to ensure full adhesion. The applicator shall open the roll of the sheet, and cut it to the proper length and roll it again, to ensure that the sheets are free from any defects or damages. When the applicator starts torching, he shall unroll the inspected sheet up the slope. The minimum overlap between the sheets shall be at least 50mm on the sides and 75 mm at the ends.

The second layer shall be laid directly over the first layer and in the same direction but overlaps and joints shall not coincide with the bottom layer.

d. Insulation Material

Install material in accordance with manufacturer's recommendations. Boards shall be laid loose with tight joints. Cut cleanly to fit around projections, upstands, rain water outlets etc. and protect from damage after installation.

e. Filter Layer

Non woven polyester sheets shall be placed below the topping material (gravel, ... etc.) to stop fines passing through. Laps between polyester sheets shall not be less than 300mm.

f. Topping

Place topping evenly as shown on the drawings



5.4 Wet Area Water proofing

5.4.1 Sheet Membrane System

Primer

A solvent based bitumen primer shall be applied to reduce the porosity of the substrate. The primer should have the following characteristics when tested in accordance with BS 2000: Part 72: 1988.

- I. Minimum volatile solvent content 40% by mass.
- II. Maximum viscosity (STV at 25°C, 4mm):10s.

Waterproofing Sheet

The waterproofing sheet shall be 4mm thick membrane. The carrier shall be 180 g/m² polystyrene and the coating shall be 7 – 13% of an approved Styrene Butadiene Styrene (SBS). The bitumen sheet shall comply with the following:

Property	Requirement	Standard
Longitudinal Tensile Strength	800 N/50 mm	BS 2576
Transverse Tensile Strength	600 N/50 mm	BS 2576
Longitudinal Tear Resistance	220 N	BS 747
Transverse Tear Resistance	270 N	BS 747
Longitudinal Elongation	50%	BS 2576
Transverse Elongation	55%	BS 2576
Burst Strength	2400 Kpa	BS 3137
Low Temperature Flexibility	-150C	BS 747



Waterproofing sheets must be covered with minerals whenever they are exposed to the surface and allowance must be made for locations of sheets overlaps.

5.4.2 Liquid Applied Waterproofing Membrane

Liquid applied waterproofing membrane of approved type shall be applied in two coats (minimum) of 400 micron DFT thickness minimum on each layer with a geotextile membrane as sandwich layer (of minimum 100gm/sq.m). Additional care shall be exercised on those area where there are penetrations on the substrate.

The system shall be warranted for a minimum period of 10 years.



SECTION 6

CARPENTRY, JOINERY AND IRONMONGERY

MATERIALS

6.1 Structural Timber

Timber grading for structural use shall comply with BS 4978 and shall be used in accordance with the recommendations contained in BS 5268. Samples of all timbers are to be submitted to the Engineer for approval and the timber used throughout the works are to be equal in all respects to the approved sample having particular regard to consistency of grain and colour where this is of visual importance to the finished works. The timber for carpentry and joinery shall comply with BS1186 part 1.

6.2 Carpentry and Joinery Timber

The timber for carpentry and joinery shall comply with BS 1186 part 1 along with following requirements

- a. Timber shall be properly seasoned, sawn square, planed straight and true.
- b. Knots should not exceed the following dimensions.
 - 1- For faces up to 25 mm :1/2 size of face
 - 2- For faces 26 mm to 50 mm :13 mm dia
 - 3- For faces 51 mm to 100 mm :1/4 size of face
 - 4- For over 100 mm :25 mm dia

For elliptical knots, the diameter is the mean of maximum and minimum dimensions.

No dead or loose knots shall be permitted.

No two major knots shall be closer together than 300 mm.

- c. Timber shall be free of decay and insect attack.



6.2.1 Softwood

- a. Generally, the maximum moisture content shall not be more 10% and the density shall not be less than 480 kg/m^3 at the specified moisture content.
- b. Moisture content up to 15% will be allowed if the density of soft wood is not less than 500 kg/m^3
- c. Growth rings are to number at least 8 rings per 25 mm at any point on the cross section (measured as an average over 75 mm starting at least 25 mm from the heart).

6.2.2 Hardwood

- a. Hardwood shall be Red Meranti unless otherwise instructed by the Engineer.
- b. The maximum moisture content shall be 10%.
- c. The density shall not be less than 550 Kg/ m^3 at the specified moisture content.
- d. Moisture content up to 15% will be allowed for densities more than 575 kg/m^3
- e. Checks and shakes not to exceed 0.3mm wide, 300mm long and 25% of depth of piece.
- f. No warm holes to be permitted.

6.3 Manufactured Boards

- a. Blockboard shall comply with BS 3444 Grade 2 BR Bonded, for internal and external use in all locations.
- b. Plywood generally shall comply with BS 6566. External plywood shall have Grade 2 veneer with WBP bonding and internal plywood shall have Grade 2 veneer with MR bonding except in wet areas (Bathrooms, toilets, kitchen) which are to be WBP bonding.



Thickness:

Table 6-1 Allowable Thickness

Nominal Thickness	Max.	Min.
4 mm	4.2	3.60
6 mm	6.2	5.42
12 mm	12.2	11.24
18 mm	18.2	17.06

Moisture Content

The moisture content of plywood shall be less than 10% by weight when tested according to Appendix A of BS 6566 : Part 5.

Bond Quality

The bond quality shall not be less than 7 when tested in accordance with Appendix C of BS 6566 : Part 8.

6.4 Decorative Plastic Laminate

Decorative laminated plastic sheeting shall be 1.5 mm thick complying with BS 3794 Class 1. Manufacturer, colour and type shall be to the approval of the Engineer.

6.5 Doors

The doors shall comply with BS 4787 : Part 1. The skeleton framing for the door leaf shall be manufactured from softwood to comply with BS 1186: Part 1. Door elements (the frame and architrave) shall be carefully selected and treated by an approved method such as staining, to match the finish of the door.



a- Internal Flush Doors

The internal doors shall be minimum of 50% solid with a core of frame and battens covered with 6 mm minimum thick plywood on both sides. The doors shall be constructed using MR adhesive and MR plywood except in wet areas where WBP plywood shall be used with approved adhesive for assembly of the door. The MR adhesive shall Polyvinyl Acetate (PVA) based complying with the requirements of BS4071. When tested to BSEN204, the MR adhesive shall meet the performance requirements of BSEN204 class D3 (Conditioning sequence to BSEN205 # 4). The adhesive used for constructing doors in wet areas (WBP) shall meet the requirement of BSEN204 class D4 (conditioning sequence to BSEN205 # 6). The doors shall have a 8 mm thick hardwood lipping on all four edges.

b- External Flush Doors

The external doors shall be minimum of 50% solid with a core of frame & battens covered with 6mm minimum thick WBP plywood from both sides. The doors shall be constructed using approved adhesive meeting the requirements of BSEN204 class D4 (conditioning sequence to BSEN205 # 6). The doors shall have a 12mm thick hardwood lipping on all four edges. Wherever specified in the drawings openings for glass shall have glazing fillets. Doors fixed in pairs shall have rebated meeting stiles worked on the lipping. Separate fillets will not be permitted. External doors shall be fitted with aluminum threshold and weather bar with brushes.

c- Solid Doors

Solid doors shall be of hard wood complying with the requirements of clause 6.3. The type and thickness of hardwood shall be as specified in the drawings. All wood members of the door and other door element (including frame and architrave) shall be carefully selected and matched to avoid color difference. Elements shall be, as directed by the engineer, treated by an approved method such as staining to avoid any difference in color.



d- Flush Fire Doors

Fire doors shall be rated as minimum half hour fire door complying to BS 476. Fire doors shall be fitted with an effective approved door closures complying with clause 6.10. Doors shall satisfy safety requirements of Civil Defense and Fire Services Directorate.

6.6 Roof Hatch Cover

Roof hatch cover shall be made of either :

a. 2mm thick UV stabilized GRP cover, white in colour, fully bonded to WBP plywood as detailed in the drawings.

Or

b. 24 Gauge aluminum cover having mastic-sealed and fixings to inside vertical edge 25 mm x 25 mm hardwood lipping as detailed in the drawings.

6.7 Treatment

All timber is to have wood preservative treatment in accordance with BS 1282 by either pressure impregnation or by immersion in an approved preservative. The Contractor shall treat all cut ends and notches etc., with a brush applied preservative.

6.8 Fixings

Nails shall comply with BS 1202, screws with BS 1210, bolts with BS 4190 and timber connectors with BS 1579.

6.9 Priming

Priming paint shall comply with BS 5358.



6.10 Storage

Timber shall be stored under cover clear of the ground and protected from dampness. All joinery shall be protected from the weather during transit and stored under cover clear of the ground before fixing. Where liable to damage during the progress of the works, joinery shall be covered and protected and any damaged work reinstated and made good.

6.11 Ironmongery

- a. The Contractor shall submit samples of all ironmongery for the Engineer's approval before ordering and shall obtain and deposit with the Engineer an undertaking from the suppliers that the goods will be delivered in such consignments and quantities to ensure progress and completion of works in accordance with the contract. The approved samples shall be retained on the site as the standard for subsequent deliveries and shall ultimately be used in the project. Any samples approved must be upheld for the duration of the works and not changed without the prior approval of the Engineer.
- b. All ironmongery shall be of reputable manufacture, properly functional and finished in SAA, stainless steel, solid brass, satin chrome or die cast aluminum. All cut outs, sinking, key access and spindle access holes shall be neat, tidy and workmanlike. Fixing screws shall be non-ferrous driven properly and shall be of the correct size to match the relevant fitting.
- c. Brass Hinges for external doors and for the fire check doors shall be 100mm, minimum 3mm thick solid brass butts as per BS 7352 with tempered brass pivot pins and the fixing screws staggered on the hinge leaf. There shall be three number hinges per door.
Brass Hinges for internal doors shall be 75 mm, minimum 3mm thick solid brass butts as per BS 7352 with tempered brass pivot pins and fixing screws staggered on the hinge leaf. There shall be three number hinges per door.
- d. Stainless steel hinges shall be ball bearing stainless steel hinges tested to BS 1935:2002 or equivalent class 13 material grade SS 316 minimum with dimensions 102mm (4") x 3mm and with quality mark.



- e. External door locks shall be mortise locks complying with BS 12209, category A with the dimensions of 72mm centre to centre and 55mm backset and shall be with 3rd party quality mark. Euro Profile Double Cylinder shall be with minimum 3 Brass Keys keyed to differ and meeting BS EN 1303.

The reversible latch bolt operated by lever handles shall have a strong return spring. The latch bolt shall project minimum 12mm. The latch bolt spring tension shall be strong enough to overcome the frictional forces of the lever handle. The lever handle shall have an independent spring mechanism and a properly designed stopper to eliminate transferring of forces to the latch bolt when the lever is depressed.

Dead bolt shall be reinforced with two hardened steel inserts or stainless steel and shall have a minimum projection of 14mm. The dead bolt shall be cylinder operated which can be opened by a key from either side of the door.

- f. Internal door locks to all doors except WCs and bathroom shall be similar to details of the above external locks' specifications. However, dead bolt may not be strengthened with hardened steel inserts.
- g. Locks for WCs and bathrooms shall be lever type mortise lock complying with BS EN 12209, category A with dimensions of 72mm centre to centre and 55mm backset and shall be with 3rd party quality mark. Operation mechanism of the reversible latch shall be similar to the above external locks. The dead bolt shall be operated by a turn button or thumb turn.
- h. All locks shall be supplied with anodized aluminum lock furniture of an approved color along with suitable matching screws or solid stainless steel handles (Grade 316) approved finish compatible with other approved ironmongery and meeting BS EN 1906 or equivalent with 3rd party quality mark. In case of stainless steel handles fore end and strike plates of the lock also shall be of stainless steel. Locks and cylinders shall be from the same source.
- i. Door bolts shall be fixed top and bottom to one leaf in double door locations. They shall comprise two solid drawn, brass, aluminum or cast aluminum or stainless steel 150 mm long square profile bolts complete with keepers for head fixing and keepers for threshold fixing.



The bolts shall incorporate keepers fixed into a screed to maintain the doors in an open position.

- j. Hinges for external compound gates shall be 305 mm, minimum 3mm thick tee hinges screwed to gates with dome head screws. Hinges and screws shall be galvanized or zinc coated, three number per gate leaf. Gate fastening shall be one galvanized size 3 Suffolk latch.
- k. Door closers shall be supplied in an approved color and selected in accordance to the size and weight of the door. The door closer shall be equipped with speed adjusting screws and hold open facility.
- l. Ironmongery shall include for supplying all keys, clearly labeled.
- m. The Contractor shall allow for inspecting all items of ironmongery on delivery, safely storing and protecting and making good any deficiencies. Samples shall be collected and tested by 3rd party laboratories to confirm compliance to the specification.
- n. Screws shall be round headed of a suitable gauge and material for the purpose and shall match the article to be fixed in color.

WORKMANSHIP

6.12 General

- a. The term plugged shall mean the provision and fixing of hardwood or approved proprietary plugs, or at the Contractor's option, fixing by means of a cartridge operated rivet gun or other approved mechanical means.
- b. Framed work shall be properly mortised and tenoned, wedged, glued and cramped together and doweled where necessary. The use of nails for fixing or framing any items of joinery will not be permitted. Springs may be used for glazing beads only.
- c. All moldings shall be worked true to details and all joinery shall be dressed and sand papered.



- d. The surface of all joinery work shall be wrought and finished so that the plane marks do not show.
- e. All nailing to joinery shall be done with fine wire nails and concealed as much as possible. All framed joints to joinery in timber 32 mm thick and upwards to be double mortised and tenoned except where otherwise described.
- f. The Contractor shall allow for :-
 - i) Priming all joinery with a coat of priming paint either before leaving the workshop or within three days of delivery on to site. All cut ends, mortises and tenons etc. to both internal and external joinery to be primed before fixing.
 - ii) Pencil rounding on all exposed arises on joinery.
 - iii) Balancing veneers on all veneered or plastic covered plywood, blackboards, etc.

6.13 **Door Frames**

Frames in openings shall be built in with galvanized clamps size 3 x 25 x 225 mm one end turned up 50 mm twice drilled and screwed to timber frames. Three clamps to each side of door frames. Alternatively, door frames might be fixed by using approved 100 mm brass screw with rawl plug. The total number of these screws shall be adequate based on the size and the use of the door to properly fix the frame. Door frames shall be doweled to floors with 10 mm diameter galvanized steel dowels.

6.14 **Jointing**

- a. All necessary mortising, tenoning, grooving, matching, tonguing, housing, rebating and all other work necessary for correct jointing shall be executed satisfactorily.
- b. The joints shall be constructed exactly as shown on the drawing details. Where joints are not specifically indicated, they shall be the recognized forms of joints for each position. The joints shall be made so as to comply with BS 1186.



6.15 Inspection

Facilities and arrangements shall be given to the Engineer by the contractor to inspect all work in progress in the workshops, on the site and wherever requested.

6.16 Making Good all Defects in Work

Should any shrinkage or warping occur or any other defects appear in the joinery work before the end of the defects liability period all defective work shall be taken down and renewed to the entire satisfaction of the Engineer and any work disturbed made good at the Contractor's expense.

6.17 Ironmongery

- a. Hinges for doors shall be let into the door frame or window frame for the thickness of one leaf of the hinge and let into the door or window shutter for the thickness of one leaf of the hinge. The leaf of the hinge when fixed shall be flush with the timber surface. Screws for 100 mm hinges shall be 38 x 12 mm and screws for 75 mm hinges shall be 32 x 10 mm and driven by screwdriver to seat into the hinge countersunk holes in a proper manner.
- b. Ironmongery and furniture shall function smoothly and positively without undue pressure being required to operate the mechanism.
- c. Ironmongery and furniture shall be left free of paint, stains, marks or damage. Hinges shall be firmly screwed as described and shall be free of packing. All hinge screws shall be fitted.
- d. Fixing of ironmongery shall include for cutting all holes, channels, grooves, pockets and recesses and neatly fitting with matching screws or other fixing devices strictly in accordance with the manufacturer's instructions before painting operations start. Ironmongeries shall then be removed before the start of the painting operations and re-fixed later after all painting operations are completed and approved by the Engineer. Ironmongeries shall then be cleaned, tested, oiled as necessary.



SECTION 7

METALWORK

MATERIALS

7.1 Nuts, Bolts and Screws

- a. Nuts and bolts etc. shall comply with BS 4190 and BS 1494 and shall have isometric thread complying with BS 3643.
- b. Stainless steel bolts are to be set bolts and shall comply with BS 4190. The stainless steel for bolts, nuts and washers shall comply with BS 970, quality EN 58 AM.
- c. Self-tapping screws shall comply with BS 4174

7.2 Aluminum

- a) Aluminum extruded sections shall comply with DIN1748 Part 4 or BS 1474. The minimum section thickness shall be 1.5mm.
- b) All exposed aluminum surfaces to be polyester powder coated complying with BS 6496 to RAL colour selected by the engineer or anodized to BS1615 or BS 3987 with a minimum protection of 18 microns
- c) Contractor shall submit for Engineer's approval complete shop drawings, including detailed drawings showing dimensions, size, profiles, and methods of attachments or anchorage to adjacent or surrounding constructions. Also required samples of aluminum sections fabricated into mock up of each intersection condition complete with all required accessories, as recommended by system supplier, shall be submitted for approval. Complete sample window shall also be submitted upon request for assessment and approval.



7.3 Aluminum Windows, Louvers, Doors and Screens

a. **General**

Aluminum windows, doors louvers and screens shall comply with the requirements of BS 4873. They shall be engineered, fabricated and installed to withstand, wind loading and impact loading without failure. They shall meet the performance requirements of Air penetration, water tightness and deflection for conditions of “serve (a)” exposure, that is a equivalent to 80km/h when tested in accordance with AFNOR.

All units shall be complete with all necessary glazing inserts, sealing strips, gaskets, skids, weather strips, glazing beads and all necessary ironmongery. All materials shall be durable and shall, if not specified, comply to an internationally acceptable standard and fit the purpose of use.

Horizontal sliding units shall be supported on rust proof and dust proof bearing devices and shall be fitted with a removable sliding fly screen manufactured from aluminum frames infilled with 14 x 14 (26/27 gauge) aluminum wire mesh, stretched tightly and evenly, and shall be free from visible joints.

sealants for perimeter shall be silicon based having electrometric properties and not subject to ultraviolet degradation. A gap of at least 5 mm but not more than 8mm shall be maintained between the aluminum frame and the structural opening. EPDM marine quality glazing gaskets shall be positioned on both sides of the glass and shall be correctly sized to provide the required support and weather seal. Drainage water provisions must be considered and incorporated. All aluminum joints must be sealed with an approved mastic acrylic fluid for weathering enhancement. All gasket joints must be welded (vulcanized) sealed using approved glue.

All units shall be assembled by a local manufacture.



b. Hardware

All ironmongery shall be stainless steel or alloyed aluminum of a matching finish. Doors & windows shall be fitted with suitable heavy duty hinges, locks, wheels, latches, pull handles, pull plates and floor springs or door closers where specified. All metal parts in direct contact with the aluminum must be either stainless steel or aluminum. Hardware of incompatible material must not be used.

Stainless steel screws shall be used for fixing aluminum windows, doors, ... etc. to concrete or blocks. All accessories, including weather piles/brushes shall be approved by the aluminum system manufacturer.

c. Fabrication

All frames shall be of rigid and robust frame assembly with welded or mechanical corners preventing torsion opening the corners when fitted in the buildings.

All doors & windows sash corners shall be mitered, angle reinforced and epoxy bonded. A permanent water tight joint shall be made between vertical & horizontal members of fixed frame.

Corner fastening devices such as pins, screws, bolts shall not be visible on the exposed surfaces of the frame.

No cut ends shall be exposed without suitable durable protection. All aluminum shall be insulated from and not in direct contact with concrete or mortar render.

d. Installation

Aluminum units shall be installed to ensure resistance to penetration of external moisture to the inside of the building. Fixing of frames for all units to the building shall be such as to ensure solid, void free, waterproof joints. The joints shall be caulked from both inside & outside using approved silicone sealant. which does not sag or run, non-hardening, non-staining.



7.4 **Aluminum Flashings and Copings**

Aluminum flashings and copings shall be 0.9 mm thick aluminum strip complying with BS1470. The width of strip is to suit the particular location in which it is to be used.

A Provisional Sum is included in the Bill of Quantities for this item.

7.5 **Garage Door**

Garage door is to be an approved pattern roller-shutter door, quiet in operation, suitable for domestic use and fitted with a counterbalance and complete with finger grip pull handle & approved locking mechanism. The shutter shall be capable of being locked internally and externally.

Curtain shall be made of prepainted Galvanized steel profile of minimum 0.4mm thickness excluding paint thickness meeting AS-1397 or equivalent. It shall be sturdy enough to avoid wind speed rattle.

Curtain running strip shall be nylon braided around a foamed PVC core and fixed to both faces on each vertical edges of the curtain.

Bottom rail shall be extruded aluminium connected to bottom sheet of the curtain with weather seal. Door tracks shall be of 1.5mm minimum thick aluminium channel section. Axle shall be galvanized steel pipe of minimum 37mm OD and minimum 2.6mm wall thickness. Drum assembly shall be galvanized press formed with nylon bearings and attached to springs. Two tempered helical torsion springs made of carbon steel shall be used to reduce manual effort. Mounting brackets shall be sturdy enough and corrosion resistant. Locks shall be centrally mounted incorporating lifting handles on both sides with horizontal lock bars providing locking through door track.

WORKMANSHIP

7.6 **Shop Drawings**

- a. Prepare and submit shop drawings where required and obtain the Engineer's written approval before proceeding with the fabrication and work. The Contractor shall check site dimensions and make fabricated work correspond to the 'Approved' Shop Drawings.



- b. Drawings shall show in detail the various portions of the work, kind of material and the standard they are complying with, size of members, and methods of securing same together and to the work of other trades.

7.7 **Generally**

- a. Coordinate with other trades in obtaining the exact site dimensions and the contractor will be held responsible for the accurate execution of all parts of the work specified. All fastenings shall be concealed where possible. The approved shop drawings shall be followed exactly.
- b. Form exposed connections with hair line joints which are flush and smooth using concealed fasteners wherever possible. If exposed fasteners are unavoidable use countersunk flathead screws or bolts.

7.8 **Aluminum Flashings and Copings**

- a. Aluminum flashings and copings shall be dressed into chases where appropriate and shall be dressed evenly down the surface to which they are applied. All edges shall be sealed with mastic. Joints in the running length over 50 degrees or on vertical surfaces shall be lapped at least 150 mm. Where flashing is nailed to timber fillets, this shall be done with aluminum nails at 100 mm centers.
- b. Flashing collars shall be at least 150 mm high and welded at the lower end of a 450 x 250 mm base. The upper edge shall be protected by means of a cap fitted on top of the pipe.

7.9 **Storage and Handling**

- a. All items described under this Section shall be handled, delivered or stored in a manner that will avoid damage, rust or deformation. Items shall be stored off-ground and shall be entirely covered with weatherproof coverings in storage area.



- b. Items which become rusted or damaged because of non-compliance with these conditions will be rejected, and such items shall be removed from site immediately and replaced without additional cost to the Employer.

7.10 **Protection**

- a. Thoroughly isolate all non-ferrous items in contact with dissimilar metals, concrete, masonry, and mortar with approved zinc-chromate coating or plastic membrane on contact surfaces before installation.
- b. Immediately upon arrival on site, windows and doors should be carefully stacked upright well clear of the ground and should be well covered and protected from damage.



SECTION 8

PLUMBING INSTALLATIONS MATERIALS

General

All standards referred to in this specification are deemed to be the latest publications which include all amendments.

The contractor shall adhere strictly to all standard specifications, codes of practice, building regulations, etc. which are referred to in the contract document. If no standard is specified then the relevant British Standard is deemed to apply. However, where a BS is specified, it shall be a guide line. It is to the engineer discretion to approve materials in accordance with other standards (eg. ASTM, DIN, Australian Standards, etc.) if the quality is equivalent or superior to the BS.

Quality Control

All materials shall be manufactured by a factory possessing an established and approved quality assurance / quality control scheme complying with the requirements ISO9000 standard. However, local manufacturers' products must be continuously tested for compliance with the relevant standard at an approved independent laboratory. The local manufacturer shall have a satisfactory, functioning and fully documented quality assurance procedure. Access for MOH engineer must be granted to the factory to ensure presence of such system.

All products manufactured internationally must possess third party certification for compliance of the product to the manufacturing standard. Third party marking and product certification (such as the BSI kite mark), must be presented for the Engineer's approval.

Unless otherwise specifically stated all pipes, fittings, sanitary ware, accessories, mixer taps, pumps and related materials, ...etc. shall be marked with proper identification as per the relevant standard. The products manufactured in countries other than local should carry a third party quality mark.

A full range of samples shall be submitted for approval purpose. Catalogues and product technical data shall be submitted along with the material approval certificate.



8.1 Soil & Ventilating Pipes, Fittings and Jointing Material

- a. Soil and ventilating pipes, fittings shall be Unplasticised PVC (UPVC) complying with BS 4514.
- b. Pipe jointing shall be by using either elastomeric sealing ring or solvent cement. Elastomeric sealing rings shall comply with BS 2494 and solvent cement shall comply with BS 6209.
- c. All pipes and fittings shall have proper identification marks such as manufacturer's identification, number of relevant standard, nominal size, etc. Also they should carry a third party quality mark.

8.2 Waste Pipes, Fittings and Jointing Material

- a. Waste pipes and fittings shall be Modified UPVC (MUPVC) complying with BS 5255. The pipes shall be jointed with solvent cement complying with BS 6209.
- b. Trap Floor gullies shall be manufactured from MUPVC Complying with the requirements of BS5255 The minimum seal depth shall be 50mm.
- c. All pipes and fittings shall have proper identification marks such as manufacturer's identification, number of relevant standard, material code, nominal size and third party quality mark.

8.3 Copper Water Pipes & Fittings

a. Hot and Cold Water Supply

The hot and cold water services pipes and fittings shall be copper or other suitable material. The proposed material shall be durable and capable of withstanding the service conditions of the plumbing network. If a new material (other than copper) is proposed, not withstanding clause 8.5, fully detailed product technical data, samples and relevant certificates shall be submitted to the Engineer for approval. New material shall have past records of proven capability's to withstand the physical and chemical properties of the transported



water quality and the environmental conditions and supplier shall prove strong future support.

b. **Copper Pipes**

Copper pipes generally shall be half hard copper tubes in straight lengths complying with BS2871 Part 1 Table X. Copper pipes installed underground or imbedded in concrete/mortar shall be plastic coated as per BS 3412. Pipes may be bent with the aid of proper tools. However, the radius at the inside of the bend shall not be less than three times the pipe diameter.

c. **Copper Pipe Fittings**

The fittings generally shall be Capillary type fittings to BS 864 Part 2 with integrated soldering. The solder used in the joint shall be lead free. Compression type fittings to BS 864 Part 2 may also be approved by the Engineer, if the body and the chamber are gunmetal to BS 1400 LG2 or De-Zincification resistance brass. All compression rings shall be copper.

Threaded end fittings, male or female, shall be BSP threaded to BS 21. Clips and brackets shall comply with BS 1494.

8.4 **Polyethylene Water Pipes & Fittings**

a. **Polyethylene Water Pipes**

Polyethylene pipes for cold water service shall be Medium Density Polyethylene pipes complying with BS 6730 with pressure rating of 12 bar.

All pipes shall be marked as per BS 6730 with manufacture's identification, BS No., nominal size followed by the letters "PE", pressure rating and the word "WATER". Also, pipes shall have a third party quality assurance mark.



b. Pipe Fittings

The pipe fittings shall be compression type. The chamber of the fitting shall be Gunmetal or De-Zincification Resistance brass. The thrust nut may be brass and the compression rings shall be copper. The complete fitting shall include a serrated copper insert. Threaded end fittings, male or female, shall be BSP threaded to BS 21.

8.5 Plastic Piping system

General

Where specified, the plastic piping plumbing system shall consist of plastic pipes running through corrugated plastic polyethylene conduits and brass fittings (PEX) or Poly Propylene Random Copolymer (PPR).

a) PEX System

The PEX system is intended to facilitate replacement of inner plastic pipes by pulling them whenever necessary. The full system shall be manufactured by an approved manufacturer having a quality management scheme certified by a third party body. The system shall be certified by a third party recognized body for compliance to international standards and for suitability for use with drinking water. The plumbing system shall comply with the requirements of DIN1988 and EN12318-5

Pipes shall be made from high density polyethylene improved by cross linking. The pipes (known commercially as PEX) shall meet the requirements of DIN 16892 / 16893. The pipe shall be capable of withstanding the local water quality conditions and carrying drinking water at a temperature range of 10C to 95C and up to 100C as a short term temperature during normal working pressure (up to 8 bar). When required, adequate information about the moulding material shall be submitted to prove compliance with DIN16776. The manufacturer shall ensure, and demonstrate when required, that the minimum degree of cross linking has been achieved to enhance the long term properties. All pipes delivered to site must bear the following marking:

- 1- the manufacturer's name or trade mark



- 2- third party certifying bodies' marks
- 3- the outside diameter and the wall thickness
- 4- the manufacturer's standard number
- 5- the pressure rating
- 6- manufacturing date and
- 7- machine number

Pipe Sleeve (Conduit):

The conduit used for the pipes must be adequately corrugated type to ease the movement of the pipes. The conduit shall be made of polyethylene or any other approved suitable material. The conduit shall be available in at least two colors to distinguish between hot and cold water pipes.

Manifold

Each manifold shall consist of the following:

- 1- a manifold cabinet of an inert plastic material that is suitable wall installation. The cabinet shall have a plastic cover. The manifold cabinet shall be of adequate size to accommodate the manifold and other materials necessary for the system.
- 2- water distribution manifolds made of brass and
- 3- brass interception valves connected to the manifold. Slow closing valves shall be used when necessary to reduce the effect of water hammering. Valves to comply with BS5154

All brass items shall comply to distribution fittings requirements.

Distribution Fittings:

Distribution fittings shall be brass to DIN1982 and EN1254.

Accessories :

All other accessories related to the system (such as brackets, clips, base plates, ... etc.) must be submitted for approval. Accessories must be durable and compatible with the system. Metal accessories shall be made of galvanized steel.



b) PPR System

PPR Pipe Manufacturers shall be ISO Certified and the pipes and fittings shall be marked for Water Quality – DVGW or Equivalent. Third Party Certification and Markings on the pipes is mandatory to confirm compliance to Standards such as DIN 8077/8078.

Supplier shall submit a procedure for installation and maintenance of these pipes. The PPR system shall be guaranteed for a minimum period of 10 Years against any manufacturing and workmanship defects. PPR pipes exposed to weather shall be protected from UV rays. Stabi- pipes for exterior usage shall also be protected. Shop drawings shall be submitted where all sizes shall match the design internal pipe diameter. If a different diameter is proposed, the new design shall be supported by design calculations.

8.6 Storage Cisterns

a) Fibre Glass Tanks

Glass fiber cold water storage tanks shall be produced by an approved manufacturer with the capacity shown on the drawings and shall comply with the general requirements of BS 4994. They shall be white in color produced by a closed mould process such as vacuum assisted resin injection so as to give an ex- mould surface both internally and externally. They shall be fitted with a GRP dust cover with an approved locking mechanism. Sufficient vertical plane surfaces shall be incorporated to allow fixing of all inlet and Outlet pipe work. The tank shall be guaranteed for a minimum period of five years from practical completion against any manufacturing defect. No repair of tanks is allowed during the first three years of the guarantee period.

b) Polyethylene Tanks

Polyethylene water storage tanks shall be produced by an approved manufacturer with the capacity shown on the drawings and shall comply with the general requirements of Ministry of Housing. The tanks shall be manufactured by Rotational Molding on ASTM or equivalent testing standards using UV Stabilized virgin food grade



Linear Low Density Polyethylene in compliance with recommendations and statutory regulations regarding packaging materials coming in contact with foodstuff. The construction shall be in three layers minimum– an outer white layer, middle black layer and inner white layer. The water capacity shall be above prescribed volume excluding between inlet and outlet. The tanks shall carry a minimum ten year free replacement warranty against any manufacturing defect.

8.7 **Valves**

a. **Stop valves**

The stop valves shall be of screw down pattern to BS 1010. All components that are in contact with water shall be gunmetal to BS 1400 LG2. The body ends shall be suitable for fixing with capillary or compression fittings in accordance with BS 864 part 2. The thrust nut may be brass in compression type body ends. Threaded end fittings, male or female, shall be BSP threaded to BS 21.

All valves shall have proper identification marks as per relevant Standard. Also they should carry a third party quality assured license mark.

b. **Gate Valves**

The gate valve shall be as per BS 5154, series B valve with metallic disk and seat. All components that are in contact with water shall be gunmetal to BS 1400 LG2. The body ends shall be suitable for fixing with capillary or compression fittings in accordance with BS 864 part 2. The thrust nut may be brass in compression type body ends. Threaded end fittings, male or female, shall be BSP threaded to BS 21.

All valves shall have proper identification marks as per relevant British Standard. Also they should carry a third party quality assured license mark such as BS Kite mark.



c. Float valves

Float valves shall be to BS 1212 with a plastic float to BS 2456 marked with manufacturer's name or trade mark, the size and the BS number.

8.8 Sanitary Fittings

Sanitary appliances shall be white in color, unless otherwise stated in the contract, and the fixtures shall be matching types, patterns & color. All sanitary appliances shall be with 3rd party quality mark (such as Kiwa, NF etc). All sanitary fittings shall be chromium plated to BS 1224, service condition 2.

a. Bath Tub and Fittings

Bath Tub

Bath tubs shall be made of acrylic material complying with BS 4305. Size shall be 1700×700 mm and 5 mm thick with two 36mm diameter tap holes 180mm apart on the flange or as required by the bath tub mixer. The adjustable supports shall give a minimum range height adjustment of 50mm. The bath shall have a waste outlet hole and overflow hole. Where the base of the tub is reinforced with wood it shall be covered with glass fibers and polyester resin fiber laminate. The bath tub shall be legibly marked to BS 4305 and shall carry an informative label as per national appendix A of BS 4305.

The bath tub shall be supplied with a 43 mm (1 1/2") chromium plated combined waste and overflow fitting with chain and plug to BS 3380 Part 1 and a 43mm (1 1/2") diameter shallow seal bath trap with a cleaning eye (38 mm water seal minimum) to BS 3943.

Bath Mixer

The mixer tap shall be chromium plated metal body combination tap assembly to BS 5412 with 3/4" inlets and 3/4" BSP threads, and hot and cold identification. It shall consist of integral spout (dual flow spouts are not acceptable) outlet to discharge into the bath and service



connection to the shower head with shower diverter. The shower head set shall be complete with handset rose, flexible hose and swivel jointed wall mounting for handset rose.

b. Close coupled WC suite

The WC pan and flushing cistern shall be to BS 7358 "Close coupled suites with maximum flushing capacity of 7.5 liters. The WC suite shall be a separately cast pan and cistern. The WC pan and cistern shall be manufactured from vitreous china complying with BS 3402. The height of the WC pan measured at the front shall be 405 ± 10 mm (excluding the seat and cover). The maximum width shall be 400mm while the overall length including the cistern shall not be more than 800mm.

The seat and cover shall be to BS 1254 type 2 manufactured to match the suite in pattern and colour. The seat and cover shall be installed in accordance with the manufacturer's instructions.

The flushing cistern shall be maximum 7.5 liters capacity to BS 7357, manufactured from vitreous china to BS 3402 and complete with cover, chromium plated lever action handle, UPVC flushing pipe, side warning plastic pipe, ball valve to BS 1212 and plastic float to BS 2456. Cisterns with lower flushing capacities will be accepted provided that the flushing mechanism is approved by the engineer.

c. Wash Basin and fittings

Wash basin

The wash basin shall be from vitreous china to BS 3402 with the a provision for single hole basin mixer or as approved by the Engineer. Unless otherwise stated in the drawings, the basin shall be type B2 (nominal size 560mmx405mm), with pedestal and overflow to BS 1188. The height of the wash basin when fixed on the pedestal and measured at the front shall be 800 ± 20 mm. The wash basin shall be supplied with a 36mm (1 1/4") chrome plated slotted strainer waste fitting, chain and plug (or 1 1/4" chrome plated pop-up waste to BS



3380 Part 1) and 36mm (1 1/4") diameter plastic waste trap ("P" trap) to BS 3943. The seal depth shall not be less than 50mm.

Wash basin Mixer

The basin mixer tap shall be monoblock chromium plated metal body (to match the wash basin) with hot and cold identification to BS 5412 and with 1/2" inlets and 1/2" BSP threads. It shall consist of integral cast spout.

d. Shower and fittings

Shower Tray

The shower tray shall be to BS 6340 manufactured from vitreous china. Unless otherwise stated, the tray shall be 760mm x 760 mm square with a minimum height of 125mm. The base shall be slip resistant and the shower tray shall be supplied with 43mm (1 1/2") chrome plated slotted strainer waste to BS 3380 Part 1 and a waste trap of 38mm min. water seal and cleaning eye (if trap is accessible).

Shower Mixer

The shower mixer tap shall be chromium plated metal body combination tap assembly to BS 5412 with 3/4" inlets and 3/4" BSP threads and hot and cold identification. It shall consist of integral spout (dual flow spouts are not acceptable) outlet into the shower tray and another service connection to the shower head with shower diverter. The shower head set shall be complete with flexible hose and a handset rose mounted on a chrome plated vertical slide bar.

e. Bib Taps and Garden Taps

Bib taps and garden taps shall be chromium plated metal body to BS 1010. They shall consist of threaded nozzle for the attachment of a metal body hose union where necessary as per drawings.



8.9 **Kitchen Unit.**

Unit kitchens shall include cabinets, countertops, sinks and mixer taps

a) **SUBMITTALS**

- 1) Shop Drawing Submittals: Submit manufacturer's shop drawings showing layout, profiles and product components.
- 2) Quality Assurance Submittals: Submit materials, fittings, accessories and manufacturer's installation instructions and required test certificates.

b) **PROJECT CONDITIONS**

- 1) Field Measurements: Verify actual finished openings and plumbing and electrical locations by field measurements before fabrication. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays. Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabrication without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

c) **WARRANTY**

- 1) Manufacturer's standard warranty period shall commence on Date of Practical Completion.
- 2) Manufacturer's Warranty
 1. For unit kitchens, mixers , sink and aluminum cabinets, warranty period shall be **one(1) year** in which the contractor shall provide, at no additional charge, parts and service to replace defect if any.

d) **CABINETS**

1) **Aluminum Cabinet Boxes**

1. Aluminum Cabinet Boxes



- a. Shall be constructed of [1.6 mm] aluminum sections (BALEXCO or approved equivalent).
- b. Color: [aluminium sections and door panels shall have wooden finish or color approved by the Architect]
- c. Shelves shall be made of 3 mm minimum thick High Pressure Decorative Laminated Sheets (HPDL)
- d. Base cabinets shall have a 100 mm attached toe kick of Aluminum section (color to be approved by the Architect)
 - 1) Unless otherwise specified, wall (top) cabinets should have a cornice made of aluminum with the approved finish and at least two wall unit door panels should be with glass or as approved by the Architect
- e. Bottom of wall units shall be covered with a flat HPDL sheet.
- f. Drawers shall have smooth tracking rollers
- g. All hinges shall be free swinging complying with the requirements of BS BS6222 part 2:1992 when tested under level G. Hinges shall have proper and clear identification marks. Hinges shall be Fixed internally (concealed) by screws (not rivets). The opening angle for hinges shall be 170° but a smaller angle may be used where door opening is restricted.
- h. HPDL sheets shall consist of layers of fibrous sheet materials impregnated with thermosetting resins and bonded together by means of heat and pressure of 5 MPa minimum. Sheets shall comply with the requirements of ISO 4586-1:1995(E).

2. Aluminum Doors

- a. Shall be composite doors, front with molded 2mm thick aluminum sheet or 3mm thick HPDL Sheet or GI Sheet (approved finish) and back with plain sheet and a sandwich layer of polystyrene in between.
- b. Shall be pre-punched for 5” [127 mm] centered handles.
- c. Shall be supplied with 5” [127 mm] centered bail handles in a color (white, black, bisque or chrome) to compliment door color and as approved by the Architect.
- d. Doors shall have rubber or fiber sticker attachment to close quietly
- e. Color: [wood finish to be approved by the Architect]



e) COUNTERTOPS

1) Granite

Granite dimension stone shall include stone that is sawed, cut, split, or otherwise finished or shaped, and shall specifically exclude molded, cast, or otherwise artificially aggregated units composed of fragments, crushed and broken stone. All granite shall be free of cracks, seams, or starts which may impair the structural integrity or function. Inherent color variations, characteristic of the quarry from which it is obtained, will be acceptable. Granite stone shall have 20 mm thickness.

1. Shall be a solid, non-porous surface.
2. Shall have a 75 mm high backsplash with 8 mm of granite projected from wall.
3. Edges shall be finished smooth and round.
4. Joints in Granite shall be smooth and finished properly
5. Color: [to be approved by the Architect)

f) SINKS

Drop-in stainless Steel

Inset stainless steel, single bowl, single drainer sinks to BS 1244 Part 2 with a minimum size of 930 x 485 mm a thickness of .83mm. The bowl shall have a minimum depth of 180mm and minimum internal dimension of 400 x 340mm.

Chromium plated 1 1/2 " waste and overflow fittings, with plain external finishing, including plug and chain 450 mm long and 1 1/2" plastic waste bottle trap.

g) MIXER TAP

Swivel mixer tap shall be single piece bridge type chromium plated metal body combination tap assembly with 1/2" inlet and 1/2" BSP threads with hot and cold water identification. Monoblock mixer shall have minimum 10mm inlets. It shall consist of integral cast or tubular spouts (dual flow



spouts are not acceptable).Mixer tap shall be connected to the main water supply lines (two) through angle valves of approved quality.

h) EXECUTION

1) EXAMINATION

A. Examine areas to receive product. Do not begin installation until areas are in satisfactory condition. Ensure horizontal blocking, if necessary, and floor are complete.

2) INSTALLATION

A. Install product in accordance with manufacturer's installation instructions at locations indicated on drawings.

3) CLEANING

A. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.



Table 8.1 - Properties of HPDL¹

No.	Property	Description	Working Top	Shelves & Panels
1	Resistance to surface wear	N	3	2
2	Resistance to immersion in boiling water	mass increase (%) thickness increase (%) Appearance (N)	3.5 6.3 3	2.5 5.5 3
3	Resistance to dry heat at 180°C	Gloss finish (N) other finish (N)	3 4	No Requirement No Requirement
4	Dimensional stability at elevated temp.	dimensional change (%)	.25 for L ² .58 for T ³	.23 for L .54 for T
5	Dimensional stability at 20°C	dimensional change (%)	.18 for L .25 for T	.16 for L .22 for T
6	Resistance to impact by small diameter ball	N	3	2
7	Resistance to cracking	N	4	4
8	Resistance to scratching	N	3	2
9	Resistance to staining	N	3	3
10	Resistance to color change in Xenon arc light	groups 1&2 (N)	6	6
11	Resistance to cigarette burns	N or minutes to failure	3 100	No Requirement
12	Resistance to steam	N	3	3

8.10 Domestic Water Pump Set

¹ Refer to ISO 4586-1:1995(E) for further clarifications

² L=cross longitudinal (or cross machine) direction

³ Refer to ISO 4586-1:1995(E) for further clarifications



The contractor shall allow for supply, installation, commissioning and maintenance during the defect liability period of wet riser fire mains including the package of pumps and relevant control panel and equipment. The whole set shall be installed in accordance with the local fire department recommendations such as the requirements of pumps output, minimum head, tank capacity, maximum outlet pressure, ... etc). The relevant British standards and the manufacturer's instructions shall also be followed.

Unless otherwise specified in the drawings, two vertical multi-stage, inline centrifugal intermittent duty pumps of equal capacity shall be provided unless otherwise stated in the drawings. One pump shall be working and the other shall be standby. The pumps shall operate alternately for each operation cycle. Pump set to be self contained, fully automatic package unit complete with control panel and accessories. The pump set shall be equipped with two pumps controlled by pressure switch/time (whenever required).

The pumps shall have stainless steel bodies, casing, impeller & shaft of grade 316L and be fitted with tungsten carbide faced mechanical seals. The pump shall be equipped with a mechanical self adjusting, self lubricated shaft seal. Cast iron casting shall not be permitted. The pump shall be multistage directly coupled to induction motors. The pumps shall be vertical, quiet running and high efficiency type.

The electric motor shall operate on 415 volts, 3 phase 50 Hz. The electric motors shall be T.E.F.C. (IP 55 as per B.S. 5490) vertical flange mounting type to B.S. 3979 and B.S. 5000 part 99 with class "F" insulation. The motor shall be arranged for start-delta starting.

All bolts, nuts & washers etc. shall be of stainless steel.

Control Panel

Whenever specified in the drawings, the control panel shall be supplied with all electrical instrument/equipment involved. The Contractor shall submit the circuit diagram of the control panel giving necessary technical details about all the components involved. All electrical installations related to the pump Set are part of the Contractor's scope of work and the Contractor shall coordinate the installation and ensure that ducts, sleeves, conduits etc. are provided for all cables. All labour, material, appliances, equipment, tools,



transportation to install a completely tested and operational Booster Pump system in accordance with specifications and the applicable drawings shall be included in the scope of work.

The Contractor shall include all appurtenances and appliances not necessarily called for in this specification or the drawings but which are necessary for the completion and satisfactory functioning of the works. No claims for extra payment shall be accepted from the Contractor because of his non compliances with the above requirements.

All electrical installations shall comply with the “ Electricity Regulation” issued by “Electricity Directorate Bahrain ED” and “Regulation for Electrical Installation” issued by the Institute of Electrical Engineers (IEE) London, latest edition.

All materials shall be new, factory made and comply in every respect with the standards required by regulation in force, or with the requirements of this specification whichever is the most rigorous in the opinion of the Engineer.

The control panel shall be designed to comply with (IEE wiring regulation 15th edition. Protection shall be provided from both direct and indirect contact by earth equipotent bonding and earth leakage circuit breakers. The control panel shall include but not be limited to the following :-

Incoming isolator, automatic starters, overload relays, MCB's and ELCB, Hand-off auto isolator switches for each pump, selector switch between two pumps, one delay timer (if indicated in drawings), impulse delay, automatic change over between pumps and automatic change over between pumps in case of failure of one pump, indication lamps for pump run, trip, low water level and alarm for high water level, provision for wiring from the field devices such as low level and high level float switches, pressure switches, ... etc., contactor for under voltage release, earthing bar, indicating lamps for power on, system pressure gauges, controls for heaters in the pump motors.

The above equipment shall be complete with all necessary terminals, labels, interconnection, wiring diagrams and spare fuses. The control panel shall be constructed from sheet steel, dust and damp protected IP55 housing with lockable door, requiring one incoming three phase, four wire electrical supply to main isolator. All control panel labeling shall be in English and Arabic. The pump set shall be protected against dry running. A warning lamp shall be provided in the control panel to indicate when the cut off is in operation



and the pump set shall automatically resume operation when normal conditions prevail.

The whole system shall be placed on a fabricated steel base to provide a complete works tested package until finished with a coating system as described in section 12.

The pumps shall be able to deliver the head, close head valve, maximum power and flow rate stated in the drawings.

WORKMANSHIP

8.11 Contract Drawings

The Contractor is to understand that while every attempt has been made to ensure that the Contract Drawings fully indicate the work required to be carried out, they do not necessarily fully detail all work. The Contractor shall nevertheless include for all detailed works of every description required for the absolute completion and proper functioning of the works and shall arrange and install the works accordingly.

8.12 Builders' Work

- a. The Contractor shall allow for all builders' work in connection with this installation. This should include for all minor structural and similar work necessary for the proper execution of this section of the contract. Where drawings are required to be provided, these should include for items such as minor pits, trenches, gullies, equipment bases, plinths, supports, holes through walls floors or ceilings for the passage of pipes, etc., chases in walls or floors for the recessing of pipes and for building in to main structure of brackets, supports, pipe sleeves etc. Details and information are to be provided by the preparation of drawings or by `marking-off' or setting out on site.
- b. In cases of `making-off' or `setting out` the work is to be carried out by experienced and competent tradesmen in full possession of all necessary information and details.



8.13 Layout of Work

- a. The Contractor shall exercise care and consideration when installing the works and shall plan all pipe runs to fit into the surroundings as neatly and unobtrusively as possible and shall position all units and equipment with due consideration for appearance so that they shall not clash or interfere with other units, equipment or services.
- b. Any pipe fittings, appliances or items of equipment which the Engineer shall consider to be incorrectly installed shall be removed and correctly re-fixed at the expense of the Contractor.

8.14 Interruption of Services

The Contractor shall not, without having received the written permission of the Engineer interfere with or interrupt in any way the operation of any existing service such as water, sewers, electricity cables, telecommunications, etc., and in the case of work involving Statutory Authorities or Private Owners, without the permission of such Authorities or Owners in addition to the Engineer.

8.15 Regulations

- a. The installations are to be fully in accordance with existing regulations in the Kingdom of Bahrain and standard engineering practice.
- b. The Contractor is to inform the Engineer of the various works being undertaken and to give all necessary notices to enable the Engineer to test the installation at the appropriate times. The Contractor is also to complete and deliver to the Engineer any necessary applications completed as may be required and to pay any associated fees. The Contractor is to provide all necessary attendance upon the Engineer during tests and shall bear the cost of any subsequent tests rendered necessary by the failure of the installation to satisfy their requirements.

8.16 Supervision

The Contractor shall properly superintend and supervise the work to the satisfaction of the Engineer and must have a competent foreman constantly



on site during the progress of the work. The Engineer shall be afforded every facility for checking, inspecting and testing and the Contractor shall supply instruments as required.

8.17 Mounting Height of Equipment

The Contractor shall ensure that pipework, equipment, etc. are mounted at the correct height as shown on the drawings.

8.18 Installation of Pipework - General

- a. The Contractor shall ensure that no obstruction is left in any piping or fittings and that the full bore is maintained throughout.
- b. Any ends of pipework or fittings left open during the course of the work shall be plugged with plastic or softwood plugs. If dirt in any form should become lodged in the pipework due to inadequate plugging the system shall be flushed out by the contractor and all strainers shall then be cleaned out. The cost of this shall be borne by the Contractors.
- c. The cut ends of piping shall, before fitting, be carefully reamed out to restore the original bore of the piping.
- d. Piping shall be installed so that it follows the lines of the building structure and horizontal piping shall be graded wherever necessary to allow for venting and draining of the pipework.
- e. All pipe fittings shall be of the correct size. Changes in diameter shall be by means of reducers. Bushing down will not be permitted.

8.19 Joints

No pipework of any description shall be jointed in the thickness of walls, floor or roof slabs or any other position where access for maintenance is difficult. Joints in floor screed are not permitted.



8.20 Pipe Supports

Copper pipes shall be supported at not greater than the following centers:

- i) For 15, 22, 32, 40mm diameter pipes, the support shall be spaced at 1200 mm vertically and 500mm horizontally.
- ii) For 82, 110 mm diameter pipes, the support shall be spaced at 1800 mm vertically and 900mm horizontally

Additional pipe supports shall be provided at all joints and fittings.

8.21 Standard of Workmanship

It should be understood that neatness, exactness and a good finished appearance of all work carried out is an essential requirement. Under no circumstances will any inferior work or workmanship be accepted by the Engineer. A high standard must be maintained throughout the period of the Contract.

8.22 Method of Fixing

- a. The size of bolts or screws shall be the largest permitted by the diameter of the hole in the apparatus concerned, and shall be of adequate length. When fixing any item of equipment, all bolts of screw holes provided therein shall be used and the fixing in each hole is to be secured.
- b. All lightweight fixing of equipment to brick, blockwork or concrete shall be made with sheradised greased round headed steel wood screws and fibrous or plastic plugs. Wood plugs shall not be used in damp or exposed situations but greased, brass screws and soft metal non-deteriorating plugs must be employed. Holes of the requisite size for the plug must suit the screw used and will be neatly drilled to a depth excluding plaster or soft wall finish, equal to the length of the plug to be used. The plug length shall be such that when the screw is in place all the threaded length is in the plug.
- c. Fixings to timber shall be made with brass round headed wood screws. For fixings to hollow tiles etc., screw anchor type fixings shall be used



as far as possible. Fixings to soft or hard fiber boards etc. which are inaccessible to the back, shall be made with sheradised self trapping screws of appropriate size or with spring and gravity toggles.

8.23 Jointing Pipes

- a. All pipework shall be in the maximum lengths possible to avoid unnecessary jointing. Pipes shall be fixed to sufficient falls to prevent air locks.
- b. Joint in all types of pipework shall be perfectly smooth inside without contamination of any kind.
- c. All pipes and fittings shall be jointed as recommended by the manufacturer, additional pipe supports shall be provided at all joints and fittings.

8.24 Plastic Piping system (PPR, PB or PEX as approved by the Engineers)

- a. PPR pipe system manufactured as per DIN 8077/ 8078 or equivalent and with third party certifications and markings on pipes and fittings (DVGW or equivalent) and approved by the Engineers shall be used.
- b. Installation of the PEX pipe system shall be carried out in accordance with the manufacturer recommendations by technician with adequate experience in the installation of such systems. In particular, pipes shall be in continuous lengths between manifolds and distribution fittings. Bends shall not exceed manufacturers' recommendations. Pipes shall not be located where they will be exposed to the sunlight.. Shop drawings shall be submitted for the Engineer's approval before commencing the installation of the system. Attention shall be taken to the following matters in the shop drawings:
 - 1- the location of the manifolds,
 - 2- the degree of bends in the pipes,
 - 3- and that outlets for fittings are flush with the wall.



A complete system shall be installed in a sample house or unit and approved by the Engineer before general installation commences. The Engineer shall ensure that all pipes are easily withdrawn whenever required.

During the installation process, adequate care shall be taken to avoid damage to any element of the piping system. Pipes run in concrete slabs shall be kept away from steel reinforcement. A proper legend shall be placed at the manifold duct for future identification purpose.

When the system installation is complete, water pressure testing shall be conducted. The network shall be subjected to 10 bar pressure for one hour to ensure that the system is leak free.

8.25 Sanitary Appliances

- a. Installation of sanitary appliances shall comply with BS 6465 and the regulations and standard set by the Water Distribution Directorate in Ministry of Electricity and Water in Bahrain.
- b. All protective paper etc. shall be removed and the sanitary fittings shall be left in a clean condition.
- c. Sanitary appliances shall be free from all flaws and defects, heavily and evenly glazed, true to pattern with proper falls to outlets and carefully fixed and secured. Any fittings working loose during the defects liability period or proving defective are to be replaced at the Contractor's expense at completion. Point around sanitary fittings with proper mastic subject to approval by the Engineer.
- d. All sanitary fittings are to be carefully protected against misuse by workmen engaged on the works, and any defective soiled or broken fittings are to be replaced.

8.26 Laying of Pipework Underground

- a. Unless otherwise directed underground pipes shall be laid with a minimum cover of 600 mm below finished ground level. Concrete surrounding will be required if the cover is less than 600mm.



- b. All underground pipework shall be laid in straight lines and to even gradients following the general contours of the ground with pipes and specials of the type and diameter shown. Pipes of malleable material shall be laid with a slight snaking. Pipes shall not be laid in avoidable foul or injurious soil or material. Where pipe laying in foul or injurious soil or material is unavoidable the pipes shall be protected by an approved material.
- c. Unless otherwise directed by the Engineer no water service or distributing pipe shall be laid along a trench in which is laid any drain or sewer. Pipes of malleable material shall be laid with a "gooseneck" bend near the point of connection with the water main.
- d. No pipes shall be laid on their collars or on bricks block, tiles or other temporary supports. If the bottom of the trench has been taken too low it shall be made up with well rammed fill. Joint holes if necessary shall be formed in the bottom of the trench ahead of the work in order that joints may be properly made. The joint holes shall be as short as practicable.
- e. Care shall be taken to ensure that the bed on which the pipes are laid and the backfilling immediately adjacent to the pipes does not contain any sharp-edged stones.
- f. Pipes shall be kept free from sand, mud, debris, superfluous jointing material or obstructions during laying and until handover of works.

8.27 Inspection, Testing and Commissioning

- a. The Contractor shall from time to time as required to suit the progress of the building work air-test the Sanitary Installation in sections, to the satisfaction of the Engineer before any such work is covered. At the completion of work all soil pipes and branches and waste pipes and other parts of the Sanitary Installation connected directly with any sewage drain or sewage drain ventilating pipe or soil pipe, shall be subjected to a water test and the Engineer may also direct that a smoke or any other test be applied to any other parts of the sewerage or ventilating system as he thinks desirable, and everything necessary for these tests shall be supplied by the Contractor.



- b. The complete installation shall be fully tested at the completion of the work by the Contractor, to the complete satisfaction of the Engineer who will be present at these tests.
- c. The Contractor shall provide all labor, materials, apparatus and properly calibrated and certified instruments for carrying out necessary tests of his own work.
- d. The Engineer shall have access at all times to such parts of the Contractor's work and premises as necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance of plant.
- e. The works shall not be accepted as complete until satisfactory acceptance tests on the functional system have been carried out. The Contractor shall give the Engineer reasonable notice of his intention to carry out the acceptance tests after he has satisfied himself that the installation has been completed as per drawings and specifications.
- f- Upon completion of the water supply network installation, the network shall be tested at 10 bar (150 psi) pressure for 1 hour (unless otherwise instructed).
- g. Testing water installation shall include for cleaning out storage cisterns including removing all swarf, filling and testing the whole of the installations, rectifying all defects, draining and leaving the installation in a clean and serviceable condition. Such testing is to be carried out before the fixing of any thermal insulation.

8.28 Inspection of Covered Work

Where the Engineer has given notice to the Contractor that any part of the works must be inspected prior to its being covered or hidden, the Contractor must give 7 days notice in writing to the Engineer before such work are covered or hidden. Should any such work be covered or hidden without the written authority of the Engineer the Contractor may be required to uncover the same at his own expense.



SECTION 9

ELECTRICAL INSTALLATION

9.1 Generally

- a. The whole of the installation and tests shall conform to the latest requirements and regulations of the Electricity Distribution Directorate (E.D.D)
- b. All electrical materials must be new and of standard design and conform to the relevant British Standards. A list of B.S numbers is shown at the end of this Section.
- c. All tests shall be made in the presence of the Engineer and a signed copy of the test results is to be submitted to him for approval. The whole electrical works of the contract is to be to the entire satisfaction and written approval of the Engineer.
- d. Necessary approval from Ministry of Electricity and Water must be obtained by the contractor.

9.2 Samples

Samples of all electrical materials including but not limited to wires, cables, conduits, boxes, switches, sockets, light fittings, and switchboards should be submitted, together with, where appropriate, manufacturers catalogues giving complete specifications of materials.

9.3 Service Cable

- a. E.D.D. shall provide a supply cable, cut-outs and meter at a position indicated on the drawings. This service equipment will normally be located outside the building and enclosed in a weather proof and lockable enclosure to meet the E.D.D. requirements and to be supplied and fixed by the Contractor.



- b. A 100 mm diameter P.V.C. or asbestos cement pipe shall be provided, to a length as shown on the drawings, and buried at a depth of 600 mm to accommodate entry of incoming cable.

9.4 **Means of Isolation - Main Switch**

Circuit isolation shall be provided by a Moulded Case Circuit Breaker (MCCB) to B.S. 3871 and B.S.4752 rated as shown on the drawings. This is to single phase and neutral for an installed load of up to 20 kw and three phase and neutral for an installed load of over 20 kw. In all cases the Prospective Short Circuit Current Rating shall be as shown on drawings

9.5 **Earth Leakage Protection.**

A current operated earth leakage circuit breaker (ELCB) shall be provided rated as shown on the drawings. The tripping current shall be between 30 and 300 mA. for small power and lighting sections respectively.

9.6 **Consumer Service Unit**

The consumer unit shall have the number of ways shown on the drawing. It is to be single phase and neutral or three phase and neutral as the MCCB (9.4). The main isolator and ELCB shall be integral with the consumer unit. The unit should be mounted in a position to be agreed with the Engineer, but should not exceed 1.85m above FFL.

9.7 **Miniature Circuit Breakers**

The consumer service unit is to be fitted with miniature circuit breakers (MCB) to protect each sub-circuit from overload conditions. The rating of the MCB's is to be as shown on the drawings. Thermal or magnetic tripping action will be permitted but where thermal units are used they must be suitable for local ambient temperatures.

9.8 **As-built Drawings**

After completion of the work and after obtaining partial approval the Contractor shall submit within 30 days thereafter to the Engineer, 'As-built Drawings' for record purposes. The As-built drawings shall clearly show the



route of cables and conduits and exact location of all outlets, boxes and junction boxes.

9.9 Cables in General

Colours and sizes of cables shall comply with E.D.D. regulations and should satisfy all the relevant British Standards for the service for which they are used and the following schedules :

Colour of Insulations

<u>Designation</u>	<u>Wiring</u>	<u>Flexible Cord</u>
Live	Red, Yellow, Blue	Brown
Neutral	Black	Blue
Earth	Green	Green & yellow

Size of Conductors

<u>Circuit</u>	<u>Size of MCB (Amps)</u>	<u>Diameter of Cable mm²</u>
Lighting Circuits	10	1.5
Water heater circuits	15	2.5
Ring main(socket outlets)	30	4.0
	(Live & Neutral)	
A/C circuits	30	4.0

9.10 Fuses

The Contractor shall finish a complete set of fuses for all switches. Fuses for meter box must be obtained from E.D.D.

9.11 Wiring Methods

Generally and unless otherwise specified or indicated on the drawings, wiring shall consist of non-metallic sheathed or service-entrance cables installed in areas as permitted by E.D.D and of insulated conductors in rigid conduit installed elsewhere.



9.12 **Conduit System**

- a. Conduits shall be rigid P.V.C conduits to B.S. 4607. Conduit shall be installed in accordance with the requirements of CP3 and to the approval of the E.D. Minimum size of conduit shall be 20 mm.
- b. Conduit system shall be concealed within finished walls, ceilings and floors where possible and shall be kept 150 mm away from parallel runs of flues and water pipes. Raceways shall be rigidly supported at intervals of not more than 2.4 metres, and shall have runs installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings.

9.13 **Conductors**

Conductors of cables shall be copper. Single core PVC insulated cable of the appropriate colour shall be drawn into conduits. The number of cables in any conduit should not exceed that permitted in the E.D.D. table.

9.14 **Outlets**

- a. Each outlet in the wiring or raceway system shall be provided with a flush-mounted outlet box to suit the conditions encountered, conforming to B.S. 4662. Each box shall have sufficient volume to accommodate the number of conductors entering the box.
- b. Device plates of the one-piece type shall be provided for all outlets to suit the devices installed. Plates shall be of ivory phenolic compound. Screws shall be of stainless steel type with oval heads. Plates shall be installed with all four edges in continuous contact with finish on wall surface without the use of mats or similar devices.

9.15 **Plugs and Sockets**

Plugs and sockets shall be provided as indicated conforming to B.S. 1363 Part:1 and B.S. 1363 Part:2 respectively. Socket-outlets shall be switched, 13 amp shuttered and surface mounted. A 13 amp fused plug, fitted with a 13 amp fuse shall be provided for each socket installed, of an approved type.



9.16 **Wall Switches**

Switches, switch plates and switch boxes shall conform to B.S. 3676. Light switches shall be tumbler type, mounted as required, all insulated, 5 amperes current rating, either single-pole one way or single-pole two way on and off switch as indicated on the drawings. Switch for heater shall be 20 amp, double pole; switch for a/c units shall be 45 ADP, of an approved type.

9.17 **Lamp Holders**

Bayonet lamp caps, lampholders and BC adapters (Lampholder Plugs) shall comply with B.S. 5042. Screw lamp caps and lampholders shall comply with B.S.6776. Ceiling roses shall comply with B.S. 67. Ceiling light sockets shall include the rose, 150 mm length of flexible cord and bayonet cap lamp holders. Exterior light fittings shall be bulkhead type and of weather- proof design, IP 65 rated and shall comply with B.S. 4533.

9.18 **Doorbell System**

The Contractor shall provide provision only for the bell system by means of a 20 mm PVC conduit through the wall adjacent to the front door and terminate in a flush 75 mm x 75 mm PVC box in the exterior wall face. The conduit shall be plugged and a cover fitted to the box.

9.19 **Electric Water Heaters**

Water heater shall be electric type, suitable for operation with 240V/1Ph./50Hz. Power supply.

Water heaters shall be UL listed. Heating element shall be screw type immersion element. The heater shall be externally insulated with non CFC foam insulation and glass lined internally. Protective magnesium anode rod shall be provided to inhibit corrosion of tank interior.

The heater shall be complete with factory installed nipples. Fast acting surface mounted thermostats shall be provided for automatic temperature



control. Also factory installed sensitive energy cut off for safety to prevent overheating to be provided.

Special intake dip tube to be provided to guide cold water to the bottom of the tank, which will eliminate mixing of cold and hot water.

All heater shall be provided with temperature & pressure relief valves and a surface mounted thermometer to indicate the temperature of the contents.

The capacity in liters and heating element capacity shall be as per the drawings.

All the replaceable parts such as thermostat, heating elements, aluminum anode rod, dip tube, drain valve, shall have a minimum warranty of 2 years and the tank casing and internal lining shall have a minimum of 5 years warranty.

9.20 **Exhaust Fan**

Electrical exhaust fans must be 220/240V~50 Hz single phase with a cord shutter operated unless the fan is located in an inaccessible location. All wiring must comply with IEEE regulations. The motor must be single phase induction type with pre-oiled bearings. The fan shall be capable of extracting 15 liter per second in bathrooms and 50 liter per second in kitchens. Fans shall be guaranteed for a minimum period of three years from date of issue of practical completion certificate.

9.21 **Ceiling Fans**

Fans shall be provided as per Contract. Socket outlets and wiring should be installed as indicated on the drawings. The Contractor should supply and fix a 5 amp 1 way switch in lieu of the Controller.

9.22 **Television Outlet Points**

Television outlet points are to be provided and should conform to B.S. 5733

and be flush mounted co-axial single outlet complete with all necessary conduit.



9.23 Repairs of Existing Work

The work shall be carefully laid out in advance and where cutting, channeling, chasing or drilling of floors, walls, partitions, ceiling or other surfaces is necessary for proper installation, support or anchorage of the conduit, raceways or other electrical work, this work shall be carefully done and any damage to the structure, piping or equipment shall be repaired by skilled mechanics of the trades involved, at no additional cost to the Contract.

9.24 Grounding

The main earth connection of the wiring system shall be grounded in accordance with the impedance requirements of E.D.D. and generally to comply with the provisions of CP 1013. Earthing shall be by use of copper cable to an earthing rod located at a reasonable distance beyond the house, or as shown on the Drawings.

9.25 Tests

After the interior wiring system installation is completed, the Contractor shall conduct continuity tests, insulation resistance tests and polarity tests. These tests are for the Contractor's own benefit only. It shall be the responsibility of the Contractor to ensure that the completed system when tested by E.D.D. will be acceptable to that organization. The System will not be considered satisfactory until such time that E.D.D. deems the system acceptable to their standards and requirements.

9.26 LIGHTNING PROTECTION SYSTEM

- a. The air termination rods shall be 12 mm diameter hard drawn copper 600mm long with pointed ends.
- b. Roof conductor shall be 25mm x 3mm soft annealed copper strip.
- a. Down conductors shall be 25mm x 3mm soft annealed copper strip.



- d. Earth termination shall be copper bond steel cored earth rod of 20mm diameter and 3000mm long.
- e. The air terminations shall be connected together and to all the metallic objects on the roof, and connected to the earth terminations as shown in drawings.
- f. All conductor connections shall be them welded and all the bends shall be to the approval of the S.O.
- g. The installation of the earth termination shall be carried out in accordance with BS 6651.
- i. Maximum earth resistance from any point in the installation including the earth lead the earth pit shall not exceed 10 ohms.

9.27 Applicable British Standards

The following British Standards listed below form a part of this Specification. This list should not limit the scope of British Standards to those listed as the work is to conform to all relevant British Standards whether listed or not.

B.S. 67	Ceiling roses
B.S. 546	2,5,15 & 30 amp plugs, socket outlets
B.S. 731	Flexible conduit.
B.S.3456, 3676, 5733, 6220, 5738	Electrical accessories, requirements for construction safety, tests.
B.S. 1853	Fluorescent lamps
B.S. 951	Earthing clamps
B.S. 2564	Maintenance of Switchgear
B.S. 7430	Earthing
B.S. 1363	13 amp plugs and sockets



B.S. 5486	Specifications for Type Tested and Partially Type Tested Assemblies.
B.S. 2484	Electrical cable covers
B.S. 3456	Testing and approval of household appliances
B.S. 3676	Switches, switch plates and switch boxes
B.S. 3955	Electrical controls for household purposes
B.S. 4108	Pitch fiber conduit
B.S. 4363	Control and distribution units for electricity supplies for construction and building sites.
B.S. 4533	Light fittings
B.S. 4568	Steel conduit and fittings
B.S. 4607	Non-metallic conduits and fittings for electrical installations
B.S. 4662	Electrical boxes, accessory
B.S. 4678	Cable Trunking
B.S. 5042	Bayonet Lamp holders
B.S. 6004	PVC insulated cables
B.S. 6007	Rubber insulated cables
B.S. 6207	Mineral insulated cables
B.S. 6500	Insulated flexible cords
B.S. 6776	Specifications for Edison Screw lamp Holder

9.28 The Intercom System

The Contractor shall allow for supply, installation, testing and commissioning of an integrated audio intercom system in the building. The system shall consist of



1. Recessed, matt, aluminum finish, hands free, wall mounted door answering station installed in the ground floor main entrance as shown in the drawings. This station shall be able to communicate with other stations located in each flat. Flat numbers shall be printed in each call button. Total number of call buttons shall not be less than the door answering stations.
2. Wall mounted, door-answering stations located in each flat and the watchman's room. The answering station shall contain a main entrance door lock release control and a buzzer. The handset shall be connected to an extendable coil cord.
3. In addition to the electrical door lock release system, the door shall be open-able manually from inside and by key from outside.
4. Wiring, door release, power supply source, transformer, ...etc. shall be installed according to the manufacturer requirements.
5. The whole system be warranted for a minimum period of one year from the date of issue of the Practical Completion Certificate.



SECTION 10

PLASTERWORK AND OTHER FLOOR, WALL AND CEILING FINISHINGS

MATERIALS:

10.1 Cement

Cement shall be ordinary Portland Cement as described in Concrete Work complying with B.S. 12.

10.2 Fine aggregate (Sand)

- a. Sand shall be clean, sharp, well graded sand complying with the requirements of BS1199. The chemical composition shall comply with the requirements of clause 3.5b of this specification.
- b. Clay/silt content (75 microns) by weight shall not exceed 3%

10.3 Coarse Aggregate

Coarse aggregate for floor screeds shall be 10 mm aggregate and shall comply with the requirements of clause 3.3 and 3.4 of this specifications.

10.4 Lime

Lime shall be hydrated high calcium lime or hydrated semi hydraulic lime all complying with B.S. 890 Class B. No lime shall be used unless written approval is obtained from the Engineer

10.5 Mortar Plasticizer

Mortar plasticizer shall comply with B.S. 4887 and shall be used in accordance with the manufacturer's printed instructions.



10.6 Water

Water used for mixing and curing of plaster shall comply with the requirements of Clause 3.7 water for mixing and curing of concrete.

10.7 Wall Tiles and Border Tiles

Dry pressed glazed ceramic wall tiles shall comply with BS 6431 with 15% maximum water absorption. Tiles shall have a minimum thickness of 5.5 mm for sizes 200 mm × 200 mm, 200mm x 300mm or smaller and 7.5 mm for 300 mm × 300 mm tiles. Tile size shall be as specified on the drawings and shall have cushioned edges and spacer lugs unless specified otherwise. All exposed edges and corners shall be finished with round edge tiles.

10.8 Floor Tiles and Skirting Tiles

- 1) Ceramic glazed porcelain floor tiles shall be fully vitrified complying with BS 6431 with water absorption of less than 0.5%. Tiles shall have a minimum thickness of 7.5 mm for sizes 200 mm × 200 mm or smaller tiles and 9.0 mm for 300 mm × 300 mm tiles and 9.5mm for 600mm.
- 2) Dry pressed glazed ceramic tiles shall comply with BS 6431 with water absorption of less than 6%.

10.9 Terrazzo Tiles

Precast terrazzo tiles shall comply with BS 4131 with surface and total absorption of not more than 0.4% and 8% respectively. Unless specified otherwise, the size of the tiles shall be 250 × 250 × 20 mm thick. Tiles shall have a ground grouted and polished surface to a fine grit finish and the wearing face shall be plane, free from projections, depressions, and cracks. All angles and arises shall be true and sharp.

10.10 P.V.C Flooring

- a. P.V.C tiles and sheet flooring shall comply with BS 3261.
- b. tiles shall have a minimum thickness of 2.5 mm.



- c. The size of the P.V.C sheets shall suit the location in which they are to be used and shall be subject the Engineer's approval.
- d. P.V.C. tile adhesive shall be quality assured brand, compatible with both the tile and substrate. Performance certificates shall be submitted with approval request.

10.11 **Tile Adhesive and Tile Grout**

Adhesive for use with wall and floor ceramic tiles for bathrooms and kitchens shall be type 1 class AA complying with BS 5980. Tile grout shall be water resistant complying with BS 5980 and shall be of an approved color.

10.12 **Fiber Glass Plaster Reinforcing Mesh (Lathing)**

- a. Lathing for external and internal plaster shall be, woven alkali resistant glass fiber mesh covered with an alkali protective coating. Manufacturer literature shall clearly affirm the suitability of the product for use in cementitious environment such as plaster. The catalogue shall indicate product compliance with the relevant manufacturing standards.
- b. Glass fiber mesh shall not wrinkle when applied and shall have the following properties:



Characteristics	Unit	Limit	Standards
Mass Per Unit are (min.) For Housing (Load bearing) For Apartment buildings (framed)	g/m ²	150 250	DIN EN 29073
Loss by Ignition (max)	%	24	ISO 1887
Weave	Type	Leno	
Coating	Type	Alkali-resistant	Clause (c) below
Elongation	%	4-6	DIN 53 857
Mesh size (range)	mm	(4-8) × (4-10)	
Tensile strength (min) (both directions) For traditional Housing (Load bearing) Apartment buildings (framed)	N / 5 cm	>2000 >3500	EN 13934-1 OR ISO 4606
Fabric width (min)	mm	200	

- c. The mesh shall retain a minimum tensile strength 50% of the characteristic strength after 28 days soaked in 5% sodium hydroxide.
- d. Lathing glass fiber mesh shall be used at all joints between concrete and masonry blocks, at the joints between hollow and solid blocks filled with concrete and at the corners of all openings.

10.13 Expanded Metal Lathing

When specified, steel lathing for internal and external use shall be grade Z450 Galvanized steel or stainless steel complying with BS 1369. Mass per square meter shall not be less than 1.61 kg for galvanized steel and 1.09 for stainless steel lathing.



10.14 **Waterproof Membrane for Bathroom Floors**

Waterproof membrane shall be of an approved liquid applied waterproofing system. The membrane shall have minimum dry film thickness of 800 microns (in two layers). The coating shall comply with requirements of Clause 5.4.2 in this specifications. The coating system shall be reinforced for the entire area. The reinforcement shall be done by geotextile as described in Clause 5.2.2(c) or any other approved material. A letter of guarantee for a minimum period of ten years against any defect in the waterproofing system shall be submitted. The guarantee period shall start after the practical completion date during which, the contractor shall be liable to making good of any defect or failure in the system.

10.15 **Suspended Ceilings**

a. General

- i. Suspended ceilings shall comply with BS 8290 Part 1. The shape, size, pattern, fire resistance, thermal insulation and sound absorption properties shall all be as specified on the drawings or in the particular specifications.
- ii. Suspended ceilings installer shall be a specialist firm approved by the Engineer and shall provide a qualified and experienced representative to supervise the installation.
- iii. Samples shall be submitted for all type and finishes of the required suspended ceilings for approval.
- iv. When necessary, manufacturers' technical data and installation instructions along with certified laboratory test reports shall be submitted.

b. Aluminum Strip Suspended Ceilings

The aluminum strip ceiling shall be of an approved system, consisting of panels made of 0.5mm minimum thickness enameled aluminum alloy AA5050. The strip shall be 84 mm wide 16mm deep, with round sides. Panel carriers shall be made of 0.95mm thick enameled aluminum, 62mm



wide and 29mm deep, with prongs to hold panels in a module of 100mm. The 16mm wide gaps between the panels shall be closed with flush join profiles of enameled aluminum. The edge shall be covered with edge cover profile with a gap of 12mm to the wall. Fixing the system shall be to the required suspension heights. System fastening heights to the structural ceiling to form a room height shall be as shown and detailed on the drawings.

End joints shall be butted and kept in alignment with a color-matched splice fixed inside the panel at the bottom and a metal clip at the top.

c. Tiled Suspended Ceilings

Acoustic ceiling tiles shall be an approved pattern made from mineral fibers and sprayed with white emulsion paint. Unless otherwise stated, the size shall be 600 × 600 × 12mm thick. Tiles shall be fixed using an aluminum / galvanized steel framing system with aluminium capping suspended from the slab soffit. Engineer's approval shall be obtained for the framing system and for the color of aluminum strips if they are exposed.

Gypsum board on metal grid suspension system shall be gypsum core tiles with decorative vinyl lamination and polished aluminium foil backing of approved thickness. Metal grid suspension system shall be hot dip galvanized steel and coated with factory applied hot baked enamel paint/aluminium capping of approved color.

10.16 Light Weight Concrete

- a. Water, cement and aggregates shall comply with the requirements given in Section 3 in this specifications.
- b. If specified in the drawings, light-weight concrete for use as screed shall have a maximum density of 1050 kg/m³.
- c. Light-weight air entrained cement screed shall have a density not exceeding 550 kg/m³.



- d. Manufacturer's printed instructions shall be submitted for Engineer's approval. Light weight concrete shall be mixed and laid strictly in accordance with these instructions.

10.17 **Marble and Granite**

- a. Marble including granite to be used on floor and treads shall be hard wearing and non-slip type. All marbles shall be free from flaws and planes of weakness which may yield to preferential cracks under stress.
- b. Variation in the surface finish, design, texture and color must be minimal. Architect approval must be obtained for such properties.
- c. Flooring marbles shall have a minimum thickness of 20 mm, for treads the minimum required thickness shall be 30 mm.

WORKMANSHIP

10.18 **Preparation:**

- a. Surfaces to receive plastering or screed shall be brushed to remove all loose particles, dust, laitence, efflorescence, etc., and any projecting fins on concrete surfaces shall be hacked off. Rake out joints of blockwork and brickwork and hack concrete to provide key. Surfaces shall be wetted and rewetted as required to control the suction before the first coat of plaster or screed is applied. In particular, dense hard concrete surfaces shall be wetted and rewetted as required before plaster is applied.
- b. All plasters and cement shall be stored in a properly roofed, weatherproof, dry, well-ventilated shed, used exclusively for this purpose, with a wooden floor not less than 150mm clear above the ground. The different types of plasters shall be kept separate and arranged so that they may be used in the order of their delivery.

10.19 **Render or Cement Plaster**

Cement plaster shall be mixed in the proportion of 1 part cement, 4 parts sand by volume, using an approved plasticizer. The plaster thickness shall be 12 mm internally and render thickness 15mm externally finished with a wooden float.



10.20 Lathing

Glass fibre mesh lathing shall be fixed at the fronts of all concrete-block interfaces. Mesh shall be installed as per manufacturer's recommendations. The wall shall be properly wetted prior to plastering. Lathing shall be fixed near to the outer surface of the plaster as much as possible using cement-rich plaster (1 Cement : 2 Sand) applied to 5-8 mm thickness. The mesh shall be pressed in position in the fresh plaster with a trowel or other proper means. An overlap of 100mm minimum shall be provided at all joints.

10.21 Wall Tiles

- a. Rounded edge or universal tiles shall be used on all external angles and unprotected ends of filing. The backing for wall tiles shall be cement : sand, plaster 1:4 applied in one 10 mm thick coat with a slightly scratched finish. Tiles shall be fixed to this backing with an approved adhesive. All tiles shall be aligned properly, with straight joints in even widths determined by the spacers on the tile.
- b. Tiles shall be grouted with coloured or white water resistant grout as a separate operation after the adhesive has set.

10.22 Floor Screeds:

- a. Concrete in floor screeds shall be Grade 20 complying with Clause 3.14 and Table 3.2 of this specifications.
- b. Where screeds are to receive clay or ceramic tiles the screed shall be finished with a slight rough finish to accept the cement paste and tiles. The mortar bed shall be spread and tamped to an even thickness over an area no greater than that which can be tiled before the mortar reaches its initial set.
- c. Screeds shall be laid in bays of suitable length and width, and to falls where described, and shall be kept wet and protected until set hard. Care shall be taken to ensure that screeds are level at abutments with wall etc.
- d. Where the area of the screed exceeds 15 m² meters, or when one single dimension of the area exceeds 7.5 m, screed shall be laid in bays of a maximum 15 m². Construction and/or expansion joints may have to be provided, location of these joints shall be approved by the Engineer.



10.23 Clay or Ceramic Floor Tiles:

- a. A thin layer of neat cement paste shall be spread with a proper "comb type" trowel over the mortar bed and the backs of the clay or ceramic tiles immediately before laying.
- b. Clay or ceramic tiles shall be positioned and tapped firmly into the mortar, laid with straight close joints with a minimum gap between the tiles of 2 mm. Any mortar extruded between the joints must be wiped off with a damp cloth and joints cleared for grouting. Final leveling shall be carried out within one hour of placing tiles.
- c. Mortar for pointing clay or ceramic tiles shall be prepackaged, non-shrinking water-resistant grout. The joints shall be pointed and flushed up by spreading the grout diagonally over the joints until all gaps are filled. Excess grout shall be removed with a damp cloth as pointing proceeds.
- d. Power tools shall be used for cutting tiles as far as practicable. Cut edges shall be straight and free from chippings and ground or filed smooth.
- e. Clay or ceramic tiled areas shall be thoroughly cleaned with soap and water or with a weak solution of muriatic acid rinsed off with cold water when pointing has hardened sufficiently to permit it. On no account shall soda or sulphate containing solutions be used for cleaning purposes.
- f. The contractor shall be responsible for the safety, integrity and appearance of the tiles. Any physical damage or change in the color of both, tiles and grout due to staining, fading, mishandling or poor workmanship will not be accepted. The Contractor shall replace all tiles or grouts in areas where such defects have taken place.
- g. Floor tiles shall be set out in coordination with the location of floor drainage gullies, both of which shall be arranged in such a way as to minimize the number of cut tiles. Floor tiles shall be laid to falls, starting at the lowest point, immediately adjacent to the floor drainage gully. These tiles shall be whole tiles only. The contractor shall prepare a sample tile layout for each different size and type of room, for the Engineer's approval.



10.24 **P.V.C Flooring**

- a. All surfaces to receive P.V.C flooring shall be examined to see that they are in proper condition. Starting of work in any area shall constitute acceptance by the Contractor of such surface as being satisfactory, and any defects resulting from use of such accepted surfaces shall be corrected without additional expense to the Employer.
- b. Surfaces shall be dried adequately before applying materials.
- c. Fill all cracks in sub-surface using approved crack-filler in accordance with the manufacturer's printed instructions. Clean surfaces of all remaining dirt and loose particles before application of flooring materials.
- d. Small dips and minor imperfections on the floor surfaces shall be corrected using an approved self levelling screed.
- e. Tiles shall be laid parallel to room axis, with continuous joints in both directions or with joints staggered in one direction as approved by the Engineer and with tiles at edges being not less than half the width of the P.V.C tiles.
- f. Lay P.V.C flooring so as to ensure full uniform contact with base material and to produce finished surfaces which are smooth, even, and in true planes, free of buckles, waves, and other imperfections. Store and use adhesive in accordance with manufacturer's printed instructions.

10.25 **Marble and Granite**

- a. Marble fixing shall be carried out by specialized teams having adequate experience in this field.
- b. Flooring marble shall be bedded on a 1:4 cement : sand mortar mix 12 mm thick and adequately compacted semi-dry sand : cement mortar mix shall be used as a leveling course. Alternative methods may be submitted for the Engineer's approval.
- c. Backing material or any of its components shall be non-staining. Cement shall be iron-free.



- d. The correct floor datum shall be first established before commencing installation
- e. Tight joints for internal work shall not exceed 2 mm. Joints shall be filled with colored grouting material specially made for this purpose. External joints shall be generally 4 mm but not less than minimum 3 mm and shall be filled with a suitable waterproof cementitious material.
- f. In large areas, allowance shall be made for movement joints for both marble and backing material. Working drawings showing compression or expansion joints shall be submitted for both Engineer and Architect approval.
- g. Finished floor level shall be controlled by series of 'spot levels'.
- h. Contractor shall avoid unsightly and esthetically improper cuttings.
- i. The contractor shall ensure that cut units present a balanced appearance when laid and are kept as large as possible.
- j. The contractor shall ensure that joint locations in the flooring and cladding patterns meet with Engineer's approval. If setting out and joint patterns are complicated by openings and features, contractor shall obtain the Engineer's approval to any proposals before starting the work.
- k. The contractor shall insure that the brass expansion joint strips if required in the drawings or by instructions, are laid in accordance with the Engineer's instructions and in an approved manner compatible with the flooring patterns.

10.26 Suspended Ceilings

- a. Contractor shall submit two copies of the shop drawings for fabrication and erection showing sections, connections and details of work around light fittings, air conditioning ducting, grilles, framed openings etc.
- b. A sample area of finished suspended ceiling work 3 × 2 meters shall be installed in an agreed location. Engineer's approval for appearance and quality shall be obtained before proceeding.



- c. Materials shall be handled and stored as per manufacturers' recommendations. Materials shall be handled carefully and kept clean if they are later removed to access concealed services for the purposes of inspection or any other remedial work.
- d. Suspended ceiling shall be installed only if building is weather-tight, wet trades have finished their work and services are complete above ceiling level.
- e. The Contractor must liaise with the Engineer and provide all necessary details of the work as needed to ensure coordination of all required installations such as; light fittings, air conditioning ducting, grills and other related building elements and services. This also include ceiling hanger inserts in concrete to provide suitable hanger spacing.
- f. Suspended ceiling materials shall be fixed to manufacturer's recommendations, ensuring compliance with design and performance requirements.
- g. Ceilings shall be set out accurately to give level soffits free from undulations and lipping, with all lines and joints straight and parallel to walls unless otherwise, specified.
- h. Where not shown otherwise, ceilings shall be set out to ensure that edge sheets are never less than half width or length. Position grid to suit panel size(s), allowing for permitted deviations from nominal size(s).
- i. Suitable means shall be provided to make up for expansion due to temperature increase in a fire. Allowance for expansion per unit length shall be not less than that used in the relevant fire test of the ceiling system.
- j. Gaps around pipes, ducts etc passing through ceiling shall be sealed with tightly packed mineral fiber. Contractor shall ensure that junctions of ceilings with cavity barriers shall also be fully sealed.



SECTION 11

GLAZING

MATERIALS

11.1 Glass and Mirror

Clear Float or Polished Plate Glass

Unless otherwise specified in the drawings, Glass to all windows and doors (except bathrooms and W.C.) shall be generally Clear float glass complying with BS. 952 Part 1 Table1. The thickness shall be as shown in the drawings.

Wired Glass

Wired glass shall comply with BS 952 Part 1 Table 4 and shall have a true regular arrangement of wires. The minimum thickness of the glass shall be as indicated on the drawings.

Patterned Glass

The patterned glass shall be a translucent cast glass with a decorative pattern on the surfaces. The patterned glass has to approved by the Engineer.

Mirrors

Mirrors shall have 6 mm minimum thickness cut to the size shown in the drawings and sealed from all sides shall comply with BS 7449 : 1991.

11.2 Putty

- a. Linseed oil putty for glazing to wood shall comply with BS. 544 tropical grade.
- b. Putty for glazing to metal windows shall be an approved tropical grade mastic putty used in accordance with the manufacturers' instructions and recommended by the window manufacturer.



11.3 **Roof Light**

Unless stated otherwise, roof lights shall have a pyramid or dome shape. The glazing unit shall be double skin acrylic and opal color. The dimensions of the roof light shall be as shown in the drawings. The color fastness shall meet BS 1006:1961 scale 6/7. The base unit shall be of an approved color of extruded aluminum sections. The base shall be well fastened to the structure using stainless steel screws. If an openable roof light is required, the opening angle shall not be less than 90°. The locking mechanism and the holding arm shall be adequately rigid and strong enough such that they do not allow excessive lateral movements or splitting of the different components.

The complete arrangement of the roof light shall be watertight. Samples demonstrating the required internal and external finishes as well as colors shall be submitted for approval.

11.4 **Hollow Glass Blocks**

Glass blocks shall be of an approved pattern, color and type. The size of the glass blocks shall be 190×190×100 mm unless otherwise specified.

WORKMANSHIP

11.5 **Preparation:**

- a. Before beginning any work, the Contractor shall measure and inspect frames to receive glazing to determine that other trades have completed preparatory work and that sash and frames are ready to receive his materials.
- b. Frames and sash shall be adjusted, plumbed and squared. All rivets, screws, bolts, nail heads, welds, and other projections shall be finished flush in the glazing rebates. All corners and intersections shall be sealed and weather tight.
- c. Opening sashes shall be fastened and kept closed until glazing compounds, except non-setting type, have cured or set.



- d. Surfaces to receive glazing materials shall be free of dirt, dust, grease, oil and other foreign materials, and shall be painted or sealed, before glazing work is begun.
- e. Do not begin glazing work until all cleaning and repairing of surfaces has been completed.
- f. Aluminum glazed frames requiring dry glazing method shall be glazed in accordance with the frame manufactures' written specification.
- g. Cut glass accurately to fit openings. Sizes of glass indicated on the drawings are approximate only, and the actual sizes required shall be determined by measuring on site the frames to receive the glass. Size glass to permit required clearances around full perimeter of glass.

11.6 **Glazing**

- a. The glass to be cut to sizes with proper clearance and to be well back puttied, sprigged for timber rebates or pegged for metal rebates and neatly front puttied. Putty must not appear above the sight lines. Glass to all windows and doors (except bathrooms and W.C.) shall clear sheet glass. Glass to bathrooms and W.C.'s shall be an approved obscured glass.
- b. Glass shall be fitted in accordance with BS 6268
- c. Glass panels over 0.10 m² in metal windows for putty glazing shall be secured by means of spring glazing clips fixed in the performed holes.
- d. Mirrors for bathrooms shall be fixed using a WBP plywood

11.7 **Beads and Wash-Leather**

Glass to doors and screens and other places subject to vibration or as directed by the Engineer shall be bedded in wash leather and fixed with beads. Where so specified the beads shall be fixed with brass cups and screws. The Contractor shall allow for taking out and re-fixing beads as required.



11.8 **Protection**

- a. All glass shall be protected from damage until Practical Completion of the building and if glass is broken or defective it shall be removed and replaced with the specified type.
- b. Plaster, mortar, paint, excess sealant, putty etc. or any other material shall be removed immediately after contact with the glass and shall not be permitted to collect or remain on the glass surface.
- c. Remove all labels, excess glazing compounds, stains and spots from glass on completion of glazing.
- d. Remove all rubbish and debris from the site at the end of each day's work. Clean compound smears and stains from adjacent surfaces as the work progresses.
- e. At the completion of the entire project, all glass surfaces shall be thoroughly cleaned and washed.



SECTION 12

PAINTING AND DECORATING

MATERIALS

Quality Control

Paint supplied to Ministry of Housing projects must be produced by factories having an established and approved and quality control / quality assurance schemes. The quality control scheme must be complying with the ISO 9000 requirements and certified by a third party accreditor. The quality manual must be made available for their review and approval. Whenever required, the quality manual must be submitted for review to ensure contents will meet requirements set by Ministry of Housing. The manufacturer must provide full access to MOH personnel for inspection and evaluation.

Quality control on site shall be maintained on a regular basis through testing. The Engineer shall be at liberty to take samples for the purpose of test analysis.

12.1 General

- a. Paint manufacturers / suppliers must maintain a technical team to support MOH projects who are capable of giving advise upon request and carry out regular site visits to ensure that paint is applied in accordance to the manufacturer requirements and up to their standard.
- b. Wherever possible all primers, undercoating and finishing paints shall be obtained from one manufacturer approved by the Engineer. No intermixing of brands is allowed under any circumstances. The coatings proposed must be submitted in a system for approval along with all relevant supporting documents. The system shall detail all area of paint application of the paint and the relevant system recommended. The submission shall also contain a list of each type of paint quantities required for the site.
- c. The approval of the paint system does not relieve the Contractor from his contractual obligations. It shall be the Contractor's responsibility to completely hide the substrate by the painting system without any visible patches. The paint shall not discolor or deteriorate.



- f. Paints are to be used exactly as received in the sealed cans from the manufacturer in accordance with the manufacturers' instructions. Dilution on site is not allowed for water based paints under any circumstances. The addition of thinners, dryers, or other materials for solvent based paints will only be permitted when specially required by the manufacturer and approved by the Engineer. These additives must be used in accordance with the manufacturer's recommendations.
- g. The Contractor shall be deemed to have allowed in his prices for the extra cost where small quantities only of a particular type or color of materials are required.
- h. The Contractor shall submit a guarantee for the paint system against discoloration and deterioration for a period of four years starting from the issuing date of the Practical Completion Certificate.
- i. Painting shall generally comply with BS6150.
- j. Paint shall show easy brushing, good flowing, spreading and leveling properties. These properties shall be demonstrated on test specimens at the request of the Engineer. Coats that have any noticeable pull under a large brush and that show poor or fair spreading and flowing properties will not be acceptable.
- k. Paint shall dry to a uniform, smooth, gloss appearance under ordinary conditions of illumination and wearing. There shall be no laps, skips, high-lighted spots or brush marks. Tinted paints shall dry to a uniform color.
- l. Recoating of a previously painted surface shall produce no lighting, softening or other film irregularities.

12.2 Marking

The paint shall be delivered to site in sealed containers bearing manufacturers' label. The following shall be clearly identified on the container:

- i) Manufacturers' name
- ii) Product name
- iii) Batch number
- iv) Date of Manufacture
- v) Shelf life.



12.3 Paint and the Environment

The paint system applied in all MOH shall be, wherever possible, environmentally friendly and shall meet local authorities particular requirements with respect to rules and regulations. Particular attention shall be given to means of disposing empty paint containers and excess paint. Paint containing lead must not be used under any circumstances.

12.4 The Paint System

The contractor shall submit proposal for the paint system to be applied in the project from a single source whenever possible unless otherwise approved by the engineer. The system shall be specially intended for application to that particular surface and shall generally consist of primer, filler and two finishing coats unless otherwise specified. The system shall detail areas of application of the paint and the recommended coatings required for each of these areas. The system shall be submitted with all necessary documents such as certificates, test results, track records, technical data, quality manual, ... etc. The paint system shall follow the following requirements:

- 1- External Walls Paint System: The external paint system shall provide an approved texture that will adequately cover plaster undulations. The paint system shall be water based, alkali resistant and shall have an anti-carbonation property. The paint, when tested in an international accredited, approved and recognized firm shall provide an effective anti-carbonation property, particularly when tested for carbon dioxide diffusion and moisture vapor transmission. The system shall contain a binder of a pure acrylic and when top coats are tested on a washability apparatus to BS 7719, it shall resist 3000 scrubs. Primer coats if tested for washability to BS on a washability apparatus to BS7719 shall resist 500 scrubs. The top coat opacity shall be 94% (minimum) when tested to BS3900. In case of apartment buildings six story and more, the external paint system shall follow clause 12.5
- 2-
- 3- Internal Walls Paint System: Internal walls paint system shall be water based, alkali resistant and shall give after application a matt finish unless otherwise specified. The paint shall comply with the requirements of BS7719-1994. The binder used in the paint shall be an acrylic or acrylic modified binder. Top coats when tested for washability to BS7719 the paint system top coats shall withstand



3000 scrubs. However, primers shall resist at least 500 scrubs. The top coat opacity shall be 94% (minimum) when tested to BS3900.

- 4- Internal wall paint system for wet areas: Paint for wet areas shall be specifically intended for these areas. The paint finish shall be, unless otherwise specified, semi-gloss with a reading of 20 to 50 when tested to BS3900. The paint system shall be alkali resistant, water based and shall use an acrylic binder. When tested for washability to BS7719, the paint system top coats shall withstand 3000 scrubs. However, primers shall resist at least 500 scrubs. The topcoat opacity shall be 94% (minimum) when tested to BS 3900.
- 5- Paint system for wooden surfaces: Wherever wooden elements are in direct contact with concrete or masonry, an approved wood preservative shall be applied. The wood preservative shall have an anti fungus property. Whenever knotting is required, it shall comply with the requirements of BS1336. The applied paint system shall then follow the following requirements:
 - a- Painted surfaces: The proposed system shall be acrylic water based except the primer and the undercoat, which shall be alkyd solvent based complying with the requirements of BS5358. The finished painted surface shall be semi-gloss unless otherwise approved by the engineer. The gloss reading for the top coat in case of semi gloss shall be 20 to 50 when tested in accordance to BS3900. When tested on a washability apparatus to BS7719, the paint system top coats shall withstand 3000 scrubs
 - b- Exterior/Interior wooden surfaces (Polyurethane system): The proposed system shall consist of a minimum of two coats of wood protection stain and two coats of PU sealer. The top coat shall be polyurethane clear minimum one coat. The finished coated surface shall yield to an approved shade and color. The overall system shall give an adequate resistance to weather conditions especially when applied externally and shall meet the requirements of BS6952.
 - c- Exterior/ Interior wooden surfaces (Nitrocellulose system) wood stain may be applied to achieve the required color. The proposed system shall consist of a minimum two coats of NC sealer. The top coat shall be NC clear minimum one coat. The overall system shall meet the requirements of BS 6952.



6- Paint on metal surfaces: The paint system shall generally follow the guidelines of BS EN ISO 12944:1998. For general internal housing applications, the paint system on metal surfaces shall follow the following requirements:

	Ferrous	Galvanized
Short	One coat of alkyd zinc phosphate primer, one coat of alkyd undercoat, two coats alkyd paint, DFT=120 mic.	One coat wash primer, one coat of zinc phosphate alkyd primer, two coats alkyd paint, DFT=100 mic.
Medium	One coat epoxy based primer, two coats of epoxy based undercoat pigmented with zinc phosphate and two coats of epoxy top coat, DFT=350 mic.	One coat epoxy zinc phosphate based primer, two coats of epoxy based undercoat and two coats epoxy top coat, DFT=300 mic.
Long	One coat epoxy based primer, two coats of epoxy based undercoat pigmented with zinc phosphate and two coats of polyurethane top coat, DFT=400 mic.	One coat epoxy zinc rich primer, two coats of epoxy based undercoat and two coats polyurethane top coat, DFT=350 mic

The alkyd-based primer, under coats and top coats shall contain not less than 50% solids by volume.

The applied coating system will mainly depend on the usage and location of the metal or as indicated on the drawings. Generally, metal located internally will fall under the short category and metal located externally will fall under the medium category.



12.5 External Walls Paint System for Apartment Buildings (6 story +)

The external paint system shall provide an approved texture that will adequately cover plaster undulations. The paint system shall be alkali, weather and ultraviolet light resistant. Notwithstanding clause 12.1.f, the whole system shall be guaranteed by both, the contractor and the paint supplier, jointly and severally, for a minimum period of ten years starting from the date of the practical completion certificate against any deterioration, cracking, discoloration, blistering, roller marks and any other paint defect. The system shall consist of a minimum of four coats as described below:

- a- One coat of water based acrylic primer. When tested on a washability apparatus to BS 7719, it shall resist 500 scrubs minimum.
- b- One coat of fine textured acrylic water based intermediate paint. This paint, when tested in an international accredited and approved firm shall provide an effective anti-carbonation property, particularly when tested for carbon dioxide diffusion and moisture vapor transmission. When tested on a washability apparatus to BS 7719, the paint film shall resist 3000 scrubs.
- c- Two coats of two pack polyurethane, solvent- based paint

The total paint system opacity shall be 94% (minimum) when tested to BS3900.

12.6 Paint Colors

Colors applied shall comply with BS4800.

12.7 Paint consumption

Along with the system submission, the contractor shall submit a list of theoretical quantities required from each type of the paint. This list shall be endorsed by the paint manufacturer / supplier.



The contractor shall then maintain documents as a proof of paint quantities consumed on site. The paint manufacturer / supplier must maintain regular records for paint quantities supplied to each site for MOH verification.

12.8 Stopping

Stopping shall be as follows:

- a. Stopping for plasterwork shall be an approved plaster or plastic based filler.
- b. Stopping for woodwork shall be a composition of white lead, whiting and gold size reduced if necessary to knifing consistency with white spirit or turpentine or an approved proprietary filler.
- c. Stopping for clear finished woodwork shall be as last but tinted to match the surrounding timber.

12.9 Bituminous Paint

Black bituminous paint shall comply with B.S 3416 Type 1 for general use.

All bituminous paint used for coating blockwork and concrete below ground shall be solvent based, reinforced with inert mineral fibres and applied in 2 coats to a minimum total film thickness of 1000 microns.

12.10 Sundries

- a. Turpentine shall comply with B.S. 244 and 270.
- b. White Spirit shall comply with B.S. 245

WORKMANSHIP

12.11 Acceptance of Surfaces



- a. Before proceeding with the application of Painting and Decorating, the Contractor shall inspect all surfaces and determine that they are in proper condition to receive decoration.
- b. The starting of painting operations will be construed as acceptance of such surfaces as being satisfactory, and any defects in work resulting from such accepted surfaces shall be corrected by the Contractor.
- c. All spaces shall be swept clean and all surfaces dried before painting is started. All dust, dirt, plaster, grease and other extraneous matter affecting the finish of work shall be removed. Foreign matter on surfaces shall be removed.

12.12 Preparation of Surfaces

- a. Paint and paint related activities shall be applied when the room temperature is within the manufacturer allowable limit.
- b. Woodwork shall be cleaned down to remove dirt, grease etc. rubbed down or scraped smooth and dusted off before painting.

Knots and resinous areas shall be coated with knotting compound and allowed to harden before priming. When the primer is hard all cracks, nail holes, open joints and other imperfections shall be made good with stopping. When this stopping is hard the surfaces shall be rubbed down overall and all dust removed.

- c. Priming paint on joinery shall be applied on site. All items fabricated off site shall be primed in the factory. All woodwork shall be primed all round before fixing. Items of carpentry work, such as ends of roof timbers, which are to be built into walls shall first be treated with creosote in accordance to BS 144.
- d. Plaster or mortar splashes and the like on plastered, rendered, concrete blocks and brick surfaces to be painted, shall carefully be removed by scraping or by the use of dilute hydrochloric acid. Holes and cracks etc. shall be stopped and allowed to dry out thoroughly and all surfaces cleaned down to remove dust and loose materials.

In addition all traces of mould oil shall be removed from concrete surfaces by scrubbing with sweet water and detergent and rinsing with



clean sweet water. Any efflorescence shall be removed by wiping first with a dry, coarse cloth and then with a damp cloth, the surface then being left for forty-eight hours to see if the salts re-appear; painting should not be attempted until efflorescence has ceased. Oil paint on plastered or rendered surface will not be allowed unless the plaster or rendering has dried out. All surfaces shall be treated with a coat of alkali-resisting priming paint, which shall be applied by brush and allowed a minimum period of twenty-four hours in which to harden thoroughly and a period of at least 24 hours or longer if necessary, shall be allowed between subsequent coats.

- e. Galvanized and zinc surfaces shall be cleaned to remove grease and dirt before priming. Where rusting has occurred through damage to the galvanizing, such dust shall be removed by wire brushing back to clean metal and the galvanizing made good with a rust-inhibiting agent. The surface shall then be treated in accordance with clause 12.4.
- f. Primed metal surfaces shall be examined to ascertain that the priming paint is hard, firmly adhering and in good condition. If not satisfactory the priming paint shall be removed and the surfaces cleaned to remove rust. The surface shall then be re-primed. If the condition of the priming paint is satisfactory, the surfaces shall be cleaned to remove grease and dirt, minor damage to the priming paint being made good with a compatible priming paint after removal of rust.
- g. Unprimed and ungalvanised surfaces shall be cleaned to remove grease and dirt, and wire-brushed, grit-blasted and scraped to remove all rust and scale before applying the approved painting system.
- h. Priming paint shall be brushed well into the surface and shall be allowed to dry and harden thoroughly before the application of subsequent coats.
- j. Copper pipework shall have the surfaces slightly abraded with glasspaper and white spirit or similar solvent and wiped clean. No priming paint will be necessary, the surfaces being finished with two coats of gloss paint.
- k. All scratches, cuts, cracks and abrasions in cement plaster surfaces shall be cut out as required, then filled with approved patching cement or plastic based filler flush with adjoining surfaces and when dry shall be sanded and sealed before application of priming coat.



1. The Contractor shall touch-up-finished coats of factory finished items that become damaged before completion of the building. Sand damaged areas smooth and apply specified primer before applying finishing coat. Where spot touch-up cannot be done neatly and blended smooth with the finish material, repaint the entire surface or panel as approved by the Engineer.

12.13 **Quality of Work**

- a. All painting and finishing shall be carefully done and left perfect. No paint spots shall be left on glass, hardware or other finished work. Skilled tradesmen shall apply all materials and all paint shall be evenly spread and thoroughly brushed out. Finished surfaces shall be uniform in gloss, finish and color and shall be free from brush marks. The applicator shall properly prepare all surfaces before painting by cutting, stopping, filling etc., to ensure a smooth and uniform surface.
- b. All cutting to line and all lines of demarcation between paints of different colors or shades shall be carefully drawn so as to be true and free from blurred edges.
- c. No claim concerning the unsuitability of any material specified or ability to produce first class work with same shall be entertained after the contract is signed.
- d. Before application, materials in containers shall be thoroughly stirred, unless otherwise directed by the manufacturer of the paint used, to ensure uniformity of color and mass, and all paint skins and other material that would cause lumps and roughness shall be strained out. Materials shall be applied without the addition of any ingredients and without reducing or thinning except as recommended by the manufacturer, subject to the approval of the Engineer.
- e. The finishing coat of paint to walls and ceilings shall be applied after the completion and testing of the electrical installation. Any paint splashed on the electrical fittings, switches, sockets, outlets etc. shall be carefully cleaned off.



- f. Every possible precaution shall be taken to keep down dust before and during painting processes. No paint shall be applied to surfaces structurally or superficially damp and all surfaces must be ascertained to be free from condensation, efflorescence etc., before the application of each coat.
- g. Primed or undercoated woodwork and metalwork should not be left in an exposed or unsuitable situation for any undue period before completing the painting process. No exterior or exposed painting shall be carried out under adverse weather conditions such as rain, extreme humidity, dust storms etc.
- h. Metal fittings such as ironmongery etc., not required to be painted shall first be fitted and then removed before the preparatory processes are commenced. When all painting is completed the fittings shall be cleaned and re-fixed in position.
- j. The Contractor will be required to repaint at his own expense any work on which the paint is found to be incorrectly applied. The Contractor shall be responsible for protecting from damage the paint work and all other work during and after the painting operations including the provision of all necessary dust sheets, covers etc.
- k. Each succeeding coat of priming and undercoating paint shall be sufficiently different in color to be readily distinguishable.
- l. Brushes, pails, paint pots etc., used in carrying out the work shall be clean and free from foreign matter. They shall be thoroughly cleaned before being used for different types or classes of materials.
- m. The use of kerosene (paraffin) in painting work is FORBIDDEN and the Contractor must prevent its use by workmen as thinners or for cleaning brushes etc.. All paintwork that is contaminated by kerosene will be rejected and must be removed and repainted according to the Specification.
- n. Primers shall be applied by brush or roller. Each coat of paint shall be allowed to harden before the next is applied. The work shall be well rubbed down between each coat and cleaned off. No priming coats shall be applied until surfaces have been inspected and the preparatory work approved in writing by the Engineer. No undercoats or finishing



coats shall be applied until the previous coat has been similarly inspected and approved.

- o. Remove blisters or other imperfections in previous coats caused by foreign substances or paint skins from all painted surfaces before the subsequent coat is applied. All wood and metal surfaces shall be rubbed down before finishing between coats with fine sandpaper or steel-wool, leaving a perfectly cleaned surface. Smooth finished surfaces shall be sanded before finishing and between coats as required to smooth out rough areas and to assure smooth, even finish. All surfaces to receive paint shall be smooth and free of all sandpaper scratches, mill marks and other imperfections, and except for coats applied in shop, shall be inspected and approved in writing by the Engineer before application of prime and finish coats.
- p. All hidden stained and natural finished woodwork shall be back sealed with one coat of approved clear sealer finish. All hidden exterior painted woodwork shall be back painted with one coat of approved house paint primer. All hidden interior painted woodwork shall be back painted with one coat of approved interior trim primer. Paint or seal edges of fixtures, equipment and other material where they present an unfinished appearance.

12.14 Samples

The Contractor is deemed to have allowed in his prices for preparing under the direction of the Engineer sample areas of every type and preparation treatment, paint surface and color, all of which are to remain as a standard of quality and workmanship.

12.15 Protection

- a. Furnish and lay suitable drop cloths in all areas where painting is being done to protect floors and all other surfaces from damage during work.
- b. In no case attempt to paint around finished hardware or other items that are already fitted in place without removing or proper protection and masking as may be applicable.



- c. At completion of work in each area, remove all paint spots, oil, and stain from all surfaces, including ironmongery.
- d. Adequate care shall be taken to protect surfaces while still wet by the use of screens and 'wet paint' signs in both English and Arabic where necessary.

12.16 Re-painting Existing Surfaces

- a- **Surface preparation** : exiting surface must be thoroughly cleaned. Surface cleaning shall be done manually and if required, particularly externally, by high-pressure water getting to remove chalk and ensure filly clean surface. If the paint starts to peel off due to the high pressure of water, the peeling paint shall be removed mechanically and the water jetting shall be repeated.
- b- **Paint Removal:** Existing paint, particularly peeling, flaky, chalky, crazing, ... etc. shall be thoroughly removed to the highest possible extent. The contractor shall allow in his prices to remove the paint mechanically by means of scrubbers, wire brushes operated manually or mechanically and Chemically by means of paint removers only if the paint remover does not contain hazardous materials that will affect subsequent coats and only if accepted by the paint manufacturer and approved by the Engineer. Machines causing excessive noise shall not be used unless otherwise approved by the engineer.
- c- **Walls' attacked by Fungus:** the wall shall be thoroughly removed and cleaned. Anti fungus solutions may be used.
- d- Prior to paint application, the manufacturer shall visit the site and submit a written acceptance for the condition of the surface expressing his complete satisfaction with the surface preparation standard. The provided surface must be even and leveled to eliminate any distinction between old and new paint.
- e- **Paint application:** Paint application must be made in accordance with the manufacturer recommendations.



- f- The external paint system shall provide an approved texture that will adequately cover plaster undulations. The paint system shall consist of :
1. A solvent based penetrating sealer that has high capability of penetrating into the repainted surface. This penetrating sealer shall be compatible with the subsequent coat.
 2. At least two coats of a water based, alkali resistant and shall have an anti-carbonation property. The paint, when tested in an international accredited, approved and recognized firm shall provide an effective anti-carbonation property, particularly when tested for carbon dioxide diffusion and moisture vapor Transmission . The system shall contain a binder of a pure acrylic and when top coats are tested on a washability apparatus to BS 7719, it shall resist 3000 scrubs. The top coat opacity shall be 94% (minimum) when tested to BS3900.



SECTION 13

SEWERS

13.1 Quality Control

All materials used in the system shall be manufactured by a factory possessing an established and approved quality assurance / quality control scheme complying with the requirements ISO9000 standard. However, local manufacturers' products must be continuously tested for compliance with the relevant standard at an approved independent laboratory. The local manufacturer shall have a satisfactory, functioning and fully documented quality assurance procedure. Access for MOH engineer must be granted to the factory to ensure presence of such system.

All products manufactured internationally must possess third party certification for compliance of the product to the manufacturing standard. Third party marking and product certification (such as the BSI kite mark), must be presented for the Engineer's approval.

Unless otherwise specifically stated all pipes and fittings shall be marked with the proper identification as per the relevant standard. The products manufactured in countries other than local should carry a third party quality mark.

A full range of samples shall be submitted for the approval of the Engineer. The catalogues and product technical data shall be submitted along with the material approval certificate.

13.2 Unplasticised PVC Pipes and Fittings:

The drainage pipes and fittings shall be brown in colour manufactured from UPVC confirming to BS 4660. The pipes fixing shall have elastomeric sealing rings which comply with BS 2492. The lubricating grease used in jointing pipes and fittings shall be non toxic.



13.3 Vitrified Clay Pipes and Fittings.

Pipes

Vitrified clay pipes shall be plain ended pipes conforming to EN 295. Pipes shall be fully glazed both internally and externally. When tested according to EN 295: Part 3, the crushing strength of the pipe shall not be less than 34 kN/m.

Fittings

Fittings shall also be fully vitrified fully glazed both inside and outside. The fittings shall be sleeve coupling type with ring seal joints. The sealing ring element material shall be as per clause 3 of EN 295. The fittings shall correspond in all respects with the dimensions specified for pipe of the corresponding size.

Markings

Each length of pipe and each fitting shall be marked with relevant international standard number, manufacture's identification, nominal size, and crushing strength in KN/m. Also they shall be marked with the identification mark of the third party certification body.

13.4 Concrete

Concrete used in sewerage work shall be as described in Section 3 of this Specification.

13.5 Inspection Chambers

Inspection chambers shall be circular made of polypropylene and consisting of base and risers fitted on top of each other to suit levels. The chamber shall comply with the requirements of BS7158 and BS8301. The depth of the chamber shall not exceed 1.0 meter to invert unless otherwise permitted by the engineer. The chamber shall incorporate sealing rings to BS 2494. The inlets and outlets shall be suitable for use with 110mm diameter UPVC pipes or 100mm diameter sleeve jointed vitrified clay pipes.



13.6 Inspection Chamber Covers

Inspection chamber cover and frame shall be cast iron complying with EN124 and as detailed on the drawings or plastic frame and cast iron cover as supplied with the preformed inspection chamber

WORKMANSHIP

13.7 Generally

- a. The Contractor shall check any levels of existing sewers, and manholes before any sewerage work is commenced and shall notify the Engineer immediately if the declared levels prove to be inaccurate.
- b. The bottoms of all excavations shall be trimmed and consolidated to the correct levels. Unauthorized excavations below the required levels shall be filled with concrete of the same composition as for sewer beds or approved sand at the Contractor's expense. Where the bottom is insufficiently firm the Contractor shall excavate until, in the Engineer's opinion, a firm bottom is obtained and the level shall be made up with concrete of the same composition as for sewer beds. Care shall be taken not to undermine the foundations of buildings and, if so directed by the Engineer, earthwork support shall be left in or other means adopted to protect the foundations. Particulars of such additional work shall be agreed with the Engineer before the work is covered up, otherwise no claim in this respect will be entertained.
- c. Sewers shall be laid truly straight and to line and gradient as detailed on the drawings and the full bore shall be unobstructed.
- d. All sewers passing through walls or foundations shall have sleeves of sufficient size to allow a clearance round the sewer, packed with polystyrene as detailed on the drawings.
- e. Suitable plugs shall be provided and maintained in all open ends of the pipelines so as to exclude silt and deleterious matter until the pipelines are commissioned. The pipelines will be inspected before commissioning and, if required by the Engineer, shall be cleaned in whole or in part.



13.8 Pipe Bedding and Trench Fill Material

a. **Type `A` Bedding**

Shall be well graded broken stone or gravel material passing a 20 mm sieve and retained on a 2 mm sieve. Under wet conditions, to prevent the intrusion of fine grained soils such as clays, silts or fine sands into the bedding, the stone or gravel shall be thoroughly mixed with a free draining course sand in the proportion of 1:1. Sands containing an excess of fine particles shall not be used. The mixed material shall be well graded.

For PVC pipes the use of sharp edged stones which could cause damage to the pipes shall be avoided.

b. **Type `B` Selected Fill**

Shall be uniform readily compatible material free from tree roots, vegetable matter, building rubbish, etc. and excluding clay lumps retained on a 25 mm sieve.

c. **General**

The granular bedding and fill shall be carried out to the depths and positions as shown on the drawings.

13.9 Concrete Beds and Surrounds

Concrete beds for sewers shall be used if there is less than 600 mm cover to the pipe and shall be a minimum of 150 mm thick surround to the pipes and finished to the correct gradients. After testing, the sewers shall be hunched up on both sides in concrete to half the diameter of the pipe or shall be surrounded with concrete 150 mm thick as detailed on the drawings.



13.10 **Backfilling of Trench Excavation**

- a. After the pipe laying, granular surrounds and concrete work have been completed and the Engineer's approval has been obtained back-filling shall commence. This material shall be rammed manually to the satisfaction of the Engineer and in such a way that the pipework and any concrete protection is not damaged or displaced. The remainder of the trench shall be backfilled with suitable material in layers not exceeding 150 mm thick and compacted with mechanical rammers all to the satisfaction of the Engineer and to achieve a compaction of at least 95% of the maximum dry density at once as determined by BS. 1377 Test 13 or 14.
- b. Each layer shall extend over the whole width and length of the excavation before the next layer is spread and compacted. The Contractor shall be responsible for any subsidence, which may appear during the Defects Liability Period. No work shall be subject to traffic loads without the prior permission of the Engineer.
- c. Trenches adjacent to foundations are to be backfilled with concrete as detailed on the drawings.

13.11 **Inspection Chambers**

Inspection Chambers are to be constructed in accordance with the drawings.

13.12 **Testing**

- a. All sewers must be tested in accordance with the appropriate BS by means of an air test and by a water test should the air test not be passed.
- b. Inspection Chambers must be tested by an internal hydrostatic test.
- c. All sewer lines are to be flushed clean.



SECTION 14

EXTERNAL WORKS

14.1 Generally

The description of materials and workmanship given elsewhere shall apply equally to this section.

14.2 Precast Concrete paving slabs

- a. Precast concrete paving slabs shall be hydraulically pressed and shall comply With BS7263 and sections two, four and five of CP 116 except as amended herein.
- b. Slabs shall be 50mm thick size 600 x 600mm.
- c. Precast concrete slabs shall be laid on 75mm sand bed (Class 4 fill) on a hardcore (Class 7 fill) sub-base at least 150mm thick.
- d. Slabs shall be laid to the required falls and cross falls and bedded on 50mm thick sand (Class 4 fill)

14.3 Precast Concrete Block Paving

14.3.1 Paving Blocks

Paving Blocks shall be in accordance with BS 6717 except as amended herein. Paving blocks shall be rectangular; nominal dimensions 200 x 100mm. Paving blocks shall be 80mm, 60mm and 50mm thick (refer to the drawings for specific block thickness) and shall have a 10 minute water absorption of less than 3.2%.

All paving blocks shall have chamfered edges (5mm chamfer).

a. **Cement Aggregate and Water**

As specified in Section 3 Concrete Work.



b. **Pigments**

Any pigments shall comply with BS 1014.

c. **Cement Content**

The cement content of the compacted concrete shall be not be less than 380 kg/m^3 .

d. **Dimensions**

The length and width of all paving blocks shall be within +/- 2mm of the nominal specified dimension. The thickness of all paving blocks shall be within +/- 3mm of the nominal specified thickness.

e. **Compressive Strength**

The specified characteristic strength shall be 45 N/mm^2 .

The Compressive strength of paving blocks shall comply with the following:

- i. The average strength as determined from 16 sample paving blocks shall exceed the specified strength by N/mm^2 .
- ii. The strength determined from any single sample paving block test result shall not be less than 40 N/mm^2 .

f. **Samples**

Sampling and testing shall be in accordance with BS 6717 Part 1 (1986)

The Contractor shall submit samples of paving blocks for approval by the Engineer. The samples shall represent the size and colour of units being provided. Colour samples shall be provided, including but not limited to the following: Charcoal, grey, red, light brown.



14.3.2 Workmanship

a. **Sand Bedding Course**

Sand, used for bedding and jointing purposes, shall be washed sharp sand to BS 882, 1201 with Zone 2 or 3 grading. The sand shall not contain in excess of 3 % by weight of silt.

The following grading shall be achieved:

<u>BS % Sieve</u>	<u>% Passing</u>
5mm	90 – 100
2.36mm	75 – 100
1.18mm	55 – 90
600 µm	35 – 59
300 µm	8 – 30
150 µm	0 – 10

The bedding course shall be screed to the appropriate level so that its mean thickness after compaction is as stated on the drawings. It shall be spread in one layer making due allowance for the reduction in thickness produced during compaction. To maintain uniformity the sand shall be obtained from single source, allowed to drain before use and sheeted over to minimize moisture changes.

The maximum permitted content of chlorides and sulphates expressed as percentage by weight of dry sand are 0.06% (as acid soluble Cl) and 0.4% (as acid soluble SO₃) respectively.

b. **Laying Paving Blocks**

Refer to the Drawings for specific laying patterns.

Paving blocks shall be laid and placed firmly together to the specified pattern on the screeded bedding layer. Joint widths between blocks shall not exceed 4mm and joint lines shall be straight and square. Laying shall commence from an existing layer face or edge restraint wherever possible.



Full paving blocks shall be laid first, with closures and cutting around obstructions following afterwards. The block-layer shall work from blocks already placed taking care not to disturb them.

Cut paving blocks shall be kept to a minimum. Where cuts are essential, the contractor shall use an approved cutting system.

When laying is complete, the surface course shall be compacted using a mechanical flat-plate vibrator with square plate sufficient to cover at least 12 laid paving blocks. The paving blocks shall be settled into the bedding layer and the bedding compacted by not less than two passes of the plate compactor.

Compaction shall follow as closely as possible after laying the block paving. All paving shall be left compacted at the completion of each day's laying to within one meter of the laying face.

Any blocks damaged during compaction shall be immediately removed and replaced with sound blocks.

c. Joint Filling to Paving Blocks

Sand used for filling joints shall comply with BS 882. It shall be washed sand and shall not contain more than 5% voided shells and free of soft substances or vegetable matter. The maximum permitted concentration of chlorides and sulphates expressed as percentage by weight of dry sand are 0.06% (as acid soluble C1) and 0.4% (as acid soluble SO₃) respectively. The blending of crushed stone fines may be permitted provided that the blended product meets all the requirements for fine aggregate. It shall be graded such that 90% passes a 1.18mm BS 410 test sieve and not more than 10% passes the 75 µm sieve.

As soon as practicable, after the initial compaction of the paving blocks and infilling of closures, sand shall be brushed into the joints by further passes of the compactor. Joints shall be completely filled with sand. Sand shall be left on the paving for 2 weeks to allow joints to be topped up as the sand vibrates down. All excess sand shall be removed and the final surface left tidy prior to completion of the works.



d. Final Surface Tolerances

The final surface of the paving shall be within +/- 5mm of the design level provided that the surface level is at least 5mm above drainage channels or gully entries and continuously graded towards them. The deviation from a 3m straight edge shall not exceed 4mm and the difference in level between adjacent paving blocks or slabs shall not exceed 2mm. Ponding of surface water, as a result of the combination of tolerances, will not be accepted in roadways, road junctions and other paved areas.

List of British Standards Amendments

CLAUSE	CURRENT	AMEMDED
6.1	BS CP 112	BS 5268
6.5	BS 3794	BS EN 438
7.1C	BS 4194	BS 4174
8.22A	CP 305	BS 6465
11.6b	CP 152	BS 6268



SECTION 15

FIRE PROTECTION

General

All standards referred to in this specification are deemed to be the latest publications which include all amendments.

The contractor shall adhere strictly to all standard specifications, codes of practice, building regulations, local authorities rules, ...etc. which are referred to in the contract document. If no standard is specified then the relevant British Standard is deemed to apply. However, where a BS is specified, it shall be a guide line. It is to the engineer discretion to approve materials in accordance with other standards (eg. ASTM, DIN, Australian Standards, etc.) if the quality is equivalent or superior to the BS.

Quality Control

All materials used in the fire protection system shall be manufactured by a factory possessing an established and approved quality assurance / quality control scheme complying with the requirements ISO9000 standard. However, local manufacturers' products must be continuously tested for compliance with the relevant standard at an approved independent laboratory. The local manufacturer shall have a satisfactory, functioning and fully documented quality assurance procedure. Access for MOH engineer must be granted to the factory to ensure presence of such system.

All products manufactured internationally must possess third party certification for compliance of the product to the manufacturing standard. Third party marking and product certification (such as the BSI kite mark), must be presented for the Engineer's approval.

15.1 Fire Alarm System

Fire Alarm Panel

- a. The system shall comply with BS 5839.



- b. The fire alarm panels certified by B.S. 3116 Part IV shall be equipped to the presignal and general alarm circuits and permit the immediate recognition of the zone from where the presignal alarm was released.
- c. They shall be equipped with a control circuit to avoid false alarm due to an interruption in wiring or an accidental earthing in the system.
- d. They shall have a control circuit to indicate when the supply is interrupted. This should be indicated by Optic/Acoustic signals.
- e. The system shall meet the requirement and regulations of the Kingdom of Bahrain and shall be approved by the S.O.

Automatic Temperature Detectors

Automatic temperature detectors shall be differential type with a combination fixed temperature and rate of rise type. The element of the fixed temperature shall be factory set to function at a temperature of 60⁰C. The element of the rate of rise shall be set in the factory to function above the rate of rise of 10⁰C per minute.

Manual Break-Glass

Break-Glass shall be of the metallic type construction and of the manual type with a lever and break glass.

Smoke Detectors

Smoke Detectors shall have a radiation source of Americium 241 with radioactivity less than ONE MICRO CURIE. It shall have a self latching thyristor circuit and RED L.E.D. indication of activated detector. It shall have an operating voltage as 16 – 30 volts D.C. and complying to B.S. 5445.

Signal Bells

The signals bells shall be of the vibrating type with a solenoid and with a diameter of 150mm.



Power Supply

The power supply shall be composed of Nickel Cadmium battery, battery charger and rectifier to be supplied for operation under 240 volts single phase 50Hz.

15.2 Fire Extinguishers

A recessed cabinet containing 1 No. 9 liter water/ CO_2 type fire extinguisher and 1 No. 2 Kg. CO_2 extinguisher should be provided adjacent to, or below the dry riser or wet riser outlet, and shall be of matching appearance and specification.

Additional extinguishers shall be installed where indicated on the Contract Drawings or to meet the civil defense requirements.

Extinguishers shall be sourced from an agent with servicing facilities in Bahrain approved by the Engineers.

15.3 Dry Rising Mains

Dry Riser Inlets

The dry riser shall comprise of a two-way vertical inlet breeching with spring loaded non return valves, blank caps and drain valve. Inlets shall be 2.5 inch instantaneous type, outlet 100 mm flanged. Inlets shall be earthed.

Vertical inlet cabinet(s) with lockable inlets armoured glass shall be provided, construction shall be from 16 SWG steel; sheets with red polyester powder coated finish, all to BS 3980.

Landing Valves

Landing valves (dry riser outlets) shall be gate valves in gun metal with 65 mm female instantaneous outlet fitted with plug and chain. Inlet flanged 65mm diameter. Valves shall be marked with the direction of operation and shall have pressure rating in accordance with the local Fire department.



Valves shall be hand-wheel operated, all in a recessed cabinet with hinged armoured-glass door. Cabinet construction from 16 SWG steel sheet with red polyester powder coat finish.

Dry main riser pipe & fittings

Dry main riser pipes shall 4 inch diameter in heavy grade galvanized mild steel to BS 1387 with screwed galvanized iron fittings to BS 143 or flanged joints to BS 4504. Two instantaneous male inlets to BS 336 for fire bridge shall be provided as described above. Whenever pipes are buried under the ground, approved waterproofing system shall be applied.

15.4 Wet Riser Main

The contractor shall allow for supply, installation, commissioning and maintenance during the defect liability period of wet riser fire mains including the package of pumps and relevant control panel and equipment. The whole set shall be installed in accordance with the local fire department recommendations such as the requirements of pumps output, minimum head, tank capacity, maximum outlet pressure, ... etc). The relevant British standards and the manufacturer's instructions shall also be followed.

The wet riser pumps' system shall maintain sufficient head to maintain the discharge specified in the drawings. The pump set shall be complete with duty / stand-by pumps, water tight tank and pressure switches. The whole unit shall be supplied completely assembled and tested, on a common frame work, with all necessary gate valves, test cocks and non return valves.

Operation of the system

When the system is at rest, it shall be pressurized to the maximum head produced by the pump. This is retained by the jockey pump non return valve and a high pressure vessel. When a landing valve is opened, the pressure in the pipe line will fall quickly and when it is at a certain head (default 1.7 bar at the highest outlet), the selected pump shall start. This should then increase the pressure at the top outlet to the head stated in the drawings. If the selected pump does not achieve this pressure for any reason, then the stand-by pump shall start automatically in not less than 10 seconds from the start time of the first pump. Hunting of the pumps system is not permitted by providing a minimum run time timer. The pump shall continue to run until



all wet riser outlets are closed but not before the minimum run time is achieved (four minutes).

Where a diesel engine driven pump forms part of a set, an additional pressure switch and further contacts on the flow switch provide automatic control, via the D.C. supply from the engine batteries.

Vertical Multi-stage Pumps

The contractor shall install vertical multistage stainless steel pumps. The pumps body, outer sleeve, seal holding disc, shaft, diffusers, and spacers are to be stainless steel AISI304 and impellers to be of stainless steel AISI316L. The pumps motors are to be of the totally enclosed, fan cooled type 3PH/415V/50HZ/2900 RPM and must be rated for continuous operation at 45 deg. C ambient temperature.

Fire Pumps set

The fire pump set shall have two pumps (one duty, one standby) with duties as specified and each set shall comprise:

Two vertical multistage, inline centrifugal type pumps. The pumps shall be of heavy duty construction with stainless steel 304 casing & shaft and stainless steel 316L impellers and with a mechanical, self adjusting, self lubricated shaft seal.

The pumps motors shall be of the totally enclosed, fan cooled type 3PH/415V/50Hz/2900RPM and must be rated for continuous operation at 45 deg. C ambient temperature.

Isolating valves to be provided on the suction and discharge side of each pump and non-return valves to be provided on the discharge side of each pump. A pressure gauge is to be provided on the discharge side. The pumps manufacturer on a common base frame shall preinstall all these accessories along with the suction and discharge manifolds.

The control panel shall be supplied along with the pump set in the same common base frame and shall have the following components: incoming isolator, automatic starters, overload relays, MCB's, Hand-Off-Auto selector switches for each pump, selector switch between two pumps two pumps, delay timer, automatic changeover between two pumps, indication lamps for pumps run, trip, low and high water level alarm. There shall be provisions for wiring from the field devices low & high-level float switches.



The pumps, control panel, suction and discharge manifolds with valves etc. shall be mounted on a common base frame of epoxy coated heavy gauge steel.

Level float switches from water tanks to be interlocked with pumps sets.

Features of Package Wet Riser Pumping Set (Electric Driven)

The following features must be achieved by the pumping arrangement.

- Compact fully automatic pumping system including pipe-work, valves, flow switch and electrical controls.
- Pumps type 'K' providing back pull-out design for ease of maintenance.
- Membrane tank for positive energy source to system when pumps are at rest. Tank also provides a small reserve of water to prevent the too frequent operation of pump in event of a small leak in system.
- Pressure switch and gauge housed in tamper-proof control box.
- Control panel to give adequate and easy access and protection to electrical equipment.
- Valves and test points to meet the local Fire Department Authority requirements.
- Minimal work required to install and commission, i.e. suction and discharge connection and mains electrical supply with neutral and earth.

Landing Valves

Landing valves (wet riser outlets), to BS5041 shall be gate valves in gun metal with 65 mm female instantaneous outlet fitted with plug and chain. Inlet flanged 65mm diameter. Integral pressure regulating valves shall be provided. Valves shall be marked with the direction of operation and shall have pressure raring in accordance with the local Fire department.

Air release Valve

Unless otherwise specified, 25 mm gun metal air release valve shall be provided to vent the wet riser. The valve shall automatically release air when main is being filled with water.



Main wet-riser Pipes & fittings

Wet-riser pipes shall 4 inch diameter in heavy grade galvanized mild steel to BS 1387 with screwed galvanized iron fittings to BS 143 or flanged joints to BS 4504. Whenever pipes are buried under the ground, approved waterproofing system shall be applied.

Fire man Inlet connection (breaching)

The contractor shall install pumping-in breaching for wet riser system as required and indicated in the drawings. Breaching steel cabinet to BS 5041 shall be provided wherever specified. The words “Wet riser inlet” shall be printed in red capitals on the glass panel of the cabinet. The breaching set shall have two, 64 mm male instantaneous inlets, each complete with non return valve, blank cap and chain. Malleable iron body of breaching fitted with 25 mm drain valve and blank cap.

Main Water Storage Tank

Unless otherwise specified, a fully water tight GRP sectional tank to be installed to the size indicated in the drawing. The tank shall meet the requirements of BS7491 and quality control requirements of BS4549 and panel laminate structural requirements of BS4994.

The internal panel surface shall be isophthalic gel-coated to improve resistance to biological growth. The resin shall be approved top grade orthophthalic and pigmented to BS4800 to an approved color and shall resist Ultraviolet attack. Reinforcement glass to be type E glass and to be 40mm minimum. The proportion of resin to glass shall not be less than 30% w/w.

The bracing system shall be designed to maintain the tank structure under fluctuating loads and must not subject the panel to a point load. Internal bracing components shall be grade 18/8 stainless steel to BS970. All external support to be hot dip galvanized to BS729 pt 1 and must not exceed the gross external tank dimensions by more than 50mm

Full height divisions when used shall be supported by the same method as the side walls of the main tank structure and provide leak free compartments (all internal bracing parts to be in stainless steel).

The tank shall be supported in accordance with the tank manufacturer’s recommendations and tolerances.



Connections and provisions to the connections shall be factory fitted in positions as required by the engineer. 600 mm square access for maintenance shall be provided next to the water supply point.

If the tank height is more than 1.8 meters, internal access ladder shall be provided of GRP or stainless steel. External aluminum or MS steel ladder shall be provided if tank height is more than 1.5m

Base support shall be provided in accordance with the manufacturer requirements (wood is not acceptable). Screened overflows, warning pipes and cowl vents shall be fitted with the tank.

Warranty

The full system of pumps shall be warranted for a minimum period of three years from date of issue of the Practical Completion Certificate. However, the GRP sectional tank shall be guaranteed for five years from the date of issue of practical completion certificate.

15.5 Spare Parts

The contractors shall indicate separately price for supply of Spare Parts recommended by Manufacture/Supplier for not less than five years of continues operation, under the local climatic condition.

A fully itemized list of the recommended Spare Parts shall be submitted with the tender documents.

15.6 Identification of Services

All electrical and mechanical services shall be identified as per BS 1710.

15.7 Testing and Commissioning

Testing and Commissioning of all electrical and mechanical services should be carried out in accordance with the relevant British Standards.



15.8 Shop Drawings

The Contractor shall submit in triplicate shop drawings of all installations for Consultant's approval before the commencement of site works. Digital copy of shop drawings shall also be submitted, if required by the Engineers.

15.9 As Built Drawings

As built drawings shall be completed within 15 days after completion of works and before the issue of the substantial completion certificate. Two prints and one set of negative prints of "As Built Drawing" of the completed installation shall be submitted in an approved manner to the Engineer. Digital copy of "As Built Drawings" shall also be submitted within the above period .

Three sets of operation and maintenance manuals of all equipments installed shall also be submitted in an approved manner to the Engineer within the above period.



SECTION 16

Passenger Elevator Specifications

16.1 General

All standards referred to in this clause are deemed to be the latest publications, which include all amendments. The contractor shall adhere strictly to all standard specifications, codes of practice, building regulations, etc. which are referred to in the contract document and relevant to manufacturing, installations and operation of elevators in buildings. If no standard is specified then the relevant British Standard is deemed to apply.

All components of elevators must be manufactured by a factory having a quality management scheme to ISO 9001/2 and **certified by third party**. Wherever applicable, all components installed in the lift must be certified by a third party for compliance to international standards (such as the BSI Kite mark).

The scope of work shall include supply, installation, testing, commissioning and handing over of all elevators in a satisfactory condition. The whole system shall be warranted for the full defect liability period stated in the contract document and this warranty shall allow for parts and labor.

In case there is more than one lift installed in the building, they shall all be from one manufacturer who shall in turn have an approved resident agent in Bahrain. The agent shall be capable of providing a 24-hour service, seven days a week including holidays. The agent shall demonstrate his capability of maintaining such lifts through substantiated submission. Copy of the draft maintenance contract for the lifts shall be submitted for approval.

16.2 Submittals

The contractor shall submit original catalogues and technical details for the evaluation of the submission. The contractor shall, at an early stage of the project, submit all necessary drawings, in particular those requiring structural modifications to accommodate lift services, allowing adequate time for such alterations.



The contractor shall submit, at the time of practical completion, three sets of each of the followings to the Ministry of Housing.

- 1) As-built drawings,
- 2) Operation and maintenance manuals,
- 3) Original catalogue and technical details
- 4) Draft copy of maintenance contract after M.G. period is over.

16.3 Standards

Elevators shall generally comply with the requirements of BS 5655 or any other equivalent standard.

16.4 Safety

The elevator must be equipped with all safety devices in accordance with the Civil Defense Directorate of Ministry of Interior requirements. The elevator must be supplied with battery-operated emergency landing device to take the lift to the nearest floor, and open the doors, in the event of power failure. The lift shall also be fitted with emergency light to operate in this particular event and an overload audio control to notify passengers in case of weight overload.

The lift shall also be supplied with a bell which when operated in case of emergency, shall ring in the building main floor (ground) and the watchman room or the main entrance lobby. A fireman key operated switch shall be installed at the ground floor to override all other controls. The switch shall be installed in the call button face-plate. A key operated emergency switch in the elevator has to be provided for maintenance purpose.

16.5 Lift general details

Generally, Passenger lift speed shall be at least 1 meter per second and lift minimum capacity shall be 6 to 8 passengers (450kg load) except in buildings with 8 floors or more, the lift speed shall be at least 1.6 meter per second and lift minimum capacity shall be at least 10 passengers (800kg load) unless otherwise stated in drawings. The car size, overall travel, lift shaft and lift pit dimensions shall be as indicated in the drawings. However, the following sizes are deemed to be the minimum for the following lift types:



6 Passenger lift	(as per contract drawings)
10 Passenger lift	(as per contract drawings)
Lift clear height is	2.2m

The number of stops and openings shall suit the requirements stated in the drawings.

The lift operation shall be simplex down collective control where there is one lift only and duplex down collective control if there are two lifts side-by-side. The lift shall be electric traction with variable voltage, variable frequency drives. The lift breaking shall be spring activated and direct current electrically released. The breaking system shall be capable of holding 125% of the rated load with normal counterbalancing. The lift shall be supplied with centrifugal, low noise, automatically operated extraction fan. The lift shall be programmable to land in a particular desirable floor when there is no traffic. The lift shall be energy efficient where power shall automatically turn off when not in use.

16.6 Elevator Doors

Unless otherwise specified, elevator doors' finish shall be hairline/ vibration finish, stainless steel grade 304. Door dimensions shall suit openings available in the shaft and shall be at least 800 mm wide and 2000 mm high. The door shall be two panels protected with infra red light curtain with a response time not less than 0.3 second. In addition, lift doors must be supplied with a door closing force limiting switch to operate in case the infra red light fails. All doors must have the facility to operate manually (by key) in case of emergency.

16.7 Machine Room

The machine room shall be directly located above the lift shaft. The room shall be air conditioned with minimum two A/C. When both A/C's in operation, they shall be capable of maintaining a temperature of 26C when the outside ambient temperature is 40C and relative humidity 75%. The room shall be sealed against entry of dust and moisture and shall be provided with a lockable door. The room's door lock shall be manually operated internally and key operated externally. The lift control panel shall be with microprocessors having necessary control devices to protect against sustained under-voltage, over-current, phase reversal, over-load, earth fault, and phase



loss. The electricity supply shall suit requirements. All wiring (in the car and machine room) shall be plug-connected.

Where a machine room-less elevator is specified, the manufacturer recommendations must be followed in this regard. The contractor has to ensure that the lift shaft temperature is controlled to meet the lift manufacturer's requirements and his price shall allow for air-conditioning wherever necessary.

16.8 Operating buttons and indicators

Call buttons shall be stainless steel vandal resistant type fitted in the wall in a flush hairline/ vibration finish stainless steel plate at each floor level. Buttons must be supplied with LED display for signal acknowledgment. Above the door in the jamb, hairline/ vibration finish stainless steel LED indicator panel shall be installed to indicate the lift arrival and direction of travel.

Inside the car, a stainless steel recessed panel shall contain hairline/ vibration finish stainless steel vandal resistant buttons with floor levels and LED display for signal acknowledgment, close door, open door controls, alarm, alphanumeric car position indicator, rocker switch for emergency stop and overload buzzer indicator. The lift car shall also be supplied with intercom and a metal no smoking sign.

All call buttons must be supplied with Braille printing on them and must be fitted on a proper approved height to facilitate handicapped passengers. The lift shall also be supplied with audio floor number call out system in Arabic to indicate the lift location.

16.9 Lift finishes

Unless otherwise stated in the drawings, finishes shall be as follows

- Sills hard Aluminum
- Jamb stainless steel hairline/ vibration finish covering full width of opening



- Call buttons and indicators stainless steel hairline/ vibration finish, vandal resistant with function printed in a groove (Braille)
- Inside walls Hairline/ vibration finish stainless steel with sound insulation and a full height mirror on the rear wall
- Floor Granite as approved by Architect
- Handrail Stainless steel on one side (back)
- Ceiling Vandal resistant metal ceiling with sufficient concealed florescent lighting

16.10 Testing

All lifts shall be tested in accordance with BS5655 part 10. All necessary instruments and materials shall be provided. Testing shall take place prior to handing over and shall be conducted with an approved third party inspection body and shall meet with local authority's requirements.

16.11 Maintenance

The contractor shall allow for carrying out emergency and routine maintenance during the defect liability period in accordance with the manufacturer recommendations. Maintenance shall include 24 hour attendance. The contractor shall also submit on behalf of the lift supplier a proposed maintenance agreement.