



Enabel in Palestine

Annex 3 - Technical Specifications

Public works contract for “the creation of a multipurpose hall at the Ministry of Local Government in Ramallah”

Reference number: PSE22004-10087

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1 General conditions

1.1 General

- TS-1* These specifications are to specify the quality of materials, level of workmanship, and methods to be followed and respected in executing and maintaining

1.2 Drawings

- TS-2* The contractor shall be provided with a list of drawings included in this bid. All expenses burned by the contractor, to execute the conditions included in this section, on the contractor own cost and his unit rates in the bills of quantity shall be deemed to include all costs and expenses.

- TS-3* In case the contractor asks for additional copies of the project drawings.

1.3 Shop drawings

- TS-4* The contractor must prepare shop drawings for all tasks and works and submit them to the Managing Official for approval. The Managing Official has the right to instruct the contractor at any time to submit shop drawings, which the Managing Official consider necessary for executing a certain task. The contractor is to abide by this instruction and don't proceed with the task before the Managing Official approves the shop drawings.

- TS-5* The shop drawings must be fully detailed with a suitable scale and unless otherwise specified be submitted in four copies.

- TS-6* The Managing Official shall within a reasonable time from receiving the shop drawings approve the drawings. If the Managing Official returns the drawings with notes, the contractor shall adjust the drawings as instructed by the Managing Official and resubmit to the Managing Official for approval and he must point out the adjustment made to the first drawing according to the standard procedure.

1.4 As- Built Drawings

The contractor, at his own cost, shall check drawing number as necessary during execution of works. The contractor is required to obtain the Engineers approval on this adjustment. When the contractor hands over the works, he shall prepare a new set of drawings for the project as executed with all adjustments (if any) and submit to the Engineer for approval. When the Engineer approves the As-Built drawings the contractor shall submit one scaled calculation copy and soft copy (AutoCAD) written on it the project name and the phrase "AS-BUILT DRAWINGS".

The final payment to the contractor shall be paid according to the works actually executed as recorded in the AS-BUILT drawings mentioned above.

1.5 Scaffolding

- TS-7* The contractor shall provide, erect and maintain the needed scaffoldings to execute the works of this project. Upon completion the contractor shall remove them. The contractor is to take all the necessary safety measures related to these scaffoldings and repair any damages caused by the scaffoldings to the permanent works during the execution period.

1.6 Protection of works

- TS-8* See 2.17 Organisation of the construction site (Art. 79) of the Tender Specifications document.

1.7 Materials and its equivalent

- TS-9* All materials and goods must be according to technical specification. In no instance will environmentally harmful products, such as asbestos, dangerous wood varnishes, etc. be used.
- TS-10* The contractor is to submit the specification and description of the materials that he intends to supply with all necessary information to the Managing Official to investigate before supplying. These information include, but are not limited to, trade name, manufacturer address and the contractor is to submit samples if asked by the Managing Official.
- TS-11* Wherever a trade name or catalogue number to any material or any item of work in the specification or bills of quantities or drawings, this is necessary to specify the level of specification required. The contractor can suggest alternatives for these materials provided it is with the same level of specification, and to obtain the Managing Officials approval.
- TS-12* When an alternative material, other than mentioned in the contract, is approved and it was not in the same level of specification, the Managing Official has the right to refuse deduction to the unit rate of these materials. No increase to the contractor prices should be made if better materials were provided (compared to the required specification).
- TS-13* Wherever, in the bills of quantity or specification or drawings, a trade name is mentioned or materials known by its manufacturer company or distributing company or catalogue number, it is to be automatically understood that the required is these materials or equivalent even if the phrase “or equivalent” is not mentioned.

1.8 Samples

- TS-14* The contractor must be always ready to submit samples for materials and workmanship according to the Managing Official's instruction. The Managing Official shall test and inspect these samples to determine their compliance with the technical specification and contract documents. The contractor shall execute the works according to the accepted samples and following conditions:

1. The cost of all samples shall be borne by the contractor.
2. The contractor is to submit samples before a reasonable time of starting the work to give the Managing Official time to inspect the samples and make the required tests.
3. The samples shall be submitted with a letter containing all the needed information to obtain the Managing Officials approval.
4. The samples shall be kept at the Managing Officials office in the site.

1.9 Materials' testing

- TS-15* The Managing Official has the right to ask the contractor to accompany the required materials with a testing certificate from the source either from the manufacturer or a laboratory approved by the Managing Official. See also 2.10.3 Implementing documents, 2.13.1 Preliminary technical acceptance (Art. 41 -42) and Acceptance of the works performed (Art. 64-65 and 91-92) of the tender specifications.
- TS-16* The Managing Official has the right to test samples from any material supplied to the site, and whenever needed, either in the lab specified by the Managing Official inside the country or outside. Any materials that don't pass the test shall be rejected.
- TS-17* The contractor is to make for the Managing Official and his assistants all necessary assistance and services to test the materials brought to site and taking samples and checking measurements and weighs and provides on his own expenses whatever need from labor, tools, materials ...etc.

1.10 Temporary offices and warehouses

- TS-18* The contractor must, from the day of the order to start works, bring or build in the site a movable or temporary office for the use of his staff, the supervision staff and the contracting authority when needed. The office shall be in the size suitable for the contractor's needs and requirements and he must obtain the prior approval of the Managing Official on this office.
- TS-19* The warehouses needed for the contractor use sufficient to store all construction materials needed for the project including equipment and tools. These warehouses must have all the conditions required to protect the materials from the environmental conditions.
- TS-20* The contractor shall be responsible to guard and maintain all the above-mentioned temporary constructions that are used by the contractor. He shall also be responsible to provide the required services for these constructions.
- TS-21* The contractor shall bear all the costs of constructing these temporary constructions.

1.11 Removing the temporary constructions

- TS-22* All temporary constructions for the contractor use shall be kept in all times in a good condition until all stages of works are completed and finally handed over. Afterwards, the contractor shall remove all these constructions and its residuals

and cleaning its locations properly so that they leave no trace. If the contractor didn't fulfill this obligation, the Managing Official has the right to execute these tasks on the contractor's account and deduct all the expenses from the contractor's payment and insurance with the Contracting Authority, whatever sum it reach without any legal procedure.

1.12 Temporary and permanent services

- TS-23* The contractor shall, at his own expense, redirect public services if exist (like electricity, water, ...) which he found during work and according to Managing Official's directions and approval. If existing services is connected to or related to or related to the works, the contractor shall maintain and keep in place until handing over the works.
- TS-24* The contractor shall, on his own cost, repair any damages to the public services like telephone, electrical , sewage and water services for the concerned authorities or a third party.
- TS-25* If the concerned authority or the third party decided to repair the damages by itself, or asking any of its representatives to do so, the contractor shall born the cost of these repairs don by the concerned authority or the third party. The Contracting Authority, according to the contract conditions, shall not be responsible for any claims for such actions.

1.13 Contradiction in the Contract Documents

- TS-26* The contract documents complete each other and in case of contradiction or ambiguity in the contract documents the contractor shall raise it to the Contracting Authority's attention. The Contracting Authority shall make the appropriate decision and inform the contractor. In case of contradiction or ambiguity, as mentioned above, the contractor price shall be as recorded in the bills of quantities. In case any material or work needed to execute the works is not mentioned in the bills of quantities, the contractor has to execute these materials or works and their cost shall be deemed to be automatically included in the contractor's price for the related item.

1.14 Site meetings

- TS-27* During executing the works and on a periodical base, site meetings shall be held every 2 weeks or whenever needed for the purposes to coordinate the works and to be sure that it is properly executed according to contract conditions and technical specification. Minutes of the meetings shall be prepared by the Supervision Team or his representative and distributed to all parties and it shall be followed.
- TS-28* The contractor shall present in the meeting detailed of the works intended to be executed in the next two weeks, which shall be discussed and proper instruction shall be given, and these instructions and approval issued in the meeting shall be followed by the contractor.

1.15 Daily reports

- TS-29* The contractor shall submit to the Managing Official (or his representative) a daily report containing the required information on the labor (No.s types & hours), equipment and materials arrived to the site and works executed in that day.

1.16 Photographs of progress of works

- TS-30* The contractor at his own expense shall submit once a month, or as the Managing Officials find suitable, suitable number of colored photographs for the executed works or works under progress as directed by the Managing Official.

1.17 Work Schedule

- TS-31* The contractor shall prepare and submit schedule of the work including all tasks to be performed.
- TS-32* The contractor shall make bi-weekly adjustments to the schedule according to the site conditions and work progress.

1.18 Handing over works and removing residuals

- TS-33* The contractor must hand over all works clean and insure removing all materials or construction residuals or rejected materials or remains in the site in general or in the buildings or nearby. The completion of the works as explained here shall be on the contractor's expense and according to the Managing Official's approval. If the contractor didn't fulfill this obligation, the Managing Official has the right to execute these works on the contractor expense and deduct it from the contractor payments or insurance.

1.19 Measurement of works

- TS-34* The Engineering measurement (international measurements) shall be used for all works; all openings and intersection shall be deducted. Actual net distances shall be calculated but not exceeding the measurement reported in the drawings.

1.20 Codes and standards

- TS-35* All building materials and equipment should be registered with an international recognized norm institution or correspond to an international recognized norm. The standards used shall be DIN, ISO, and B.S..Standard or approved equivalent.

2 Excavation and earthworks

2.1 Datum and nature of excavation

- TS-36* The Contractor shall be responsible for setting up and maintaining a site datum level. 'Zero' datum shall be given on the site by the Managing Official, unless otherwise noted on the Drawings.
- TS-37* Information pertaining to the nature of the ground may be given to the contractor, when available, but without any guarantee of correctness or accuracy.

2.2 Benchmarks

- TS-38* The Contractor shall establish permanent benchmarks determined by an approved land surveyor or professional civil engineer. Maintain all established bounds and benchmarks and replace as directed by the Construction Manager those, which are destroyed or disturbed due to the excavation operations, at no cost to the Contracting Authority.
- TS-39* Each Benchmark (B.M.) or centerline for the building and/or other constructions to be under this contract, shall be properly set out by the Contractor as shown on the Drawings and inspected and approved by the Managing Official prior to commencing excavations.

2.3 Surface levelling

- TS-40* All earth works on Site shall be completed before any fill is deposited. Excavations over areas of Site or filling with approved material shall be carried out where required to the levels shown on the Drawings or to such other levels as may be directed by the Managing Official.

2.4 Size and depth of excavation

- TS-41* Excavation shall be cut to the size of the foundation shown on the Drawings and taken down to the foundation levels shown on the Drawings. If, without the Managing Official's written instructions, the Contractor goes down below the foundation level specified, he shall fill up the part so excavated with concrete of the same type and grade as that required for the piles as defined in Concrete Works and the Bill of Quantities at his own expense.

2.5 Reduced levels

- TS-42* All excavation for reduced levels shall be carried out to the lines and levels shown on the drawings or to such lines and levels as directed by the Design Professional.
- TS-43* If, from any cause whatsoever, excavation are carried out beyond their true line and level other than that directed by the Design Professional, the Trade Contractor shall, at his own cost, make good to the required lines and levels with mass concrete as directed by the Design Professional.

TS-44 All excavations shall be performed so that the works are continually and effectively drained.

2.6 Shoring excavations and dewatering

TS-45 The sides of excavations shall be supported as necessary to maintain a vertical face and/or to prevent caving-in of any nature, especially during subsequent operations. The Contractor shall be responsible for the design, supply, fixing, safety and removal of all planking, strutting and shoring required to the side of the excavation. The Contractor is responsible on the type and nature of soil to be excavated; also he is to use any equipment, including dewatering equipment, to carry out the work required by this Contract.

2.7 Types of excavations

TS-46 Excavations shall be classified according to the nature of the materials to be removed either as excavation in rock or as excavation in earth. Excavation in rock shall be classified as including all excavations in hard and consolidated materials which cannot be removed by normal excavation tools and equipment, and which require drilling or other special means for their removal. All excavation which is not in rock shall be defined as excavation in earth.

2.8 Required bearing capacity

TS-47 The Contractor shall notify the Managing Official and obtain instructions if the required bearing capacity:

1. is obtained at a lesser depth than that shown on the drawings.
2. is not obtained at the depth shown on the drawings.

TS-48 Excavation bottoms are to be approved before new work is laid on them. The Contractor is to inform the Managing Official when excavations are ready for inspection. If, after approval, surfaces become unsuitable due to flooding or other causes, the Contractor shall excavate further, backfill with approved filling material and compact to approval at no extra cost to the Contracting Authority.

TS-49 Should the soil condition, after the Managing Official has been informed the excavations are ready for inspection, be such that the Managing Official deems it necessary to carry out tests, the Contractor shall perform such tests to the satisfaction of the Managing Official. Any expenses incurred in the performance of such tests are deemed to be included by the Contractor in his tender.

2.9 Filling

TS-50 All filling materials shall be approved by the Managing Official before being placed in position. Approved earth, sand, or any other suitable material free from rubbish shall be used to make up levels as shown on the Drawings. The material shall be placed in successive layers each having a finished thickness not exceeding 250mm before compaction, watered and compacted to at least 98% compaction ratio of the

maximum dry density of the Modified Proctor test (ASTM D-1557) prior to the placement of the succeeding layer.

TS-51 Any exposed side or edge of fill shall be properly and evenly graded to a slope as directed or specified. When the required quantities of approved fill are not found on Site the Contractor shall, at his own expense, obtain them from locations approved by the Managing Official.

TS-52 Filling to make up levels under building shall be executed with approved suitable material from existing ground levels up to underside of ground floor slab, and shall be placed in successive layers each having a finished thickness not exceeding 250mm, compacted to at least 98% compaction ratio of the maximum dry density of the Modified Proctor test (ASTM D-1557) prior to the placement of the succeeding layer.

TS-53 The ground surrounding the building and pavements shall be filled with approved material, fine sand and coarse materials, free of foreign materials, debris, clay lumps, organic and vegetation.

2.9.2 Coarse materials

TS-54 Such as sandy gravel, gravelly sand, etc., which is the material retained on sieve no. 4, and consists of crushed rock. It shall be clean, hard, tough and free from deleterious substance.

2.9.3 Fine sand materials

TS-55 Shall consist of that portion of the total aggregate/fines passes no.4 sieve, such as sand, silty sand,...etc.

TS-56 The fill materials shall consists of the combination of coarse and fine sand and conform to the following grading:

Sieve Size	1/ 2 "	3/8"	# 4	# 10	# 30	# 60	# 200
%	90-100	80-90	58-72	42-50	28-38	8-18	2-5
	70-100	60-85	50-75	30-60	20-40	10-25	0-10
Pass	100	90-100	65-85	35-45	20-30	15-30	3-8

TS-57 The fine sand shall conform to the following grading:

Sieve Size	# 4	# 30	# 60	# 200
%	100	80-100	30-50	4-8
	90-100	80-90	20-30	0-10
Pass	100	90-100	40-90	5-15

TS-58 In addition, shall conform to the following physical requirements:

TS-59 Minimum CBR

- 35% Coarse materials, Kurkar
- 25 % Fine sand, Sand

2.10 Disposal of surplus material

- TS-60* All surplus excavated material not used in backfilling or leveling shall be loaded and transported elsewhere on the Site as required by the Managing Official or, if not required on the Site, shall be loaded and carted away from the Site to a dump to be selected by the Contractor and approved by the Municipality at the Contractor's own expense.
- TS-61* All rubbish arising from the Works shall be cleared away and removed from the Site as it accumulates according to the Managing Official's instructions and also on completion of the Works.

3 Concrete work

3.1 General

- TS-62* All materials shall be subject to such tests as the Managing Official may direct and provision for such tests shall be included in the price for such materials inserted in the Bill of Quantities or Schedule of Rates unless otherwise provided for. In case such tests required by the Managing Official, an independent and officially authorized lab shall carry out such tests and sampling.
- TS-63* Properly representative samples of all materials to be used in the works shall be submitted by the Contractor for the Managing Official's approval when required.
- TS-64* Where tests are required by the Managing Official, the Contractor shall take samples and send to a firm experienced in analysis of the material. Reports shall be submitted to the Managing Official. The Contractor shall bear all expenses consequent to the provision, taking and cartage, etc. of samples, in addition to the costs of performing the tests and reporting the results.
- TS-65* The Managing Official reserves the right to reject any material which, in his opinion is objectionable in any respect, notwithstanding its apparent compliance with the relevant Standards. Any such rejected material shall be removed from the site at the Contractor's expense at once.

3.2 Formwork for concrete

- TS-66* The Contractor shall supply, design, erect, strike and remove the formwork and be entirely responsible for its stability and safety so that it will carry the fresh concrete and all incidental loadings and preserve it from damage and distortion during its placing, vibration, ramming, setting and curing. It shall be so constructed as to leave the finished concrete to the dimensions shown on the Drawings and of a material capable of providing the surface finish specified. In any event, the maximum permissible deflection under all loads shall not exceed $1/480$ of the free span according to ACI.
- TS-67* For any kind of concrete works ready mix concrete should be used.

- TS-68* Formwork shall be of timber and / or metal and shall include all temporary concrete moulds and their supports. Bolts to be used for fixing the formwork shall be approved by the Managing Official before starting the work.
- TS-69* For concrete surfaces, which are to remain, exposed wrought formwork shall be used. Wrought formwork shall be of timber or steel framing lined with 12mm thick smooth-faced plywood or an equal lining approved by the Managing Official, or of metal, suitable to obtain a fair face finish on the concrete. All external angles or fair faced in-site concrete shall have chamfers formed with 15x15mm (5/8"x5/8") wrought hardwood angle fillets planted in the angles of the formwork, unless larger chamfers are shown on the drawings.
- TS-70* Formwork ready to receive concrete shall be thoroughly clean and the internal faces properly painted with approved shutter oil or other preparation. Joints shall be tight to prevent leakage.
- TS-71* Wherever required and prior to placing of the reinforcement the internal surfaces of all formwork shall be treated with an approved mould oil.
- TS-72* All formwork shall be inspected and approved by the Managing Official prior to concreting. This approval, however, does not relieve the Contractor of any of his responsibilities.
- TS-73* The striking of all formwork shall be carried out with the greatest of care to avoid damage to concrete.
- TS-74* The formwork to vertical surfaces such as walls, columns and sides of beams may be removed in accordance with the table below although care must be taken to avoid damage to the concrete, especially to arises and features.
- TS-75* Minimum periods in days for striking other formwork should be in accordance with the following table, or as directed by the Managing Official:
- Ordinary Portland cement Concrete Slabs: 3 (Props left under)
 - Beam soffits: 7 (Props left under)
 - Props to slabs: 7
 - Props to beams: 16
 - Vertical surfaces as walls, columns, and sides of beams: 1
- TS-76* Formwork, shuttering, props, or any other means of temporary or semi-permanent support shall not be removed from the concrete until the concrete is sufficiently strong to carry safely the load (dead and temporary).
- TS-77* The Contractor shall inform the Managing Official when he is ready to strike the formwork, or remove any form of Temporary support, and shall obtain his written consent before proceeding.
- TS-78* The times given for the removal of props are based on the assumption that the total live plus dead weight to be supported at the time of removal is not more than one half of the total design load .
- TS-79* For horizontal members where the loading is to be a higher proportion of the total design load these times may need to be increased.
- TS-80* The Contractor shall be responsible for any damage to the concrete work caused by or arising from the removal and striking of the forms and supports any advice, permission or approval by the Managing Official relative to the removal and

striking of forms and supports shall not relieve the Contractor from this responsibility.

TS-81 Any work showing signs of damage through premature loading is to be entirely reconstructed at the Contractor's expense.

TS-82 The Contractor shall confirm positions and details of all

- 1. Permanent fixings**
- 2. Pipes and conduit**
- 3. Holes and chases**

TS-83 To ensure that alterations are not made without the knowledge and approval of the Managing Official.

TS-84 The Contractor shall fix inserts or box out as required to correct positions before placing concrete, and shall form all holes and chases..He shall not cut hardened concrete without approval.

3.2.2 Quality assurance

TS-85 Concrete formwork shall be constructed /erected by the Trade Contractor in accordance with ACI 347 and applicable construction safety regulations at the place of work

3.2.3 Reference standards

TS-86 ACI-347 Recommended Practice for Concrete Formwork

3.3 Reinforcement for concrete

Grade	Minimum Yield Strength
High Yield Steel	414.MPa
Mild Steel	278.MPa

TS-87 Reinforcing Steel: High yield deformed weld able steel bars, BS 4449 and BS 4461.

TS-88 Welded Steel Wire Fabric: .Deformed type, BS. 4493; in flat sheets.

3.3.2 Quality requirements

TS-89 Steel reinforcement shall be hot rolled high strength high bond, Grade 414, complying with requirements of BS 4449, BS. 4461, and BS 8110, deformed bars.

TS-90 Steel fabric mesh shall comply with BS 4483.

TS-91 In case any other type of reinforcement is required, it shall comply with the requirements of the Particular Specification.

TS-92 All reinforcement shall be free from rust and mill scale and any coating such as oil, clay, paint etc which might impair the bond with the concrete.

TS-93 Manufacturer's test certificates for all classes of reinforcement shall be supplied when required..Specimens sufficient for three tensile tests and three cold-bending tests per ten tons of bars or fraction thereof and for each different size of bar shall

be sampled under the supervision of the Managing Official. Testing shall be in accordance with BS 4449 or other approved standard and batches shall be rejected if the average results for each batch are not in accordance with the specification. All tests should be made on the Contractor's expense.

- TS-94* All steel is to be totally free from dirt, paint, loose rust or scale when in position ready for concreting.
- TS-95*
- TS-96* The Contractor shall cut and bend bars to BS 4466 and to schedule provided unless otherwise instructed by the Managing Official.
- TS-97* Straight sections of bars must be kept out of winding. The internal radius of bends shall in no case be less than four times the diameter of the bar, except for stirrups, column binders, and wall shear bars which are to be bent to fit closely around the main bars..
- TS-98* Great care is to be taken to bend stirrups and columns binders separately and to the sizes shown.
- TS-99* All bars will be cut and bent cold using approved machines.
- TS-100* Lengthening of bars by welding, and rebinding of incorrectly bent bars will not be permitted, except where requested by the Managing Official.
- TS-101* The Contractor shall provide on site facilities for hand bending to deal with minor adjustments.
- TS-102* Unless otherwise allowed for in the particular specification splices in reinforcing bars shall be formed by lapping. Such laps in bars in any member shall be staggered. Except as otherwise indicated on the drawings the minimum overlap of lapped splices shall be 50 bar diameters or 400mm whichever is greater.
- TS-103* The steel is to be fixed in position exactly as indicated; taking in to consideration the seismic requirements and the bars are to be securely wired together with 1.6 or 1.4mm soft iron wire or approved spring steel clips wherever necessary to prevent Any displacement during concreting.
- TS-104* Spacers, chairs and the like, temporary or permanent, are to be used as required to ensure that the steel has the exact amount of cover indicated. No permanent spacers may show on a surface where a fair faced concrete finish or a brushed aggregate finish are required. Type of spacers shall be approved by the Managing Official before starting the work.
- TS-105* The placing of all reinforcement will be checked by the Managing Official and in no case is concrete to be poured around any steel that has not been passed by him. The Contractor is to ensure that no steel is displaced from its position during the placement of concrete and until the concrete is set.
- TS-106* The insertion of bars into or removal of bars from concrete already placed will not be permitted. Reinforcement temporarily left projecting from the concrete at the joints shall not be bent without the prior approval of the Managing Official.
- TS-107* Secondary reinforced concrete members for which no reinforcement details are given in the drawings or the Particular Specifications shall have a minimum ratio of reinforcement area to concrete area of 0.33 %.

3.4 Concreting

3.4.1 Cement

- TS-108* The cement used shall be Portland cement conforming in all respects to ASTM Standard Specification C150, type 1, or to BS 12, unless otherwise required, bags shall contain 50kg net + 1%.
- TS-109* If cements other than the above are required they shall be covered fully by the Particular Specification.
- TS-110* The Contractor shall at all times furnish the Manufacturer's statement of the above Standard Specifications together with the date of manufacture, certified by an independent agency in the country of origin approved by the Managing Official.
- TS-111* The cement shall be delivered to the site by the Contractor in the original sealed and branded bags or containers of the manufacturer in batches not exceeding 100 tons and shall be stored in a proper manner off the ground to prevent deterioration. Each batch shall be stacked separately and used in the order of delivery..No cement shall be used which has been manufactured more than twelve months prior to its proposed use on site.
- TS-112* All cements whether stored in bulk, bags, or containers in warehouses or on site shall be sampled for testing according to ASTM C183 (Methods of Sampling Hydraulic Cements). Test samples over and above those specified shall be taken at any time if so requested by the Managing Official. Testing of cement shall be in accordance with the methods required by ASTM C150 and C175 or BS 12 or any other accepted by the Managing Official.

3.4.2 Aggregates

- TS-113* This specification covers fine and coarse aggregates other than lightweight aggregates for use in the production of concrete.
- TS-114* When lightweight aggregates are required they shall be defined in the Particular Specification.
- TS-115* The aggregates shall be crushed gravel or stone and shall comply with BS 882 for graded or single size aggregate and shall be obtained from any quarry in the mountains approved by the Managing Official. For convenience part of Clause 5 of BS 882 (grading) including Tables 1, 2 and 3 are reproduced herein.
- TS-116* Coarse aggregate: the grading of coarse aggregate, when analyzed by the method given for sieve analysis in BS 812 shall be within the limits given in Table 1.
- TS-117* Fine aggregate: the grading of a fine aggregate, when analyzed by the method of sieve analysis described in BS 812, shall be within the limits of one of the grading zones given in Table 2 , except that a total tolerance of up to 5 per cent may be applied to the percentages under-lined. This tolerance may be split up; for example, it could be 1 per cent on each of three sieves and 2 per cent on another, or 4 per cent on one sieve and 1 per cent on another.
- TS-118* The fine aggregate shall be described as fine aggregate of the grading zone into which it falls, e.g. BS 882, Grading Zone 1.

- TS-119* NOTE: It is intended that individual zones should not be specified in contract documents relating to concrete but that the concrete mixes should be modified to make the best use of the materials readily available.
- TS-120* If approved by the Managing Official. Single-sized aggregate to BS 882 Table 1 may only be used for reinforced concrete when combined in two or more sizes to provide a well-graded mixture approved by the Managing Official.
- TS-121* Sampling and testing of aggregates shall be as required by BS 882 and in accordance with BS 812 'Methods for Sampling and Testing of Mineral Aggregates, Sands and Fillers'. All sampling shall be done by or under the supervision of the Managing Official.
- TS-122* The combined percentage of sulphates and chlorides by weight in coarse and fine aggregates shall not exceed 0.05 per cent (500ppm) of the combined weight of total aggregates.
- TS-123* Just before use the aggregate will be washed down with potable water to reduce the content of sulphates, chlorides and other extraneous material

Table 1. Coarse Aggregate

BS 410 Test Sieve	Percentage by weight passing BS sieves							
	Nominal size of Graded aggregate		Nominal size of Single-sized aggregate					
mm	400mm to 5mm	200mm to 5mm	14mm to 5mm	63mm	40mm	20mm	14mm	14mm
75.0	100	--	--	100	--	--	--	--
63.0	--	--	--	85-100	100	--	--	--
37.5	95-100	100	--	0-30	85-100	100	--	--
20.0	35-70	95-100	100	0-5	0-25	85-100	100	--
14.0	--	--	90-100	--	--	0	85-100	100
10.0	10-40	30-60	50-85	--	0-5	0-25	0-50	85-100
5.0	0-5	0-10	0-10	--	--	0-5	0-10	0-25
2.36	--	--	--	--	--	--	--	0-25

Table 2. Table 2: Fine Aggregate

BS 410 Test Sieve	Percentage by weight passing BS sieves			
	Grading Zone 1	Grading Zone 2	Grading Zone 3	Grading Zone 4
mm				
10.00	100	100	100	100
5.00	90-100	90-100	90-100	95-100
2.36	60-95	75-100	85-100	95-100
1.18	30-70	55-90	75-100	90-100

BS 410	Percentage by weight passing BS sieves			
Test Sieve	Grading Zone 1	Grading Zone 2	Grading Zone 3	Grading Zone 4
microns				
600	15-34	35-59	60-79	80-100
300	5-20	8-30	12-40	15-50
150	0-10	0-10	0-10	0-15

3.4.2.2 Handling Aggregates

- TS-124* The choice and preparation of sites for stockpiling of aggregates, the number and sizes of stockpiles and the methods adopted to prevent segregation of component sizes shall be agreed with the Managing Official.
- TS-125* Coarse aggregate shall be stockpiled in three separate gradings: 38-19mm, 19-10mm, and 10-5 mm. When aggregates of different gradings are stockpiled close together the stockpiles shall be separated by bulkheads.
- TS-126* Stockpiles are to be on concrete or other hard surface sufficiently sloped so that water is not retained in the base of the stockpiles.
- TS-127* All aggregates are to be handled from the stockpile in such a manner as to secure a typical grading of the material, care being taken to avoid crushing the aggregates and contamination with extraneous matter.
- TS-128* Aggregates need not be stockpiled when a crushing-screening plant is used in tandem with a batching plant properly equipped with several bins for different sized aggregates having the appropriate weighing scales at such bin such that a mix of the desired gradation is obtained consistently and the whole operation is conducted to the satisfaction of the Managing Official.

3.4.3 Water

- TS-129* Unless otherwise authorized in writing by the Managing Official, only water from potable supply system may be used for mixing concrete and other products containing cement.
- TS-130* Similarly only potable water may be used for curing concrete and cement products during the first 24 hours after pouring. Later, fresh water, or other water containing not more than 4750 ppm dissolved solids of which not more than 1000 ppm may be chlorides, may be used for curing.
- TS-131* No additives of any kind shall be used in the concrete without the express approval in writing of the Managing Official.

3.4.4 Quality of Concrete

- TS-132* Concrete shall be a mixture of cement, aggregates and water as covered respectively by sections above.
- TS-133* Where air-entrainment is required, the method to be used shall be specified in the Particular Specification.

- TS-134* The mix proportions, workability and strengths of the various types of concrete shall conform to the table below.
- TS-135* The terms contained in the table below are defined as follows: water/cement ratio: the term water/cement ratio means the ratio by weight of the water to the cement in the mix, expressed as a decimal fraction. The water is that which is free to combine with the cement in the mix.
- TS-136* This includes free water in the aggregate but excludes water absorbed or to be absorbed by the aggregate. The aggregate for this purpose shall be taken in a saturated surface-dry condition.
- TS-137* The absorption of the aggregates shall be determined in accordance with Section 4 of BS 812 or any other method approved by the Managing Official.
- TS-138* The strengths specified are for ordinary Portland cement to BS 12 or Type 1 Cement to ASTM C150; if other types of cement are specified, the required strength shall be defined in the Particular Specification

Table 3. Mix Proportions, Workability and Strength - Grades of Concrete

Grade	Minimum Works cube Strength ,kg/cm2		Max. Agg , mm	Limits of agg. / Cement ration by weight		Use of concrete if not otherwise specified
	At 7 days	At 28 days		Max.	Min.	
(A)	150	200	20	7:1	5:1	RC structures in general
C-200	150	200	37	8:1	6:1	RC Foundations
(B)	175	250	20	5.5:1	4:1	High load columns
C-250	175	250	37	6.5:1	4.5:1	High load foundations
(C)	200	300	20	5:1	3:1	High load columns
C-300	200	300	37	5:1	3:1	High load foundations
(D)	100	150	20	10:1	8:1	Plain concrete foundations
C-150	100	150	37	10:1	8:1	Blinding layer under RC Found.
(E)	75	100	20	14:0	12:1	Mass lean
C-100	75	100	37	14:1	12:1	Concrete filling

Table 4. Mix Proportions, Workability and Strength - Standard Mixes

Grade of Concrete	Minimum works Cube Strength Kg/cm2	Weight of dry sand per 50 kg of cement	Weight of dry sand per 50 k of cement		Max. design W/C ratio
			Workability		
			20mm max. size	37mm max. size	

	7 days	28 days		Low	Me d.	Hig h	Low	Me d.	Hig h	
			Kg	kg	Kg	kg	kg	kg	kg	
C-200	150	200	91	193	159	136	226	193	170	0.55
C-250	175	250	80	170	136	113	204	170	147	0.50
C-300	200	300	68	147	113	91	170	136	113	0.45

Table 5. Mix Proportions, Workability and Strength - Workability

Degree of Workability	20 mm Max. size aggregate		37 mm Max. size aggregate		Use for Concrete suitable which is
	Slump Mm	Compacting Factor	Slump mm	Compacting Factor	
Low	13-25	0.82-0.88	13-50	0.82-0.88	Simple sections reinforced with vibration
Medium	25-50	0.88-0.94	50-101	0.88-0.94	Heavily reinforced sections with vibration
High	50-127	0.94-0.97	101-117	0.94-0.97	Sections with heavily congested reinforcement where vibration is difficult

TS-139 In case cylinders are used for determination of concrete compressive strength in accordance with ASTM C 39, the corresponding cube strength shall be obtained by using a multiplication factor of 1.2.

TS-140 AGGREGATE/CEMENT RATIO: the term aggregate/cement ratio means the ratio by weight of aggregate to cement in the mix. For this purpose the aggregate is taken in a saturated surface-dry condition as for the water/cement ratio above.

TS-141 FINE/TOTAL AGGREGATE RATIO: the term fine/total aggregate ratio means the ratio by weight of the fine aggregate to The total aggregate in the mix expressed as a percentage. For this purpose the aggregate is also taken in a saturated surface-dry condition as for the water/cement ratio above.

TS-142 VOLUME OF AIR ENTRAINED: the air content expressed as a percentage by volume of concrete shall be determined by ASTM C231, 'Air Content of Freshly Mixed Concrete by the Pressure Method '..At least one test for each 120 cubic meters of concrete shall be made.

TS-143 SLUMP: the slump of the freshly mixed concrete shall be determined in accordance with Part 2 of BS 1881 or ASTM C143. At least one morning and one afternoon test shall be made and whenever directed by the Managing Official.

TS-144 STRENGTH OF CONCRETE: Preliminary Test Cubes shall be taken from the trial mixes designed to select the job mix and shall be made and tested in accordance with Parts 3 and 4 of BS 1881.

TS-145 SAMPLING FOR COMPLIANCE TESTING: Works Test Cubes shall be those used for control during construction and shall be made and tested in accordance with BS 5328 PART 4:1990.

TS-146 Recommended Minimum Rates Sampling

Average Rate Sampling One Sample (6 cubes) per	Maximum quantity of concrete at risk under any one decision
10 m ³ or 10 batches	40 m ³
20 m ³ or 20 batches	80 m ³
50 m ³ or 50 batches	200 m ³

TS-147 The Contractor when tendering having knowledge of the source and types of cement , aggregate , plant and method of placing he intends to use shall allow for the aggregate/cement ratio and water/cement ratio which he considers will achieve the strength requirements specified and will produce a workability which will enable the concrete to be properly compacted to its full depth and finished to the dimensions and within the tolerances shown on the Drawings and required by the Particular Specification . In any event the aggregate/cement ratio and the water/cement ratio shall not exceed the upper limits specified in Table 4 for each type of concrete. Furthermore, the quantity of cement per cubic meter of concrete shall in no case be less than the minimum specified in Table 4.

TS-148 As soon as possible after signature of the Contract, the Contractor shall prepare such trial mixes as required to satisfy the Managing Official that the specified concrete strengths will be obtained using the materials and mix proportions in accordance with the above clauses. The proportion of cement shall be increased if necessary to obtain the strengths required.

TS-149 From each trial mix, six Preliminary Test Cubes shall be made and tested at 7 days and four at 28 days, the test at 7 days being intended to give an early indication of possible variation from the required strength. If the difference between the highest and lowest test results from any one trial mix is more than 15 per cent of the average of the strength test results, the test is to be discarded and a further trial mix made, unless all test results so obtained are above the required strength. Separate trial mixes are required for each type of concrete. The trial mix or mixes agreed by the Managing Official shall be designated job mixes and used as a basis for actual concrete production.

3.4.5 Batching and Mixing of Concrete

TS-150 All concrete shall be batched by weight and mixed mechanically.

TS-151 Concrete may either be batched and mixed on site or outside the site and transported thereto.

TS-152 When mixed outside the site and transported to it, batching and mixing shall be in accordance with ASTM Specification C94, 'Standard Specification for Ready-Mixed Concrete'.

TS-153 When mixed on site, batching and mixing shall be as follows:

- TS-154* **BATCHING BY WEIGHT:** The cement and each size of aggregate shall be measured by weight. The water may be measured by weight or volume. The weight-batching machines used shall be of a type approved by the Managing Official and shall be kept in good condition while in use on the works. Checks are to be made as required by the Managing Official to determine that the weighing devices are registering correctly.
- TS-155* **BATCHING AGGREGATE BY VOLUME:** When batching Aggregates by volume is allowed as and when required, the cement shall be batched by weight and the water by weight or volume. Each size of aggregate shall be measured in metallic containers the depth of which is at least equal to their greatest width. The containers shall be of such shape that their volume can be easily checked by measurement.
- TS-156* **MIXING CONCRETE:** the location of the batching and mixing plant shall be agreed with the Managing Official.
- TS-157* The amount of concrete mixed in any one batch is not to exceed the rated capacity of the mixer .The whole of the batch is to be removed before materials for a fresh batch enter the drum.
- TS-158* On cessation of work, including all stoppages exceeding 20 minutes, the mixers and all handling plant shall be washed with clean mixing water. If old concrete deposits remain in the mixer drum, they shall be rotated with clean aggregate and water prior to production of new concrete.
- TS-159* Concrete mixed as above is not to be modified by the addition of water or in any other manner to facilitate handling or for any other reason

3.4.6 Work in cold or hot weather

- TS-160* Concrete is not to be mixed or placed at a shade air temperature below 2 deg .C on a rising thermometer or at a shade air temperature below 3 deg .C on a falling thermometer.
- TS-161* When the shade air temperature is 37 deg .C and rising, special precautions shall be taken during concreting operations, such as shading of the aggregates and plant, cooling of the mixing water or other methods approved by the Managing Official, so that the temperatures of the concrete when placed shall not be in excess of 39 deg .C.
- TS-162* Fresh concrete placed at these temperatures shall be shaded from the direct rays of the sun to the satisfaction of the Managing Official for a period of at least 24 hours.

3.4.7 Placing

- TS-163* Concrete shall be conveyed from the mixer to its final position in any suitable manner, provided there is no segregation, loss of ingredients or contamination.
- TS-164* It shall be placed in its final position before initial setting takes place and within 20 minutes of the addition of the water to the mixer without using any additives. Water is not allowed, only by the instructions of the Managing Official. In the manufacturer specifications of such additives must be handed over to the Managing Official to be approved before using it.

- TS-165* The order of placing concrete shall be such as to prevent water from collecting at the ends, corners and along the faces of forms. It shall not be placed in large quantities at a given point and allowed to run or be worked over a long distance in the form.
- TS-166* Whenever possible concrete shall be placed and compacted in even layers with each batch adjoining the previous one.
- TS-167* The thickness of the layers shall be between 150 and 300mm for reinforced concrete and up to 450mm for plain (non -reinforced) concrete, the thickness depending on the width of forms, the amount of reinforcement and the need to place .each layer before the previous one stiffens.
- TS-168* Concrete shall not be allowed to drop freely for more than 2 meters. To convey the concrete as near as possible to its final position, drop chutes of rubber or metal shall be used for small sections and bottom dump buckets or other suitable vessels for large sections.
- TS-169* Concrete shall be carefully compacted when placed to ensure a dense and uniform mass free from air holes and cavities. Concrete type "A", "B"& "C" shall be compacted by vibration , whereas type 'D' and 'E' concrete may be vibrated or rammed , tamped and rodded. Vibration shall be performed by mechanical or electro -mechanical vibrators. The vibrators shall be of the plunger (poker) type for insertion in the concrete:.except that plate type vibrators (external) shall be used if requested by the Managing Official.
- TS-170* The plunger (poker) type vibratos shall have a diameter compatible with the lowest spacing of reinforcement, a sufficiently high frequency and be properly handled by experienced personnel.They hall be immersed at regular intervals close enough .to vibrate .all . of the concrete , but not too close to affect previously vibrated and partially set concrete.
- TS-171* Each immersion shall continue until shortly after air bubbles cease to appear on the surface of the concrete but shall not last more than 30 seconds. The vibrators shall be withdrawn gradually and vertically to ensure that no air pockets are formed.
- TS-172* When external vibrators are used As directed by the Managing Official, they shall be clamped to the forms whenever possible to avoid large impact during handling, and the forms shall be so constructed as to withstand the additional vibrations.
- TS-173* All vibrations, compaction and finishing operations shall be completed within 15 minutes from the time of placing the concrete in its final position. Until it has hardened sufficiently to carry weight without distortion, workers shall not be allowed to walk over freshly placed concrete.
- TS-174* Concreting of any one part or section of the work shall be carried out in one continuous operation, and no interruption of concreting work will be allowed without the approval of the Managing Official. Where beams and slabs together form an integral part of the structure they shall be poured in one operation.
- TS-175* A record is to be kept by the Contractor on site of the time and date of placing the concrete in each portion of the works and the number and identification of the Works Test Cubes, corresponding to these portions. Such records are to be handed to the Managing Official weekly during the progress of the work.

- TS-176* If placing of concrete by pumping is required it shall be specified in the Particular Specification.

3.4.8 Admixtures

- TS-177* No admixtures of any type shall be used in the preparation of concrete or concrete products unless so required by the Particular Specification or unless so directed by the Managing Official. In case any such admixtures are used the rates and methods of application shall be strictly in accordance with the manufacturer's instructions which must be approved by the Managing Official before using it.

3.4.9 Curing

- TS-178* Freshly placed concrete shall be protected from rain, dust storms, chemical attack and the harmful effects of heat, wind, flowing water, vibrations and shocks. This protection shall continue until the concrete is sufficiently set such that it is no longer damaged by these factors.
- TS-179* The Managing Official shall determine when the protection is no longer required, but in any case this shall not be less than 24 hours after the time of placing.
- TS-180* Concrete shall be cured for at least seven days and as required by the Managing Official. Curing shall be effected by the direct application of water to the surface of the concrete or by other approved curing methods or curing compounds applied in accordance with the manufacturers specifications. In case the application of such curing compounds is delayed for any reason, the concrete shall be kept moist until the application is made.
- TS-181* Timber formwork covering the concrete shall be moistened with water at frequent intervals to keep it from drying during the curing period. Metal formwork exposed to the sun must be shaded from its direct rays, painted white or otherwise protected during the curing period.

3.5 Formed finishes

3.5.1 Basic finish

- TS-182* General requirements:
1. Produce an even finish with a sheet material.
 2. Arrange panels in a regular pattern
 3. Blowholes not more than about 10mm in diameter will be permitted but otherwise surface is to be free from voids honey combing and other large defects
 4. Variation in colorcolor resulting from the use of an from discoloration due to contamination or grout leakage
- TS-183* The finish will be left as struck, making good or small defects will normally be permitted but only after inspection by the Managing Official. All blowholes shall be filled with a matching mortar to an approved sample unless otherwise instructed by the Managing Official. All faces shall be protected from damage, especially arises.

- TS-184* All faces shall be protected from rust marks and other surface disfigurements. Form tie holes shall be filled with a matching mortar to an approved sample accepted by the Managing Official.

3.5.2 Fair faced finish

- TS-185* Concrete surface which are described as fair face finished shall be finished free from honeycombing and excessive air holes, fines and projections arising from defective mixing, placing of formwork, and shall, if necessary, be filled with mortar and rubbed with fine carborundum stone all works to be approved of Managing Official. The finish shall be integral with the body of the concrete and shall not be obtained by means of an applied rendering.
- TS-186* The quality of the surface of concrete exposed to view shall be smooth and consistent throughout the project and the following methods shall be adopted to obtain the required fancy. The trade Contractor may submit alternative proposals for the approval of the Design Professional if he so desires.
- TS-187* Formwork for fair faced concrete shall be provide with regular joints to achieved the satisfaction on the job finished, be either of steel, fibrous glass reinforced plastic or exterior grade plywood not less than 16mm before placing, pouring the concrete.
- TS-188* All surplus oil on form surface and any oil on reinforcing steel shall be removed.

3.5.2.2 Approval by the Design Professional to Fair Faced Finishes.

- TS-189* The Contractor shall submit for approval of the Managing Official a sample panel not less than 60cm x 120cm to demonstrate the quality of the exposed concrete to be produced by forms, at his own expense.
- TS-190* The quality of the finished work shall be measured against the quality of the approved sample panel and the work of inferior quality shall be repaired or replaced as directed by the Managing Official without any additional cost.
- TS-191* The quality of the finished surfaces shall be of uniform color and consistency throughout the project..Should there by any inconsistency in color or texture in any of the finished surfaces the Managing Official may order the repair or the demolition of a portion of concrete work and its reconstruction at the Trade Contractor's own expense.
- TS-192* Construction Joints, in special cases of weather conditions and if approved by the Managing Official shall be studied in detail ahead of time and the joints shall be grooved in.a predetermined pattern approved by the Managing Official.
- TS-193* General Requirements:
1. Produce a smooth even finish with an impervious sheet metal.
 2. Make panels as large as is practicable and arrange to approval.
 3. Blowhole not more than about 5mm in diameter will be permitted but otherwise surface is to be free from voids, honey combing and other defects.
 4. Variation in color resulting from the use of an impervious form lining will be permitted, but the surface is to be free from discoloration due to contamination or grout leakage.
 5. Concrete cover spacers shall be used only if approved.
 6. Sample on site has to be provided of 1by 2m.

TS-194 The finish is to be left as struck. Making good will not normally be permitted. All form tie holes are to be filled with a matching mortar to an approved sample. Wire form ties shall not be used. With Approval and instruction of the Managing Official for the position of tie holes is to be obtained before use.

3.6 Quality control testing

See also 2.10.3 Implementing documents, 2.13.1 Preliminary technical acceptance (Art. 41 -42) and Acceptance of the works performed (Art. 64-65 and 91-92) of the tender specifications.

TS-195 Prior to commencing the work the contractor shall make available on site the following minimum approved equipment kept in good condition at all times :

- Six Cube moulds.
- Slump cones.
- Thermometer.
- Any other accessories as required by the Managing Official.

TS-196 All samples and testing shall be done in the presence of the Managing Official or his authorised representative either on site or in an approved testing laboratory in the area .

TS-197 The frequency of testing shall be as noted in the clauses of this section and whenever required by the Managing Official.

TS-198 The works Test Cubes shall be made as follows for types of concrete (A), (B), and (C).:

- (a) At least three times weekly per mixing plant.
- (b) At least once for three individual parts of the structure.
- (c) At least once per 100 cubic meters of Concrete .or fraction thereof.

TS-199 For types (D), and (E) concrete the rate shall be once per each 100 cubic meters or fraction thereof.

TS-200 At least six cubes shall be made at one time. Two of the six cubes are to be tested at seven (7) days. The remaining four cubes are to be tested at 28 days, and their average strength must not fall below the minimum strength specified for each type of concrete and the lowest test result shall not be more than 20% below the average of the four cubes.

TS-201 When the result of 7-day test is unsatisfactory, the Contractor may elect to remove and replace the defective concrete without waiting for the 28-day test. If the result of the 28-day test is unsatisfactory all concreting shall be stopped at the Contractors expense and shall not proceed further without the written permission of the Managing Official.

TS-202 The Contractor shall then, in accordance with the instructions of the Managing Official, remove cores and test same or conduct in- situ tests in accordance with CP 144 from or on suspect portions of the works, under the supervision of the Managing Official.

TS-203 Concrete judged by the Managing Official to be defective shall be forthwith cut out , removed and replaced at the Contractors own expense .

- TS-204* In the event of strengths consistently higher than those specified being obtained, a reduction in the number of tests may be authorized by the Managing Official.

3.7 Position of reinforcement

- TS-205* The actual concrete cover to all steel at any point should not be smaller than the required nominal cover by more than 5mm.
- TS-206* The effective depth of fully or nearly fully stressed tensile . reinforcement should not be less than that given on the drawings by an amount exceeding 5 percent.of the effective depth of the section being considered or 5mm whichever .is the greater .

3.8 Ready mixed concrete

- TS-207* Ready-mixed concrete as defined in BS 1926, batched off the site will be used with agreement of the Managing Official and shall comply with all requirements of the Contract . The quality and strength of cements shall be determined by site tests. No test results supplied by Ready-Mix Supplier shall be accepted as proof of the quality and strength of the concrete.
- TS-208* The concrete shall be carried in purpose made agitators operating continuously, or in truck mixers. The concrete shall be compacted and in its final position within 1 hour of the introduction of cement to the aggregate or as agreed by the Managing Official. The time of such introduction shall be recorded on the Delivery Note together with the weight of the constituents of each mix.
- TS-209* When truck mixed concrete is used, water shall be added under supervision either at the site or at the central batching plant as agreed by the Managing Official but in no circumstances shall water be Added in transit.
- TS-210* Unless otherwise agreed by the Managing Official Truck mixer units and their mixing and discharge performance shall comply with the requirements of BS 4251. Mixing shall continue for the number and at the rate of revolutions recommended in accordance with BS 4251 or , in the absence of the manufacturer's instructions, mixing shall continue for not less than 100 revolutions at a rate of not less than 7 revolutions per minute..
- TS-211* Prior to any ready mixed concrete being ordered, the Contractor shall submit to the Managing Official details of the supplier and shall arrange for the Managing Official to inspect the supplier's works if required.
- TS-212* Truck-mixer units shall be maintained and operated strictly in accordance with the manufacturer's recommendations.

4 Natural stone works

4.1 General

TS-213 The stone materials shall be class A and shall be local manufactured and to obtain the following Physical and mechanical properties:

- 1. Absorption: The percentage of absorption shall not exceed 3 % according to ASTM – C97.
- 2. Specific Gravity: Minimum specific Gravity of stone shall be 2.56 according to ASTM-C97.
- 3. Modulus of Rupture: Shall not be less than 6.9 N/mm² according to ASTM-C99.
- 4. Abrasion Resistance: For all stone type shall not be less than 10% according to ASTM-C241.

TS-214 Anchors: Two of each type to be incorporated in the work.

TS-215 **Submit samples of other materials specified herein upon request by the Supervision Consultants or the Managing Official.**

4.1.2 Samples

TS-216 Submit two sets of stone, full size units as selected by the Managing Official to the project site, in sufficient number to indicate the full range of color, texture and finish. One of each of the duplicate samples approved by the Managing Official, The other being returned to the stone supplier for his guidance. Color and type of the stone- dressing are as mentioned above.

TS-217 **The following physical data on proposed stone shall be submitted by the supplier:**

- **Analysis of mineral composition**
- **Analysis of chemical composition**
- **Thermal sufficient of expansion**
- **Absorption**
- **Specific Gravity**
- **Modulus of Rupture**
- **Abrasion Resistance**

TS-218 Samples of other materials specified here in shall be submitted upon request by the Managing Official.

4.1.3 References

TS-219 National Standards referenced her in are included establishing` recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the engineer.

4.2 Mock-up

TS-220 **Furnish and install a typical stone wall, application required for the project at area designated by the Managing Official. The panel shall be constructed for Managing Official's approval showing 2.0m long x 1.5m high for wall installation. Wall installation shall include a corner**

condition indicating a jamb, sill, lintel and coping stones, etc., as shall be instructed by the Managing Official.

TS-221 All work shall include setting and jointing of all stone including final cleaning as specified here in for the actual work and as required for approval Construct as many mock-ups until approval by the Managing Official has obtained.

TS-222 The approved mock-up shall constitute the quality of work to be expected throughout the entire project, and shall remain in place for visual inspection until no longer needed as directed by the Managing Official. The removal and disposition of the mock-ups shall be done by the Contractor at his expense without additional cost to the Contracting Authority.

4.3 Guarantee / warranty

TS-223 Attention is directed to the provisions of the conditions of the contract regarding guarantees / warranties for the work.

TS-224 **All warranties / guarantees to be issued by the Supplier, Manufacturers and sub-contractors shall be counter-signed by Main Contractor and both of them will be liable for repair / replace the items / works, etc., during the warrantee / guarantee period.**

4.4 Standards

TS-225 Applicable provisions of the following standard publications shall apply throughout the work :

- Palestinian General Specifications.
- Jordanian Technical Specifications.
- BS 882 Aggregate for Mortar.
- BS 12 – Portland cement.

4.5 References

TS-226 National standards referenced herein are included to establish recognized quality only. Equivalent quality and testing standards will be acceptable subject to their timely submission, review and acceptance by the Managing Official.

4.6 Qualifications

TS-227 A.Supplier / Fabricator: **A firm having an adequate supply of the specified type of stone and an annual rated production capacity to deliver the stone** to the project site on schedule within a time limit established by the Managing Official, as required, to assure no delay in the progress and completion of the Work.

TS-228 B.Installer: **A qualified stone layer with a minimum of five years successful experience** in the erection of stonework.

4.7 Design criteria

TS-229 The method of erecting, installing and anchoring of **all stone work shown on the Drawings is diagrammatic only**, and is not to be used for the purpose of bidding or construction. It shall be the responsibility of the contractor to design and guarantee the mechanical fixation of the stone to the concrete structure, the permanent anchorage, and the watertight sealing of all stone work. **The installation shall be designed to allow for expansion, contraction and differential deflection of supporting floors of the building structure. All fastenings into stone, such as plates, bolts, anchors, shelf angles, inserts, etc. are to be galvanized steel.**

TS-230 Design and calculations for stone anchor system shall be based on a minimum safety factor of five for aspects related to stone strength and anchor strength in masonry or concrete.

TS-231 Allowable stresses in stainless steel anchor elements shall not exceed the following:

- 1.Tension, bending 0.6 Fy
- 2.Shear 0.4 Fy

TS-232 Anchor stone elements to withstand a total temperature variation of 125 degrees F.

4.8 Delivery, storage & handling

TS-233 Packing and Loading: Finished stone shall be carefully packed and loaded for shipment using all reasonable and customary precautions against damage in transit no material which may cause staining or discoloration shall be used for blocking or packing.

TS-234 Site Storage: Upon receipt at the building site or storage yard, the stone shall be stacked on timber or platforms at least 100mm above the ground, and extreme care shall be taken to prevent staining during storage. If storage is to be for a prolonged period, polyethylene or other suitable plastic film shall be placed between any wood and finished surfaces, and shall be used also as an overall protective covering.

TS-235 **Defective Stone: Any piece of stone showing flaws, cracks, or imperfections such as vents, sand and clay holes, shelly bars, shakes, mottle, seams or starts upon receipt at the storage yard, or at the building site, shall be discarded and removed from the work site, at the contractor's own expense.**

4.9 Environmental requirements

TS-236 The following environmental requirements are applicable to stone set in mortar, and when caulking stone joints with sealant:

- 1. During freezing or near freezing weather provide equipment and cover to maintain a minimum of 4 degrees C and to protect stone work completed or in progress.
- 2. At end of working day, or during rainy weather, cover stone work exposed to weather with waterproof coverings, securely anchored.

- 3. Maintain materials and surrounding air to a minimum 10 degrees C prior to, during and 48 hours after completion of work.

4.10 Products

4.10.1 Stone materials and fabrication

- TS-237* Stone shall be of good quality, sound, free from cracks and defects, seams or starts which may impair its structural integrity, durability, appearance or function. Color, texture and finish shall be within the range of samples approved by the Managing Official.
- TS-238* All stone shall be obtained from quarries having adequate capacity and facility to meet the specified requirements. Cutting and finishing shall be performed by using approved equipment to process the material promptly on order and in strict accordance with the specifications. Evidence to this effect shall be provided by the contractor's.
- TS-239* Stone rejected for noncompliance with the submitted samples or the requirements of this specification shall be replaced with material acceptable to the Managing Official. Replacement shall be prompt and at the Contractor's own expense. Inspection of stone by the Managing Official shall not relieve the contractor of his responsibilities to perform all work in accordance with the Documents.

4.11 Stone schedule

- TS-240* **Refer to the Drawings for locations, sizes and herein. All stone work shall be carried out and executed in accordance with the classifications of class "Special refer to clause 1.06, item A/1. Stone Type Application/ Thickness / Finish**
- TS-241* Application: Exterior and Interior – Special Shapes include, but not limited to:
- Rebated and Splayed sills-Splayed copings with rounded edges – Splayed and mitered copings .
 - Corner stones – Quoins
 - Splayed coping quoins
 - Other, all as shown and / or noted in the drawings and in the Book of Details (Jordanian Code)
- TS-242* Thickness: As noted on the relevant details / drawings.
- TS-243* Finish: Mosamsam, Mattabeh and Tubza dressing, as noted on the drawings and details .

4.12 Stone finish

- TS-244* **The finish of stone shall be according to the drawings that show size, and thickness.** all stone work shall be carried out and executed in accordance with the classification of class (A) according to the Jordanian Specifications.

TS-245 Matabeh finish # 12 will be used for WHITE stone (First Class – Aseera or equivalent) and applied as follows:

- Thickness: 50mm thick.
- Height of courses As shown in drawings.
- Finish: Matabeh dressing without Zamleh.
- Backing: 150mm reinforced concrete.

4.13 Stone fabrication – general:

TS-246 Fabrication of stone shall be in strict accordance with approved shop drawings for fabrication, and with this specification.

TS-247 To the maximum extent possible, fabrication and assembly of stone shall be executed in the shop. Work that is not shop assembled shall be shop fitted.

TS-248 All work shall be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All materials and workmanship shall conform to the highest industry standards.

TS-249 Use no materials, equipment, or practices that may adversely affect the functioning, appearance, or durability of the stone work or work trades.

4.14 Dimensions

TS-250 **Cut all stone work accurately to shape and dimensions shown on the final approved shop drawings. Exposed plans surfaces shall be true. Bed and joint surfaces shall be dressed straight and at right angles to the faces, unless otherwise shown. Exposed arise lines shall be sharp and true. Patching of stone will not be permitted.**

TS-251 **Do all necessary cutting for anchors, support plates, shelf angles, and dowels, etc.**

4.15 Beds and joints

TS-252 Stone beds and joints surfaces shall be cut square from the face for the entire thickness of stones. Stone shall be bedded and jointed including the various expansion joints dimensions as shown on the approved shop drawings.

4.16 Backs of pieces

TS-253 Backs of all pieces of stone receiving no concrete backing shall be sawn to approximately true planes with a maximum variation of 1.5mm in thickness from that indicated on the approved shop drawings.

4.17 Exterior & interior special shapes

TS-254 All specially shaped pieces of stones shall be constant in profile throughout their length, in strict conformity with details shown on approved shop drawings.

4.18 Incidental cutting & drilling

TS-255 Provide holes, grooves, sinkages and recesses, etc., as applicable, for anchors, plates, bolts, shelf anchor supports, inserts, etc., other cutting and drilling shall be provided only when specifically shown on the approved shop drawings.

TS-256 Holes for lifting will not be permitted on any stone element with a thickness of 51mm or less.

TS-257 No cutting or drilling will be permitted on exposed surfaces

4.19 Mortar materials and accessories

4.19.1 Cement

TS-258 Cement for Setting Mortar: Non – Staining Portland Cement conforming to ASTM CI50, Type I except containing not more 0.03% water soluble alkali. **Turkish cement will not be permitted.**

TS-259 Cement for Pointing Mortar: Non-staining white Portland cement conforming to ASTM CI50.

TS-260 Grey nonfattening cement may be used for pointing mortar if the color of pointing mortar, as selected by the Managing Official, does not require white Portland cement.

4.19.2 Water

TS-261 Water shall be potable, clean and fresh from public water system.

4.19.3 Sand

TS-262 Well graded non-staining masonry sand conforming to ASTM C1 44. Use white Silica sand pointing mortar. No other Sand shall be permitted for mortar or grout unless otherwise tested and approved by the Managing Official.

4.19.4 Lime

TS-263 Approved brand of plastic hydrated, such as New England 4x, conforming to ASTM C207, Type "S"

4.19.5 Integral waterproofing

TS-264 Integral liquid waterproofed for concrete and mortar, manufactured by an approved manufacturer and conforming to ASTM C494.

4.19.6 Integral color

TS-265 Super permanent, manufactured by an approved manufacturer and conforming to BS 1014.

4.19.7 Mortar plasticizer

TS-266 As manufactured by an approved manufacturer and conforming to BS 4887.

4.20 Stone anchorage – materials

4.20.1 General

TS-267 **All stone anchorage in contact with stone shall be fabricated from approved galvanized steel.**

4.20.2 Gravity anchors

TS-268 Wherever possible and appropriate stone shall be supported by gravity anchors. The Type location and number of gravity anchors. Shall be determined by calculations, recommended practices of the BST.

4.20.3 Lateral anchors

TS-269 The type, location and number of lateral anchors shall be determined by calculations, applicable codes, and recommended practices of the BSI.

4.20.4 Dovetail anchor slots

TS-270 Fabricate from not less than 6 ga. Galvanized steel. Provide dovetail anchor slots with filler strips

4.20.5 Anchorage tolerances

TS-271 Stone anchors shall be sufficiently adjustable to overcome expected variations in the building frame and in the stone itself, and in both in combination.

4.21 Execution

4.21.1 Conditions at Site

TS-272 **The Contractor shall, prior to proceeding with the stone installation, examine all surfaces and parts of the structure to receive stone work, and notify the Managing Official in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with installation until such conditions have been corrected and are acceptable to the Managing Official.**

TS-273 Verify all measurements and dimensions coordinate the installation of inserts for this work and coordinate and schedule this work with the work of other trades. Give

particular attention to the location and size of cutouts required to accommodate mechanical, electrical, and other work or adjoining construction, in accordance with the reviewed shop drawings for such trade.

4.21.2 Stone installation

TS-274 Anchors, Brackets and Angles: Securely fix in place all supporting anchors, inserts, brackets, angles and other items requiring building into concrete, **provide location drawings in sufficient time so as not to delay job progress.**

TS-275 **Preparation for stone Installation: Clean stone prior to setting, leaving edges and surface free from dirt and foreign material. Do not use wire brushes or implements which mark or damage exposed surfaces, unless otherwise approved by the Managing Official.**

4.21.3 Mortar and Grout Proportioning – By Volume

TS-276 **General Mortar and grout proportioning shall be prepared and tested by the contractor, and in addition the contractor shall allow for preparing and testing the mortar and grout mixes included within this section to meet the Managing Official's satisfaction and approval.**

TS-277 **Setting Mortar for Stone:**

- 1. Portland Cement-.1 .part**
- 2. Hydrated lime-.0-0 .25 .part**
- 3. Sand-.3 .Parts**
- 4. Plasticiser**
- 5. Integral water proofer**

4.21.4 3. Pointing mortar:

1. White Portland cement-.1 .part
2. Sand-.1-1/2 .parts
3. Add color additive .to acquire the color of mortar approved by the Managing Official.
4. Add water proofer

TS-278 Add integral waterproofing admixture to setting and pointing mortar in the quantity and manner .recommended by the manufacturer.

TS-279 Generally, only approved mortar plasticiser shall be used in all mortars, unless otherwise instructed by the Managing Official.

4.21.5 Wall grout

TS-280 Fine grout shall be mixed in the following proportions by volume all in accordance with ASTM C476:

1. Portland Cement - 1 part
2. Hydrated Lime -.0 .1 .part
3. Sand-.2.25-3 .parts

TS-281 Coarse grout, where required, shall be mixed in the following proportions by volume, all in accordance with ASTM .C479:

1. Portland cement - 1 .part
2. Hydrated Lime - 0.1 .part
3. Fine Aggregate - 2.25 .parts
4. Coarse Aggregate- 1-2 parts

TS-282 Use sufficient water to produce a fluid, pourable consistency.

4.21.6 Mortar and Grout Mixing

TS-283 Mortar and grout shall be machine mixed. Cement and hydrated lime may be batched by the bag..Sand preferably shall be batched by weight, but subject to the approval of the Managing Official may on certain small operations be batched by volume in suitably calibrated containers, provided proper allowance is made for weight per cubic foot, contained moisture, bulking and consolidation, shovel measurement shall not be used.

TS-284 Workability or consistency of mortar on the board shall be sufficiently wet to be worked under the trowel. Water for tempering shall be available on the scaffold at all times. Mortar and grout which has begun to "set" shall be discarded. Mortar and grout which has stiffened due to evaporation shall be retempered to restore its workability. Retempering of mortar and grout at the mixer shall not be permitted.

4.21.7 Setting of exterior and interior wall stone

TS-285 All setting shall be done in accordance with the approved shop drawings. All work shall set in a rigid and substantial manner, straight and plumb, with all horizontal lines level and all vertical lines plumb, unless otherwise shown on the Drawings. Similar abutting profiles shall accurately intersect and be in true alignment. All joints shall be uniform and shall be of the size and detail shown on the approved Shop Drawings.

TS-286 Except as otherwise indicated and as herein specified. All anchoring devices shall be accurately set and adjusted. Holes and slots for anchoring devices shall be filled completely with mortar. Each stone shall be anchored securely in place.

TS-287 Joints noted to receive sealant shall be left void. If such joints cannot be sealed shortly after erection, they shall be taped or otherwise temporarily sealed in a manner as approved by the Managing Official.

TS-288 **All exterior stone joints shall be 5mm wide unless otherwise indicated.**

TS-289 As setting stone joints, the work shall be fastened securely to take care of dead loads, wind loads and forces, and erection stresses. All units of stones shall have suitable temporary braces, shores, and stays to hold them in position until permanently secured. All bolts and nuts shall be drawn tight and the bolt threads shall be nicked to prevent the nuts from backing off.

TS-290 All welding, where required, shall be done in accordance with the requirements of the Managing Official, the current edition of the "Standard Code for Arc and Gas Welding in Building Construction" of the American Welding Society (AWS Code).

TS-291 The definitions of all terms herein related to welds, welding, and oxygen cutting shall be interpreted in accordance with the "Standard Definitions, Welding, and Cutting", of the current edition of the American Society.

- TS-292* Cavities behind facing stones shall be filled with fine and /or course grout, as specifically shown on the approved shop drawings and as specified herein.
- TS-293* **Stone elements indicated to be set with mortar joints shall be set with two cushions per stone in every horizontal joint. Stone shall be set in full horizontal mortar beds and joints raked out to a depth of 19 mm before mortar has set. The face surfaces shall not be smeared with the mortar forced out of joints or that used in pointing. No hammering, rolling or turning of stones will be allowed on the wall..Precautions shall be taken to prevent seepage of moisture, through or from the exposed surfaces.**
- TS-294* Build in anchors and supports all as shown on the approved shop Drawings.
- TS-295* Allow stone units to set overnight and then completely fill joints with pointing mortar. Joints shall be toled flush. During the tooling of the joints, enlarge any voids or holes and completely fill with mortar. Surfaces of stone shall be cleaned using sponge and water to remove mortar spills from face of stone.
- TS-296* **The setting of patched, chipped, cracked, broken, stained or defective stones shall not be permitted.**

4.21.8 Protection

- TS-297* Stone shall at all times be protected from drippings, welding spatter and damage by other trades during construction. Where necessary or directed, substantial non-staining wooden or other approved covering shall be placed to protect the work. Heavy polyethylene film shall be used between stone and wood. Maintain all protection until remit final cleaning of stone work.

4.21.9 Cleaning

- TS-298* **Clean soiled surfaces using non-acidic solution of type, which will not harm stone, mortar joint materials, or adjacent surfaces. A Non-metallic tools shall be used in cleaning operations**

4.21.10 Final inspection

- TS-299* **Finished surfaces shall show no objectionable visual distinction in jointing, bedding, plane, color, texture, pattern, and finish. All stones which in the opinion of the Managing Official do not provide the required uniformity shall be relocated, or removed and replaced with new stone units to the satisfaction of the Managing Official and at the contractor's own expense.**
- TS-300* **All defective stones shall be replaced with new stones units, except that minor damages may be repaired when approved by the Managing Official. Repairs, when approved, shall be completed to the satisfaction of the Managing Official. When the repairs to stone are unsatisfactory to the Managing Official, the stone shall be replaced with new stone. All repairs and all replacements of defective and unsatisfactorily repaired stone shall be performed at the Contractor's own expense.**

5 Block work

5.1 Manufacture

TS-301 Generally the blocks used shall be of local manufacture made with concrete in approved vibrated pressure machines. The fine aggregate to be used for blocks shall be clean and sharp approved sand. It shall be chemically and structurally stable and shall comply with the Table of Gradings given hereunder. The cement, coarse aggregate and water to be used for blocks shall comply with the requirements given for Concrete Works, and the methods of measuring and mixing the material shall be the same. The following Mixing Table shall be strictly adhered to in all cases. Water/cement ratio shall be strictly governed to produce a mix of nil - slump.

5.1.2 Mixing table

TS-302 Nominal Mix (all by volume): 1 part Cement, 2 parts Fine Aggregate and 5 parts Coarse Aggregate

Table 6. Table of Grading for fine aggregates

BS 410 Sieve No	Approximate Size (mm)	Percentage (by weight) Passing BS Sieve
--	10.00	100
--	5.00	90-100
7	2.36	75-100
14	1.18	55-90
25	0.60	35-59
52	0.30	8-30
100	0.15	0-10

Coarse aggregate: 10mm single size aggregate.

TS-303 The blocks shall be hard, sound, square and clean with sharp well defined arrises and shall, unless previously approved by the Managing Official, be a work size of (400 x 200 x 200mm) with properly formed half blocks for bonding.

TS-304 Hollow blocks, where required, shall be similar quality and overall size to solid blocks, and shall be of local manufacture made with concrete as described above in approved vibrated pressure machines. The design of the cavities and webs shall be submitted to the Managing Official for approval before manufacture. The thickness of the membranes or solid portions of hollow blocks shall be not less than (30 mm) each and the combined thickness of the solid portion shall exceed one third of the total thickness in either horizontal direction (Light weight lime - blocks can be used according to drawings, bills of quantities and Managing Official's approval).

TS-305 Arrises shall be sharp and true; blocks which have damaged arrises are not to be used in the works and shall be discarded at the expense of the Contractor.

- TS-306* Immediately after molding the blocks shall be placed on clean, level, non-absorbent pallets. Blocks shall not be removed from the pallets until inspected and approved by the Managing Official. Blocks shall be cured by being kept thoroughly wet by means of water sprinklers or other approved means for a period determined by the Managing Official but in all cases for not less than three days. Blocks must not be left on earth or sand during the curing process. Blocks shall be stacked in honeycomb fashion. Solid stacking will not be permitted.
- TS-307* The average crushing strength of solid or hollow blocks shall be not less than 35 kg/cm of gross area (average of 12 blocks).

5.2 Mortars

- TS-308* **The sand to be used for mortar shall be clean and sharp. It shall be chemically and structurally stable and shall comply with the Table of Gradings below. The lime if used for mortar shall be hydrated lime complying with BS 890.**
- TS-309* Where colored mortars are required these shall be obtained either by the use of colorcolored cement or by addition of pigments complying with BS 1014.
- TS-310* The cement and water to be used for mortar shall comply with the requirements given under Concrete Works Section, and the methods of measuring and mixing shall be the same. The following Mixing Table shall be strictly adhered to in all cases.

Table 7. Mixing Table

Nominal Mix		Cement Kilos	Sand m3	Lime (Dry Hydrate) Kilos
1:4	360	1.00	as approved by the Managing Official	

Table 8. Table of Grading

BS 410 Sieve No	Approximate size: Mm	Sand Passing through Sieve: percentage
--	3	95-100
7	2.4	80-100
14	0.2	60-100
25	0.6	30-100
52	0.3	5-65
100	0.15	0-15
200	0.08	0-5

Note: the above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

- TS-311* The mortar generally shall be cement and sand (1:4) mix.
- TS-312* Where plasticizer is added to the mortar the following mixes shall be used:

1. Building mortar - cement and sand (1:6) and
 2. Mortar for pointing - cement and sand (according to plasticizer manufacturer recommendation)
- TS-313* The plasticizer shall be used strictly in accordance with the manufacturer's instructions, and subject to the Managing Official's approval.
- TS-314* All mortars shall be used before the initial set has begun. Mortar shall not be remixed after the initial set has taken place. The full description given under Plaster Work Section, shall apply also to the measuring, mixing etc. of mortar for blockwork

5.3 Construction

- TS-315* All blockwork shall be set out and built to the dimensions shown on the Drawings.
- TS-316* Walls shall be carried up regularly without leaving any part more than one meter lower than another unless the permission of the Managing Official is first obtained. Work which is left at different levels shall be racked back. In the case of cavity walls, both thicknesses shall not be carried up more than about 400 mm.
- TS-317* The courses of blockwork shall be properly leveled. The perpendicular joints shall be properly lined and quoins, jambs and other angles plumbed as the work proceeds.
- TS-318* All walls shall be thoroughly bonded in accordance with the best constructional practice and as directed by the Managing Official. Broken blocks shall not be used except where required for bond (if approved by the Managing Official).
- TS-319* All concrete blocks shall be soaked with water before being used and the tops of walls left off shall be wetted before work is resumed. The faces of walls shall be kept clean and free from mortar droppings and splashes
- TS-320* All blocks shall be properly spread with mortar before being laid and all joints shall be thoroughly flushed up solid through the full thickness of the wall at each course as the work proceeds.
- TS-321* For block walls the gauge shall be ten courses to 2100 mm.
- TS-322* Walls to be left unplastered shall have a fair face consisting of selected blocks pointed with a neat weathered or flush joint as the work proceeds using the same mortar mix as for jointing.
- TS-323* Walls to be plastered shall have the horizontal joints raked out to depth of 8 mm to form a key.
- TS-324* Blockwork shall be bonded to concrete columns and the like with 200 x 60 x 6 mm non ferrous metal ties cast in concrete and subsequently bent down, ragged and built into every 2 courses of blockwork. Gunning ties to concrete will not be permitted (other ways of bond must be approved by the Managing Official).

6 Roofing

6.1 Corrugated steel roofs

- TS-325* All corrugated galvanized steel sheeting (whether fixed to wood or steel framing) shall be of 23 or 24 gauge fixed with a minimum of 50mm end laps and with a minimum of one corrugation side lap.
- TS-326* When instructed to have a one corrugation side lap, the sheets shall have a cover of not less than 20mm and all the lapped sides shall be turned downwards. Where practicable the exposed lapped sides shall be arranged to face away from the prevailing wind. When instructed to have a one and a half corrugations side lap the sheets shall be arranged alternatively with a cover of not less than 90mm, the first sheet being fixed with the lapped sides turned upwards away from the bearer and the cover sheet with the lapped sides turned downwards.
- TS-327* Sheets shall be secured to purlins at centercenters not exceeding 300mm by galvanized self parking screws (minimum 75mm long) with galvanized diamond shaped washers and lead sealing washers
- TS-328* All holes for bolts, self parking screws etc. shall be punched from the underside of the sheets and shall be on the crown of the corrugations.
- TS-329* Galvanized steel ridge capping shall be supplied and fixed to purlins as described above.
- TS-330* Hook bolts, self parking screws and washers shall generally comply with BS 1494.

6.2 Screeds

- TS-331* The provisions of Concrete Work section shall apply to the construction of solid reinforced concrete slab roofs and to hollow slab roofs. The actual finish will be specifically shown on the Drawings or in the Particular Specification.
- TS-332* Lightweight concrete screeds for obtaining falls or as an insulation layer shall be of approved type of foamed concrete. The materials shall be measured, applied and cured in accordance with the manufacturer's instructions and to the satisfaction of the Managing Official.
- TS-333* In all cases the finished screed shall be of an approved proprietary type with a density of not less than 400kg/ m² to receive the applied roofing. Mixing shall take place using approved mechanical mixers.
- TS-334* **Concrete screeds for obtaining falls shall be (1:3:6) mix.**
- TS-335* All screeds shall be laid in bays not exceeding 10 square meters and formed between stop boards of the correct height and cut on each side to indicate the slope required in the roofing. The screed shall then be troweled with a wooden float to true and accurate falls or cross falls up to the stop boards. A 10mm side gap shall be left between each screed bay for the full depth of the screed. The screeds shall be allowed to cure thoroughly to attain maximum shrinkage. Any cracks which appear due to shrinkage shall be made good. The gaps between bays shall then be filled in with cold bitumen.
- TS-336* Where the roof screeds are to be reinforced with one layer of galvanized wire mesh, this shall be supported on top of the base on spacers to ensure that it is maintained at between 10mm and 15mm below the top of the finished screeds. It shall be at

least 100mm wide, securely wired together. It shall be stopped 20mm from the edge of each bay.

6.3 Insulation

- TS-337* When asphalt sheets are used on the top of the screeds, they shall have the following properties:
- TS-338* Asphalt sheets shall be supplied in rolls of 1-1.2 m width and 4mm thick.
- TS-339* Top surface shall have a layer of medium size white aggregates (2-3mm)
- TS-340* Applying asphalt sheets shall be made according to the manufacturer instructions.
- TS-341* Top surface of screeds shall be cleaned and a suitable prime should be sprayed before using asphalt sheets.
- TS-342* An overlap of 15-20cm shall be made on sheets.
- TS-343* Hot asphalt shall be sprayed before erecting the sheets, which should be heated (bottom side).
- TS-344* Sheets shall have at least 15cm vertical edges, all around the roof (a special groove should be made in the roof parapet to erect the vertical side of the sheets)
- TS-345* During erecting asphalt sheets, contractor shall prevent air pockets entrained under the sheets, which will be full flame applied.

6.4 Tiling

- TS-346* Tiled finishing to roofs shall be manufactured and laid as described in Section of (tiling works)
- TS-347* Tilted tiled skirting shall include a triangular fillet of screed material and pointing at top with polysulphide mastic.

6.5 Expansion joints

- TS-348* The expansion joints shall generally be of 10mm thick fiberboard impregnated with bitumen accurately cut, with butt joints and fixed vertical and straight. The top 10mm of the joint shall be filled with a grey polyurethane gun grade sealant which confirms with BS 4254.
- TS-349* Expansion joints shall continue into the tilted tile, skirtings and fillets.

6.6 Felt roofing

- TS-350* Felt roofing, below tiling, shall be two-ply, tropical grade, fiber-based bituminous roofing felt weighing not less than 1.8kg /m² and shall comply generally with BS 747 (Class 1 Type 16) and shall be executed by an approved specialist.

- TS-351* The felt shall be thoroughly bonded to the roof or screed and between layers. Care shall be taken to ensure that all surfaces upon which felt is to be laid are dry, smooth and clean.
- TS-352* The bonding shall be by means of bitumen (60 /70 penetration) applied hot as a continuous coating to an average thickness of not less than 1.5mm and not more than 2mm, so as to give a complete coat over the whole area at the rate of not less than 1.5kg /m2 and not more than 2.0kg /m2 for each bonding coat.
- TS-353* The felt shall be laid with 150mm side and end laps which shall be staggered.
- TS-354* The felt shall be carried up the walls etc., over fillets to form a skirting continuous with the roof covering. The skirting shall be bonded to the fillets and walls and shall be not less than 150mm in vertical height.
- TS-355* Application of materials shall conform in all respects with the British Standard CP 144: Part 1, 'Roof Coverings, built-up bitumen felt', or any standards approved by the Managing Official.
- TS-356* The felt shall be dressed and bonded into rainwater outlets and under flashings.

6.7 Bitumen roofing

- TS-357* Where roof finishings are required to be of a bitumen and sand mix this shall be composed of a mix to the following proportion (by weight) :

- **Bitumen 60 /70 penetration 13 %**
- **Filler (passing 200 sieve) 11 %**
- **Sand 76 %**

- TS-358* Mixing shall be carried out in an approved machine until all materials are thoroughly mixed. The mixing temperature shall be between 163OC and 191OC and it shall be applied at a temperature sufficient to maintain the workability of the mix. The covering shall be laid in one coat to give a consolidated thickness of 20mm after rolling with a light hand roller. 150x150mm angle fillets shall be laid at edges of roofs against parapets etc., properly bonded to the roof covering and with top edges turned into joints of walls. The covering shall also be pressed into rainwater outlets and under flashings.

6.8 Asphalt

- TS-359* Asphalt roofing and tanking shall be executed by an approved specialist using mastic asphalt to BS 988.
- TS-360* The asphalt shall be applied in the thickness and number of coats described in the in BOQ, with each successive coat breaking joints at least 300mm (12") and with properly formed angles, double angle fillets and fair edges.
- TS-361* Joints of blockwork shall be raked out and all vertical surfaces hacked for key.
- TS-362* Horizontal work shall be laid on a layer of stout sheathing felt.

6.9 Completion

TS-363 On completion all roofs etc are to be left sound, water- tight and in clean condition before handing over.

7 Plaster work

7.1 General

TS-364 The British Standards (BS) govern the work covered in this section.

7.2 Materials

TS-365 Portland cement, fine aggregate and water shall be as previously specified in Concrete Work section.

TS-366 The color pigments shall be of an approved manufacture, lime proof and non-fading.

TS-367 The sand for plastering shall be clean fine sand and shall be chemically and structurally stable. The sand shall be sieved and graded in accordance with the Table of Grading given below.

Table 9. Table of Grading

BS 410 Sieve No.	Approximate Size . Mm	Sand Passing Through Sieve Percentage:.	
		Undercoat	Finish coat
7	2.4	95-100	100
14	1.2	80-95	95-100
25	0.6	30-55	30-85
52	0.3	5-50	5-50
100	0.15	0-10	0-10

TS-368 Note: the above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

TS-369 Imported lime shall be of the hydrate type complying with BS 890.

TS-370 Bonding agents where required shall be of a type approved by the Managing Official, and shall be used as recommended by the manufacturer

TS-371 The Contractor shall ensure that supplies of materials are sufficient to give consistent and uniform color to surface finishes which are not to be painted.

7.3 Mixing

TS-372 The methods of measuring and mixing shall be as laid down under Concrete Work section, and the proportions shall be in accordance with the Mixing Table given below.

Table 10. Mixing Table

Nominal mix	Ratio	Cement Kg	Fine Aggregate or Sand m ³	(I) (dry hydrate) kg
1:5 cement		289	1.00	-
1:4 cement		361	1.00	-
1:3 cement		476	1.00	-
1:2 cement		577	1.00	-
1:2 cement		721	1.00	-
1:1 cement		1442	1.00	-
1:5 cement with 20% (I)	1:5:1	289	1.00	124
1:4 (I) with 10% cement	1:10:21/2	145	1.00	161

* I = Imported Lime

TS-373 With regard to the lime mortars gauged with cement, the addition just before use of the cement to small quantities of the lime/sand mix shall preferably take place in a mechanical mixer and mixing shall continue for such time as will ensure uniform distribution of materials and uniform color and consistency. It is important to note that quantity of water used shall be carefully controlled.

7.4 Plastering and similar in-situ finishing and backings

TS-374 All plastering shall be executed in a neat workmanlike manner. All faces except circular work shall be true and flat and angles shall be straight and level or plumb.

TS-375 Plastering shall be neatly made good up to metal or wooden frames and skirting and around pipes or fittings. Angles shall be rounded to 5mm radius.

TS-376 Surfaces of undercoats shall be well scratched to provide a key for finishing coats. Screed marks or making good on undercoats shall not show through the finishing coats.

TS-377 Surfaces described as troweled smooth shall be finished with a steel trowel to a smooth flat surface free from trowel marks.

TS-378 Surfaces described as floated shall be finished with a wooden or felt float to a flat surface free from trowel marks.

TS-379 All tools, implements, vessels and surfaces shall at all times be kept scrupulously clean and strict precautions shall be taken to prevent the plaster or other materials from being contaminated by pieces of

partially set material which would tend to retard or accelerate the setting time.

TS-380 Coating work shall not be started until all:

- 1. Required openings, chases or other apertures have been cut**
- 2. Pipes, fixtures, fixing pads and plugs have been fixed**
- 3. Making good has been completed.**

TS-381 The Contractor shall protect all existing work and approaches, with boards, dust sheets etc. All droppings onto finished work shall be cleaned off immediately.

TS-382 The Contractor shall ensure that all plant and tools are kept clean and free from previous mixes.

TS-383 The Contractor shall make good defective or damaged coatings before starting decoration works.

7.5 Preparation for plaster, etc.

TS-384 All surfaces to be plastered shall be clean and free from dust, loose mortar and all traces of salts. Projections and concrete fins shall be hacked off. Traces of mold oil, paint, grease, dust and other incompatible materials shall be removed by scrubbing with water containing detergent.

TS-385 Where cement plaster is to be applied the surfaces shall first be wetted and dashed with a mixture of Portland cement and sand (1:2) mix to form a key. This should be kept wet with a fine water spray until set, and allowed to harden before applying undercoat for a minimum of 3 days.

TS-386 All surfaces shall be thoroughly sprayed with water and all free water allowed to disappear before plaster is applied.

TS-387 Bonding agents where required shall be applied in accordance with the manufacturer's instructions and must be approved by the Managing Official. Before plastering is commenced all junctions between differing materials shall be reinforced in accordance with clause 9.21.

7.6 Curing of plaster, etc.

TS-388 Each coat of plaster should be kept damp for the first three days. Care must be taken to prevent too rapid drying out during hot weather and in drying winds.

TS-389 The Contractor shall therefore provide a protective covering of plastic or similar impervious sheeting which must be hung so that it is clear of the finished surface.

TS-390 Any cracking, discoloration or other defects caused by inadequate protection shall be remedied at the Contractor's expense.

7.7 Uses of plaster, etc.

TS-391 The type, mix and thickness of plaster for each location shall be as stated in the Particular Specification or shown on the Drawings, and shall generally be selected from the Schedule of Plasters given in Table P1.

Table 11. Schedule of Plasters

Description		Render and spray cement and sand	Plain face cement and sand	Gauged plastering lime and sand with cement
Total	Walls	13	15	13
Thickness	Ceilings	10	10	10
Undercoats Thickness (mm)	Mix surface	1:4 floated	1:4 scratched	1:10:2.5 scratched
	Walls	10	As required	As required
	Ceilings	7	As required	As required
Finishing thickness (mm)	Mix surface	1:1 sprayed	1:4 trowelled or floated	1:10:2.5 trowelled or floated
	Walls	3	As required	As required
	Ceilings	3	As required	As required
Remarks		External use	External or internal use may be applied in one coat to ceiling only if finished thickness is 12mm and the required surface finish is obtained	Internal use may be applied in one coat if finished thickness is 12mm and the required surface finish is obtained.

7.8 Application of plaster, etc.

TS-392 After preparation of the surfaces the undercoat shall be applied to the required thickness between screeds laid, ruled and plumbed as necessary when nearly set the surface of the undercoat shall be scratched. The undercoat shall be allowed to set hard and shall be cured. Where plastering is applied in one coat or where roughcast is to be applied the scratching should be omitted.

TS-393 The finishing coat shall be applied to the required thickness by means of a laying - on trowel and finished to give the required surface.

TS-394 The surfaces shall be finished to a true plane to correct line and level, with all angles and corners to a right angle unless otherwise specified, and with walls and reveals plumb and square. The surfaces shall be finished to within 3 mm of a straight edge 1.80m long placed on face of plaster.

TS-395 Undercoat shall be worked well into the interstices of metal work to obtain maximum key.

TS-396 Each coat shall be applied firmly to achieve good adhesion, and ruled to an even surface.

- TS-397* Each coat shall be applied to each wall and ceiling surface in one continuous operation.
- TS-398* Each coat shall be applied at full thickness down to floor level or skirting lath.
- TS-399* All undercoats shall be cross-scratched to provide key for next coat.
- TS-400* Cement based undercoats shall be allowed to dry out thoroughly to ensure that drying shrinkage is substantially complete before applying subsequent coat.
- TS-401* 50 mm each side of angle bead to be finished with neat Keene's cement before plaster finishing coat is applied. Where angle beads are not specified, angles shall be formed with pencil round arris.

7.8.2 Smooth finish

- TS-402* Finished with a steel laying trowel to an even surface.

7.8.3 Wood Float or Plain Finish

- TS-403* Finished with a dry wooden float as soon as wet sheen has disappeared from surface to give overall even texture.

7.8.4 Rough textured finish

- TS-404* Finished with a cork or carpet float to provide a rough but even open-textured surface.

7.8.5 Scraped finish

- TS-405* Finished with laying trowel to uniform thickness and after coat has set but before it is too hard, aggregate exposed by scraping surface of skin to approved texture.

7.8.6 Rough cast finish

- TS-406* Thrown on while wet with trowel or scooped to an even texture and left as cast.

7.8.7 Dry dash finish

- TS-407* Top coat of rendering finished to uniform thickness; while coating is plastic, aggregate thrown on to cover surface and particles pressed lightly into mortar to ensure adhesion.

7.8.8 Sprayed finish

- TS-408* The sprayed finish shall be applied with an approved machine to give a finish of even texture and thickness. The sprayed finish shall be applied in three separate coats allowing time for drying between coats.
- TS-409* Application in one continuous operation to build up a thick layer will not be permitted. The total finished thickness of the four sprayed coats shall be not less than 3 mm. The sprayed finish shall not be applied until all repairs and making good to the undercoat are completed. Rainwater pipes, fittings and the like shall

first be fitted, then removed during the spraying process and refitted and jointed afterwards. Any plaster which adheres to other pipes, doors, windows and the like shall be carefully removed before it has set. Curing shall take place after the application of the fourth coat.

7.9 Steel mesh lathing, stops and beads

- TS-410* Steel mesh lathing shall be galvanized type weighing 1.6kg/m.
- TS-411* Steel rods for distancing shall be hot rolled mild steel round bars to BS 4449, diameter to approval, galvanized to BS 729 or bitumen coated.
- TS-412* Steel clout nails shall be to BS 1202:Part 1, Table 3, galvanized to BS 729.
- TS-413* Galvanized steel angle bead with 50 mm galvanized expanded metal mesh on both sides of bead.
- TS-414* Mesh lathing shall be fixed with the long way of the mesh at right angles to supports.
- TS-415* In horizontal work it shall be fixed with all mesh strands sloping in the same direction.
- TS-416* In vertical work it shall be fixed with all mesh strands sloping inwards and downwards from face of coating.
- TS-417* Lathing shall be fixed from the center outwards so that it is taut.
- TS-418* Lathing shall not be lapped within 100mm of angles or curves.
- TS-419* Junctions of lathing shall be reinforced at corners with 75 x 75 mm angled plain mesh, fixed to rails with tying wire at not more than 100mm centers.
- TS-420* Ends of wire shall be bent away from face of coating.
- TS-421* Beads and stops shall be fixed plumb, square and true to line and level.
- TS-422* Metal angle beads shall be fixed to solid backgrounds with plaster dabs, and shall be fixed to timber supports with 28mm clout nail. Both types of fixing shall be on each side of angle at not more than 600mm centers.
- TS-423* At junctions between dissimilar solid backgrounds in the same plane and with the same coating, steel lathing shall be fixed with 38 mm clout nails or with staples. They shall be driven into drilled and plugged holes or into fixing bricks or plugs built in or cast in:
1. At single junctions, lathing to be not less than 450mm wide, fixed each edge at 100 mm centers.
 2. At columns, lathing to extend not less than 150mm beyond each junction, fixed each edge and centrally at 100 mm center.
- TS-424* Side edges of lathing shall be lapped not less than 25mm, and secure with tying wire at not more than 100mm centers.
- TS-425* Ends of lathing shall be lapped 40mm at supports and 50mm between supports, and secured with tying wire at not more than 100m centers.

- TS-426* Lathing fixed to metal supports shall be fixed with hair-pin shaped tying wire ties at not more than 100mm centers, passed over the support with both ends through mesh, twisted tight, ends cut off and bent flat.
- TS-427* Concrete, blockwork or masonry backgrounds shall be drilled and plugged at not more than 100x400mm centers and the lathing shall be fixed with 38mm clout nails or wire staples driven at an angle to tauten the mesh.

8 Wall and floor tiling works

8.1 General

8.1.1 Section includes

- TS-428* Ceramic and Terrazzo tile floor finish using the mortar bed application method. Approved Gravel bed under mortar for terrazzo tile, and for cement tiles.
- TS-429* Local marble tile stair treads using the mortar bed application method.
- TS-430* Interlock floor tile using the sand bed application.
- TS-431* Cements tiles.

8.1.2 References

- ANSI
- TCA
- ASTM
- BS

8.2 Materials

- TS-432* Portland cement, fine aggregate and water shall be as previously specified in Concrete Work section.
- TS-433* The marble chipping shall be of an approved quality in irregular pieces varying from 2 mm to 10 mm in size depending on the effect required. The pieces should preferably be roughly cubical in shape where flaky shaped pieces shall not be used.
- TS-434* The granite chipping shall be of an approved quality graded from 12 mm down with not more than 5 percent fine material passing a No.100 sieve.
- TS-435* Marble and granite aggregates shall comply generally with the Table of Grading. In connection with marble aggregates the percentages are approximate only. The actual grading should be selected to produce the surface effects required.

Table 12. Table of Grading

Bs 410 sieve no.	Approximate size . Mm	Percentage of aggregate passing through sieve	
		Granite	Marble
-	13	100	-
-	10	95-100	95-100
-	5	30-60	25-60
7	2.4	20-50	5-30
14	1.2	15-40	0-10
25	0.6	10-30	-
59	0.3	5-15	-
100	0.15	0-5	-

TS-436 Note: the above figures represent the limits of percentages (by weight) passing sieves of the sizes mentioned.

8.3 Cement and sand tiles

TS-437 Cement and sand tiles shall be formed with a (1:2) mix of white or colored cement, or in white cement with a color pigment added, and sand applied as a facing not less than 7.5mm thick to a Portland cement and sand (1:5) mix backing.

TS-438 The tiles shall be cast in heavy moulds under pressure to the proportions and sizes shown in the following table.

Table 13. Cement and Sand Tile Dimensions

Size . mm	Size tolerances . mm	Minimum total thickness mm
200x200	0.5	20
250x250	0.5	25
300x300	1.0	25
400x400	1.0	30
Interlock tile (size.vary)	1.0	60

TS-439 Colored cement and sand skirting to match tiles, 100mm or 200mm with chamfered top edges shall be produced in the same way as the tiles using the same mixes.

TS-440 All cement and sand tiles shall be cured by totally immersing them, after the initial set has taken place, in a tank of clean water for at least 24 hours.

TS-441 Cement and sand tiles shall be laid and bedded direct onto a concrete sub-floor on a cement and sand (1:4) mix screed. This screed shall be 25mm thick in the case of 25mm tiles and 30mm thick in the case of 20mm tiles. The total thickness of cement and sand screed and tiles shall not exceed 50mm..All tiles shall be laid with square joints.

- TS-442* All tiling shall be grouted up on completion, care being taken to fill all joints completely. The grout shall consist of neat cement of a color to match the tiling. Any surplus grout shall be cleaned off the face of the tiling and surrounding surfaces immediately and all tiling shall be carefully cleaned off.

8.4 Terrazzo tiles

- TS-443* Terrazzo tiles shall be formed with a (1:2 1/2) mix of white or colored cement or white cement with a color pigment added and granular marble chippings applied as a facing not less than 5 mm thick to a Portland cement and sand (1:5)) mix backing.
- TS-444* The tiles shall be cast in heavy metal moulds under pressure to the proportions and sizes shown in the following table.

Table 14. Terrazzo Tile Dimensions

Size mm	Size tolerances mm	Minimum total thickness mm
200x200	0.5	20
250x250	0.5	25
300x300	1.0	25
400x400	1.0	30

- TS-445* Tiles shall be cured as for cement and sand tiles and then ground, filled and polished before distribution to site.
- TS-446* Grinding shall be done wet by means of a No. 80 carborundum stone. Filling shall be carried out with a neat cement grout of the same color as the facing mix and this shall be worked into the surface with a wooden shaper to fill all voids and air holes.
- TS-447* Surplus grout shall be removed with a dry cloth. After a minimum period of 24 hours polishing shall be carried out wet by means of a No. 140 carborundum stone.
- TS-448* Terrazzo skirting 100mm high with chamfered top edges shall be produced in the same way as for tiles using the same mixes.
- TS-449* Terrazzo tiles shall be laid and bedded direct onto a proved gravel layer with a cement and sand (1:4) mix mortar. This mortar shall be 25mm thick in the case of 25mm tiles and 30mm thick in the case of 20mm tiles. The total thickness of the cement and sand screed and tiles shall not exceed 50 mm.
- TS-450* All tiling shall be grouted up on completion; care being taken to fill all joints completely. The grout shall consist of neat cement of a color to match the tiling. Any surplus grout shall be cleaned off the face of the tiling and surrounding surfaces immediately and all tiling shall be carefully cleaned off.
- TS-451* All terrazzo surfaces shall be polished on completion. Large areas such as floors shall be wet polished by means of approved machines using No. 140 carborundum wheel..Any surface too small for convenient machine polishing may be polished by hand using a No.140 carborundum stone and water. Care must be taken during any polishing operation not to damage any of angles or arrises.
- TS-452* Terrazzo covering to items such as sills, treads and risers to steps, skirtings, etc., shall generally be applied in accordance with the foregoing specification except that

the thickness of the facing shall be at least 10 mm (marble can be used if approved by the Managing Official).

8.5 Marble paving

- TS-453* Marble pavings shall generally be 30 mm thick and the size, type and pattern shall be as stated in the Particular Specification and/or shown on the Drawings. The marble slabs shall be fixed solid on a bed of cement and sand (1:4) mix 30 mm thick with tight joints grouted in lime putty. A Protective slurry of lime putty at least 3 mm thick shall be applied to the marble pavings and subsequently cleaned off.
- TS-454* Treads shall be 30mm thick fixed solid on a bed of cement and sand (1:4) mix 30mm thick. Risers to stairs shall be 20mm thick fixed solid on a backing of cement and sand (1:4) mix 30 mm thick. Window sills shall be 40mm thick bedded hollow on plaster slabs. Skirtings shall be 10mm thick, in lengths of about 1.5 meters, fixed solid on a backing of cement and to coincide with joints in adjacent pavings. Rounded arrises, nosing and moldings shall be adequately protected by means of timber casings. Treads, risers, skirtings and window sills shall be grouted and protected in a manner similar to pavings.
- TS-455* The exposed faces and edges of all marble shall be polished smooth and be free from scratches or other defects. Concealed faces of marble shall be treated with shellac or bituminous paint.

8.6 Marble lining

- TS-456* Marble lining to walls, columns and the like shall generally be 20 mm thick and the size, type and pattern shall be as stated in the Particular Specifications and/or as shown on the drawings.
- TS-457* The marble slabs shall be cut square and true and shall be uniform in shape and thickness. Patterns and mouldings shall be accurately formed in accordance with the Drawings.
- TS-458* Exposed edges and mouldings shall be protected by means of timber casing or lime putty coating. The exposed edges and faces of all marble shall be polished smooth and shall be free from scratches or other defects.

8.7 Interlock tile – coloured cement tile

- TS-459* Interlock cement tile 6cm thick, first grad from certified factory.
- TS-460* Color and shape to be approved from consultant.
- TS-461* Samples for lab testing.
- TS-462* Apply clean sand with minimum thickness 5cm
- TS-463* Lay tile according to the specification and drawings.
- TS-464* Paving on compacted basecourse layer not less than 20cm thick

8.8 Ceramic, glazed and quarry tiling

- TS-465* Clay floor quarries and fittings shall be in accordance with BS 1286 type A and the thickness and size shall be as stated in the Particular Specification or on the Drawings.
- TS-466* Ceramic floor tiles and fittings shall be in accordance with BS 1286 type B, vitrified or fully vitrified and the thickness and size shall be as stated in the Particular Specification or on the Drawings.
- TS-467* Glazed ceramic floor tiling shall be of the type, thickness and size as stated in the Particular Specification or on the Drawings.
- TS-468* The tiles shall be true to shape, flat and free from flaws, cracks and crazing and keyed on the reverse side and shall be of a manufacture approved by the Managing Official.
- TS-469* Bedding mortar shall be cement and sand all in accordance with the materials stated in Concrete Work and Blockwork sections.
- TS-470* Any admixtures to the mortar must be approved before use.
- TS-471* Grout pointing shall be white or colored cement.
- TS-472* Cement and sand mortar bed of not more than 20 mm or thickness of the tile shall be laid.
- TS-473* Tiles shall be firmly tamped into mortar to form a level surface.
- TS-474* The Contractor shall ensure that when fixing tiles with thin bed adhesive, the base to receive tiles is clean level and dry, with no loose and friable areas and surface dusting.
- TS-475* Cement-based adhesive shall be prepared and used in accordance with the manufacturer's recommendations to form a bed not more than 3 mm thick.
- TS-476* Tiles shall be laid dry and tamped well down into the adhesive to ensure a proper bond with base and a level surface.
- TS-477* When bedding tiles on thick bed, semi-dry cement and sand (1:4) mortar bed shall be spread not less than 25 mm thick.
- TS-478* Before the compacted bed has set a cement and sand slurry (1:1) about 3mm thick shall be spread over the surface.
- TS-479* The tiles shall be laid dry and tamped into the slurry to form a level surface.
- TS-480* Joints shall be even and not more than 3mm wide, in both directions.
- TS-481* Joints shall be continuous both horizontally and vertically.
- TS-482* The tiles shall be grouted up with grey or colored cement mortar (1:1) worked well into joints when bed is sufficiently firm to prevent disturbances of the tiles; surplus grout shall be cleaned off from faces of tiles.
- TS-483* Movement joints shall be provided not less than 6 mm wide where shown on the Drawings or as directed by the Managing Official.

- TS-484* Movement joints shall be carried through the depth of tile and bedding and partially filled with filling strip and finished flush with sealant to manufacturer's recommendations. Joints have to be made out of silicone.
- TS-485* Where tiling abuts against wood or metal frames or other tiling at angles and around pipes etc., it shall be carefully cut and fitted to form a close neat joint. Open irregular joints filled with cement and sand or plaster will not be permitted.
- TS-486* Tiles shall be cleaned off and polished at completion.
- TS-487* Water shall not be allowed on new tiling until bedding and grouting have completely set.
- TS-488* No traffic shall be allowed on the floor until 4 days after completion and then only light traffic for a further 10 days.

8.9 Glazed ceramic wall tiling

- TS-489* Glazed ceramic wall tiles shall be in accordance with BS 1281 with or without cushioned edges and spacer lugs and shall be grey or colored as stated in the Particular Specification.
- TS-490* Glazed ceramic tile fittings shall be rounded edge or angle bead type to match plain tiles.
- TS-491* The tiles shall be true to shape, flat and free from flaws, cracks and crazing and keyed on the reverse side and shall be of a manufacture approved by the Managing Official.
- TS-492* Bedding mortar shall be cement and sand (1:3) all in accordance with the materials stated in Concrete Work and Blockwork sections
- TS-493* Any admixtures to the mortar must be approved before use.
- TS-494* Mastic adhesives shall be of an approved manufacture and shall comply with the performance requirements of CP 212: Part 1, if approved by the Managing Official.
- TS-495* Grout pointing shall be neat grey or colored cement.
- TS-496* The Contractor shall ensure that the cement render backing is at least 14 days old, firmly bonded to its background, free from dust, with surfaces plumb and true to 3mm in any 1800 mm.

8.10 Fixing tiles with cement and sand mortar

- TS-497* The tiles shall be immersed in water for 6 hours or until saturated then stacked tightly together to drain with end tiles turned glaze outwards. Tiles shall be fixed as soon as surface water has drained.
- TS-498* The render coat shall be wetted sufficiently to prevent it absorbing water from the bedding coat.
- TS-499* Mortar bedding shall be applied to render background to an even thickness of approximately 10mm.

- TS-500* Each tile shall be buttered evenly with mortar and tapped firmly into position so that the bed is solid throughout.
- TS-501* Thickness of finished bed shall be not less than 6mm nor more than 12 mm.
- TS-502* Any necessary adjustment to tiles shall be made within ten minutes of fixing and tiles cleaned off after not less than two hours.

8.11 Fixing tiles with adhesive

- TS-503* The tiles shall be fixed in accordance with the recommendations of the adhesive manufacturer.
- TS-504* Adhesive shall be applied not more than 1sq.m at a time to avoid premature drying out.
- TS-505* Adhesive shall be applied as a continuous screed to a thickness of approximately 3mm on the surface to be tiled.
- TS-506* Dry tiles shall be pressed on to the adhesive and tapped firmly into position to ensure solid bedding without voids.
- TS-507* Any necessary adjustment to tiles shall be made immediately after bedding.
- TS-508* Tiles shall be cleaned off as soon as bedding is complete.
- TS-509* Joints shall be even and not more than 2mm wide using spacer lug tiles or spacer pegs.
- TS-510* Joints shall be continuous both horizontally and vertically.
- TS-511* Tiles shall be fixed to a finished surface that is plumb and true to 2 mm in any 2m.
- TS-512* Joints shall be grouted up not less than 24 hours after fixing tiles to porous surfaces and not less than 3 days after fixing to impervious surfaces.
- TS-513* Tiles shall be grouted by pressing mix firmly into joints, working in areas of not more than 1sq.m.
- TS-514* Surplus grout shall be cleaned off as the work proceeds.
- TS-515* Where tiling abuts against wood or metal frames or other tiling at angles and around pipes etc., it shall be carefully cut and fitted to form a close neat joint.. Open irregular joints filled with cement and sand or plaster will not be permitted.
- TS-516* Tiles shall be cleaned off and polished on completion.
- TS-517* External tiling shall be protected from inclement weather until grouting is completely set.
- TS-518* No water is to be allowed on new tiling until bedding and grouting have completely set.

8.12 Protection

- TS-519* All floor, wall and ceiling finishes shall be protected from damage during subsequent work, and shall be thoroughly cleaned before handing over the works.

9 Carpentry and joinery

9.1 Timber

- TS-520* All softwood for carpentry and joinery work shall be well seasoned sound, bright, free from shakes, large loose or dead knots, waney edges, warp, incipient decay, stained sapwood or other defects and shall be to the approval of the Managing Official.
- TS-521* Only brass, galvanized or stainless screws will be allowed to use
- TS-522* Timber for carpentry work shall be carefully sawn square and shall hold the full dimensions shown on the Drawings.
- TS-523* The hardwood for joinery work shall be to the approval of the Managing Official, well seasoned, close grained and free from all defects. Hardwood for polishing or clear treatment shall be selected and kept clean.
- TS-524* Leafs, shelves, drawers, sashes and partitions 17 mm thick of sandwich plywood covered on both sides and seen edged with (0.5 mm and 0.8 mm) thick Formica sheets internally and externally. All works shall be as per drawings and specifications.
- TS-525* Preservative treatment shall be approved by the Managing Official. an environmentally friendly preservatives.
- TS-526* The Contractor shall allow for all necessary cutting of timber to size and shape, for preparation of surfaces, for all fixings, for properly jointing and putting together including farming, gluing, doweling screwing and mortising, for all cutting and waste, notching, sinking, scribing, mitres, ends, short lengths and any other sundry items of like nature and for priming all concealed surfaces of joinery. Aluminium primer shall be applied to concealed surfaces of all joinery timber.
- TS-527* All sizes and dimensions shown on the Drawings are finished sizes unless otherwise stated.
- TS-528* Timber for joinery work shall be finished work to the exact sizes shown on the Drawings with pencil rounded exposed arises and no joinery shall be built in until inspected and approved by the Managing Official.
- TS-529* All timber shall be properly seasoned and shall be planed square, straight and true and shall be free from the following defects:
- **Sapwood slits, ring shakes and soft pith.**
 - **Checks exceeding 1,5 mm wide.**
 - **Checks exceeding 1.5 mm wide.**
 - **Checks more than half the thickness of the timber in depth.**
 - **Knots exceeding 20mm mean diameter.**
 - **Knots exceeding half the width of the surface.**
 - **Decayed or dead knots unless cut out and plugged.**
 - **Loose knots or knot unless cut out and plugged.**
 - **Pith pockets.**
 - **Decay and insect attack including pinworm holes.**

- TS-530* The whole of hardwood joinery shall be flush with timber surface ,and left clean and ready to receive any oiled or other finish
- TS-531* Where screw fixings would show on the surface of hardwood, the heads shall be countersunk 6mm below timber surface and grain matched fillets not less than 6mm thick and traped and cut from matching timber shall be glued in and finished off flush with the face. This will apply equally to hardwood which is to be painted.

9.2 Moisture content of timber

- TS-532* The softwood generally shall have a maximum moisture content of 12%.
- TS-533* The hardwood shall have a maximum moisture content of 10% and shall have been kiln dried.
- TS-534* The whole of the timber for joinery work shall be properly stacked and protected from rain and ground moisture.

9.3 Plywood

- TS-535* The minimum thickness shall be 5mm.
- TS-536* Plywood face veneers shall be approved by the Managing Official.
- TS-537* Plywood adhesives shall be approved by the Managing Official.
- TS-538* The Contractor shall not be permitted to make up the required thickness by gluing together sheets of thinner plywood.

9.4 Timber face veneers

- TS-539* All timber face veneers that are exposed shall be selected to the approval of the Managing Official and shall be hard, durable and capable of being finished easily to a smooth surface.
- TS-540* They shall be free from knots, worm and beetle holes, splits, glue stains, filling or inlaying of any kind, or defects.

9.5 Fixing and jointing

- TS-541* Joinery work shall be carefully put together and properly jointed in accordance with best practice, all joints shall be glued and screwed or doweled. Any screws appearing on facework shall have the heads let in and pelltated unless otherwise described. Softwood fixings shall be stout steel screws.
- TS-542* Where joinery is required to be put together and fixed with brass cups and screws, the cups for fixing hardwood joinery shall be cast brass cups with milled edges and shall be neatly let in to finish flush with the face of the work.

- TS-543* Nail lengths shall not be more than total thickness of sections to be joined less 5mm, but otherwise not less than twice the thickness of the section through which nails are driven.
- TS-544* Screw lengths shall be not more than total thickness of sections to be joined less 5mm, but otherwise not less than 1 times the thickness of the section through which screws are driven.
- TS-545* Proprietary plugs shall be approved by the Managing Official.
- TS-546* Steel nails shall comply with BS 1202: Part 1.
- TS-547* Wood screws shall be brass complying with Bs 1210 with slotted countersunk heads.
- TS-548* Screw cups shall be brass complying with BS 1494: Part 2.
- TS-549* Synthetic resin gap-filling adhesives shall comply with BS 1204: Part 1, type WBP.
- TS-550* Synthetic resin close-contact adhesives shall comply with BS 1204: Part 2, type WBP.

9.6 Spacings and additional supports

- TS-551* Where no dimensions are specified or shown on Drawings, space battens, fillets, grounds studs etc., shall be used in accordance with the recommendations of the manufacture of the sheets and/or sections being fixed.
- TS-552* Where not shown on Drawings, additional supports shall be positioned and fixed for appliances, fixtures, edges of sheets etc., in accordance with the manufacturer's recommendations.

9.7 Doors

- TS-553* Door leaves with a polished finish are to be veneered as approved ..hardwood veneered plywood factory finished and supplied with protective wrappings, and with all necessary preparation for ironmongery carried out.
- TS-554* All edges are to be lipped with hardwood and all beads and lippings are to match face veneers.
- TS-555* All doors whether light cored, solid cored and/or fire resisting shall conform to BS 459 and 476 and 4787 as appropriate with adequate blocking out for ironmongery etc.
- TS-556* Door frames shall be as shown on the Drawings all in wrought hardwood treated to match doors in accordance with door manufacturer's recommendations and should be manufactured and finished by the door manufacturer where possible.
- TS-557* Hardwood polished thresholds are to be provided to individual flat entrance doors. All other doors within flats should allow sufficient clearance for fitted carpets. The Contractor should ascertain requirements for clearance in all other positions from the Managing Official.

9.8 Windows

- TS-558* Windows and fanlight sashes shall be framed to the size shown on the Drawings. Sashes hung folding shall have meeting beads screwed on. Glazing bars if required shall be of twice rebated section.
- TS-559* Aluminium windows (Best quality) will be used. Color and type of section must be approved by the Managing Official.

9.9 Mosquito screens

- TS-560* Mosquito screens to doors shall be framed and braced with rails styles and braces and filled in with aluminium mesh, 18x16 meshes per inch.

9.10 Frames

- TS-561* Frames to doors, windows and mosquito screens shall be provided and built in to the sizes shown on the Drawings or as directed by the Managing Official.
- TS-562* Frames shall be securely tied to walls by means of steel or similar metal cramps, galvanised or dipped in bitumen and provided as follows:
- 1. Door frames: three cramps to each side.**
 - 2. Window frames: two or more cramps to each side according to size.**
 - 3. Any other way approved by the Managing Official (e.g. foam bond)**
- TS-563* Doors, windows, etc. shall be carefully and accurately fitted to the frames to give a uniform clearance of not more than 3mm all round.

9.11 Architraves, door stops etc.

- TS-564* Architraves, door stops etc. shall be as shown on the Drawings and all properly mitred at intersections as approved by the Managing Official.
- TS-565* Glazing beads where required shall be wrought splayed and rounded and shall be neatly mitred and fixed with small brads or lost-head nails.

9.12 Fittings

- TS-566* In connection with fittings such as wardrobes, cupboards, counters etc., the doors, frames, drawers, rails and framing etc. shall be properly and accurately framed together.
- TS-567* Before starting repetitive fabrication of any component, prototypes shall be prepared and approved.
- TS-568* Unless components are specified to be built in, these shall not be made until all site dimensions have been checked.
- TS-569* Matching clearance holes shall be provided for all sizes of screw and matching pilot holes for screws of 6 gauges or more for screwing softwood.

- TS-570* Clearance and pilot holes to match screw sizes shall be provided for screwing hardwood.
- TS-571* Pilot holes shall be provided slightly less than half the diameter of the screw for screwing particle board.
- TS-572* All nail heads which will be visible in completed work shall be punched below timber surface.

9.13 Finish

- TS-573* All joinery which is to be polished, varnished or painted shall be finished smooth and clean by rubbing down with fine sandpaper.

9.14 Protection

- TS-574* All joinery shall be protected from damage during the course of the Works and on completion shall be to the Managing Official's entire satisfaction. Before handing over the Contractor shall ensure that all doors, drawers, etc, work easily and shall make all necessary adjustments including those needed during the maintenance period.

10 Ironmongery

10.1 Description

- TS-575* The Contractor shall provide and fix the ironmongery required by the Particular Specifications or shown on the Drawings complete, including all necessary screws, bolts, plugs and other fixings. The use of nails for fixing ironmongery shall not be permitted. The Contractor shall hand over all in a finished state and to the satisfaction of the Managing Official.
- TS-576* Any fitting have to be heavy duty.
- TS-577* All ironmongery shall be of first quality and shall be obtained from an approved manufacturer. Butt hinges are to be aluminum alloy with silver anodised finish with double stainless steel washers, or as approved by the Managing Official.
- TS-578* The Contractor shall be required to submit for approval samples of all items of ironmongery he proposes to use.
- TS-579* All doors shall be provided with an approved door stop plugged and screwed to the top wall mounted all opening areas of aluminum work shall be provided with appropriate friction stays. The size, materials, finishes, type and quality of ironmongery shall be as described and shown on the Drawings.

10.2 Quality assurances

- TS-580* Field Measurements: take field measurements prior to Preparation of shop drawings and fabrication, where Possible. Do not delay job progress; allow for timing and fitting where taking field measurements before fabrication might delay work.
- TS-581* Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassemble and coordinated installation.

10.3 References

TS-582 Applicable Publications: The following publications of the issues listed below, but referred to thereafter by basic designation only form a part of this Section.

1. Federal Specifications. Naval Publications and Forms Center. 5801 Tabor Avenue, Philadelphia. Pennsylvania 19120. USA, FF-W-92B Washers, Flat (Plain).and RR-G-66'1 E Grating, Metal, Bar Type (Floor, Except for Naval Vessels).
2. American National Standards Institute (ANSI). 1430 Broadway. New York. New York 10018. USA.A 14.3-1984 Fixed Ladders, Safety Requirements.
3. American Society for Testing and Materials Standards 1916 Race street Philadelphia, Pennsylvania 19103. U.S.A
 - A 27 -83 Specifications for Steel Castings, Carbon, for General Application.
 - A 53-82 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc- Coated Welded and Seamless
 - A 123-78 Specification of Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
 - A 153-82 Specification of Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - A 307 -83aSpecification for Carbon Steel Externally Threaded Standard Fasteners.
 - A569-72(79)...Specification of Steel, Carbon (0.15 Maximum, Percent), Hot Rolle Sheet and Strip, Commercial Quality.
 - F593-82 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
4. American Welding AWS.2501 N.W. 7thStreet. Miami. Florida 33125. USA, D1.1-85.Structural Welding Code -Steel.
5. Military Specifications. Naval publications and forms center 5801 Tabor Avenue Philadelphia. Pennsylvania 19120 USA. MIL-P-21035A Paint, High Zinc Content, Galvanizing Repair (Metric).
6. National Association of Architectural Metal Manufacturers. (NAAMM) 221 N. La Salle, Chicago. Illinois 60601, U.S.A Metal Bar Grating Manual -October 1979
7. Steel Structures Painting Council. (SSPC), 440Fifth Avenue. Pittsburgh, Pennsylvania 15213, USA
 - PA1 Shop, Field & Maintenance Painting, November 1.1982.
 - Paint 20 Zinc-Rich Primers (Type1-inorganic and Type 11- organic), November 1, 1982.
 - SP3 Power Tool Cleaning, November 1, 1982.

10.4 Submittals

- TS-583* Submit items in accordance with the contract provision Product Data: Submit Manufacturer's specifications, anchor Details and installation instructions for products used in Miscellaneous metal fabrications, including paint products.
- TS-584* Shop drawings: Submit shop drawings for fabrication and Erection of miscellaneous metal fabrications. Include plan, Elevations and details of sections and connections Show anchorage and accessory items. Provide templates for anchor and bolt installation in critical area. Where materials or fabrications are indicated to comply with certain requirement for design loading, include structural computations, material properties and other information needed for structural analysis.

10.5 Finish

- TS-585* **The finish of the various items of ironmongery shall be as described as shown on the Drawings or as required and directed by the Managing Official.**

10.6 Fitting and testing

- TS-586* All screws used for fixing ironmongery shall be of a suitable type, material, finish, size and shape to the satisfaction of the Managing Official.
- TS-587* The hinges on which doors, windows, flyscreen doors etc., are hung shall be carefully housed or let into the door, window, flyscreen door etc., and to the frames.
- TS-588* All fittings shall be removed before commencing any painting operations and shall be refixed in place after all painting works are completed and approved by the Managing Official.
- TS-589* All ironmongery shall be carefully wrapped and protected until completion of the work and any items or parts which are damaged or defaced or found to be defective shall be replaced at the Contractor's expense before handing over.
- TS-590* On completion of all locks, catches and similar items of ironmongery they shall be clearly labeled, with metal tags approximately 50x20mm and securely fixed to the keys and handed to the Managing Official.
- TS-591* Door closers shall be fitted a maximum of two weeks before handover.
- TS-592* All floor and door springs are to be fully charged with oil and their operation checked to the satisfaction of the Managing Official.

10.7 Standard ironmongery for internal doors

- TS-593* Ironmongery is to be hard satin anodised aluminum alloy of best quality with matching screws fully matching and integrated. Where a supplier cannot offer the particular required ironmongery the Contractor shall produce samples. All locks

are to be provided with 2 keys on a key ring neatly labelled to indicate clearly the corresponding lock.

TS-594 Any requirements for ' Master key ' locking systems will be stated in the contract provision and Drawings.

TS-595 All knob sets shall include the appropriate mortice latch or lock with a 70 mm backset and with standard faceplates and roses unless otherwise noted.

10.8 Standard ironmongery for Trespa® doors and partitions

TS-596 All fittings of trespa doors shall be made exclusively out of stainless steel. Plastic fittings are not accepted.

11 Metal works

11.1 Cleanliness

TS-597 All materials shall be free from scale, damage or defects. All welding, brazing or hot forging shall be carried out by approved processes.

TS-598 Work includes fixing complete to the structure heavy duty dowels and three points to be fixed from each side, architrave, door stopper, ironmongery, cylindrical locks handles (Wally or equal), 6 mm Glazing, gaskets, automatic closing piston, accessories, Hammer Finish painting in three coats in addition to two primer coats as per detailed drawings and Supervision Consultants or the Managing Official's instructions.

TS-599 Metal work shall be approved by the Managing Official before starting painting works.

11.2 Hollow metal doors (and panels)

TS-600 Hollow metal doorframes shall be purpose made to the profiles and sizes shown on the drawings and obtained from an approved manufacturer. The doors shall be delivered to site complete with a factory applied anti-corrosive plastic coating, ties cast on to backs of frames for building in and rubber silencers on the locking stile.

TS-601 The frames shall be stored in a clean, dry place, off the ground and protected from the weather.

- TS-602* The frames shall be free of all dents, bumps, splits, and cracks and any defective frames shall be made good or replaced at the Contractor's own expense.
- TS-603* Hollow metal doorframes shall be fixed and shown on the drawings all in accordance with the manufacturer's printed instructions and flushed up solid with plain concrete or cement mortar.
- TS-604* The rates for hollow metal door frames are to include for the supply and assembly of the complete unit including all necessary hole for fixing in walls in accordance with the manufacturer's printed instructions and plain concrete or mortar filling as shown on the drawings.
- TS-605* Galvanize metal work as specified and describe. and as manufactured.

11.3 Aluminium windows and doors

- TS-606* Extruded aluminium sections should be used as approved by the Managing Official.
- TS-607* All visible surfaces of the sections shall be brilliantly polished prior to anodising. The color of anodising shall be as described in the Drawings and /or 8. Samples of color shall be submitted for the Managing Official's approval before work commences.
- TS-608* The sections shall be anodised to a minimum thickness of 25 microns. The supplier must submit necessary evidence to the satisfaction of the Managing Official that the thickness of anodisation is not less than 25 microns. In case of doubt the Managing Official reserves the right to send sample pieces to independent testing laboratories, at the supplier's expense. If the testing laboratory report states that the thickness or quality of the anodisation is deficient, the Employer may ask the supplier to treat the order as cancelled and the supplier in such a case shall indemnify the Employer of any / all losses incurred by the supplier.
- TS-609* All farms shall be made to fit the actual openings with a 5mm clearance all round. Discrepancies in overall width or height exceeding 5mm will not be allowed and the frames will be rejected in such cases. All small discrepancies shall have the gaps suitably backed and then filled with gun- applied mastic / sealant UV resistance as approved by the Managing Official.
- TS-610* At all opening windows and doors and where there are louvered screens and approval of the Managing Official, constructed following the principles and specifications as described elsewhere in this Specification.
- TS-611* Insect screens shall be in aluminum mesh, 18x16 meshes per inch..The gap between the insect screen and the shutter shall be covered with an adaptor PVC section.
- TS-612* For reference to window types see general arrangement drawings and elevations.
- TS-613* Tolerances are to be approved by the Managing Official before manufacture.
- TS-614* All ironmongery which is to have the same finish as the frames it is to be installed on shall be approved by the Managing Official.
- TS-615* The Contractor shall provide shop drawings for aluminium windows and doors which shall be submitted in quadruplicate to the Managing Official for approval.

- TS-616* Approval by the Managing Official of the shop drawings shall not relieve the Contractor of his responsibilities under the Contract.
- TS-617* All assembly screws shall be in 18-8 stainless steel.
- TS-618* Glazing sections shall be in special heat-resisting PVC and of channel type. Separate glazing sections on each side of the glass will not be permitted.

11.4 Sliding windows and doors

- TS-619* Weatherstripping - highdensity acrilan or wool weather - pile shall be used. There shall be double brushes at every contact between shutter and frame sections for complete insulation. These shall be present consistently throughout the unit between the inside and the outside and no portions without it are permitted.
- TS-620* The rollers for sliding shutters for windows and doors shall be of an adjustable type. The adjusting screws shall be accessible in the assembled state of the shutters and a vertical adjustment of 7mm shall be possible.
- TS-621* All sections for sliding windows and doors shall be of tubular shape and the cross sectional dimensions of same shall be not less than 60x 40 mm.
- TS-622* The outer frame must be suitable for accommodating sliding flyscreens as required or as directed by the Managing Official.
- TS-623* The handle-latch set shall have all visible surfaces of anodised aluminum or similar non-rusting material to approval. The handle shall have a proper grip. A small projecting flange or a recess in the shutter sections shall not be accepted to serve as a handle. The latching mechanism shall not be surface mounted but shall be concealed within the sections.

11.5 Side hung windows, doors and ventilators

- TS-624* All windows and doors shall be weather-stripped with heat resistant PVC sections. The weather fighting action shall be achieved by a positive compressive action against the PVC section and shall not depend on an external contact with the PVC section. At every contact between two profiles two weatherstripping sections shall be provided for complete weather protection.
- TS-625* The bottom sections of hinged doors shall be capable of being adjusted vertically if necessary. The gap between the bottom section and the floor shall be covered with a pair of special flay-type PVC sections.
- TS-626* The shutter sections for windows and doors shall be of tubular type and shall be of overall size 57x45mm for windows and overall size 81x45mm for doors (including flanges).
- TS-627* The shutters of the windows and doors shall be assembled with concealed corners of high rigidity. Hinges shall be concealed within the sections.
- TS-628* Hinges shall be in anodized aluminum with stainless steel pins and nylon washers. Handles shall be in anodized aluminum and mounted with self - lubricating nylon washers.

- TS-629* A mortice cylinder rim automatic deadlock of high quality with double pin tumbler shall be used.
- TS-630* Windows shall have anodized aluminum handles and a latching mechanism securing the shutter to the frame both at the top and bottom.
- TS-631* The glazing vinyl shall be in heat resisting PVC and of channel type to the approval of the Managing Official.

11.6 Mosquito screens

- TS-632* Flyscreens shall be fitted to all opening leaves of windows, consisting of a separate metal sub-frame filled in with fly wire as previously described. The flyscreens shall be adequately secured with suitable clips, set screws or turn buckles and shall be removable for maintenance purposes. sections to the metal casement doors and shall be fitted with removable panels of flywire, in a manner similar to that described for window flyscreens. Flyscreen doors shall be mounted where indicated on the Drawings or as directed by the Managing Official. with better system for fixing and moving fly screens.

11.7 Sealing joints

- TS-633* The Contractor shall ensure that joints are dry and shall remove all loose material, dust and grease.
- TS-634* Joints shall be prepared in accordance with sealant manufacturer's recommendations using recommended solvents and primers where necessary as approved by the Managing Official.
- TS-635* Backing strips shall be inserted in all joints to be pointed with sealant.
- TS-636* When using backing strips, the Contractor shall not leave gaps and shall not reduce depth of joint for sealant to less than the minimum recommended by the manufacturer.
- TS-637* Cavities shall be filled with sealant /mastic joint has to be uv- resistance in accordance with the manufacturer's recommendations.
- TS-638* Joints between frames and walls have to be closed with pre –compressed polyuthean foam sealant Sealant shall be tooled to form a smooth flat bed.
- TS-639* Excess sealant shall be removed from adjoining surfaces using cleaning materials recommended by the sealant manufacturer, and shall be left clean.

11.8 Expansion joint trims, etc.

- TS-640* The Contractor is to provide at all expansion joints in floors , roofs, ceilings , walls and columns extruded aluminum expansion joint cover systems as appropriate and as shown on the Drawings and fixed in accordance with their printed instructions including all necessary components and fixings.

11.9 Steel pipe railings and handrails.

TS-641 Fabricate Steel pipe railings and handrail to design, dimensions, and details indicated. Furnish railings and handrail members formed of the sized indicated conforming to ASTM A53, standard weight, galvanized.

TS-642 Fabrication jointing of post, rail, and corners shall be by one of the following methods:

- 1. Flush-type rail fittings of commercial standard welded and ground smooth with railing splice locks secured with 10 mm hexagonal-recessed-head set screws.**
- 2. Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight-fitting interior sleeve not less than 152 mm (6 inches) long.**
- 3. Railings may be bent at corners in lieu of jointing, provide bends are made in suitable jigs and that the pipe is not crushed.**
- 4. Furnish wall returns at ends of wall-mounted handrails.**
- 5. Close exposed ends of pipe by welding 5mm (3/16-inch) thick steel plate in place or by use of prefabricated fittings.**
- 6. Furnish removable railing where indicated.**
- 7. Handrails shall be capable of withstanding a concentrated load of 91 Kg. (200 pounds) applied at any point in any direction.**
- 8. Pipe 50mm dia. meter steel pipe welded joints.**
- 9. Posts 25mm diameter steel pipe; welded joints.**
- 10. Fitting Flanges fixed by screws.**
- 11. Mounting Adjustable flanges, with screws casting in concrete.**
- 12. Exposed Fasteners flush countersunk screws or bolts; consistent with design of railing.**
- 13. Splice Connectors Steel welding collars.**
- 14. Galvanized or stainless screws to be used**

TS-643 Floor joint covers shall be 5cm deep. Butt joints within continuing runs shall be a maximum of 6.00m apart and will be sealed during installation.

TS-644 Wall and ceiling joint covers shall be standard grey.

TS-645 Transition pieced at changes of direction and at joints between horizontal and vertical joint covers shall be factory fabricated.

12 Painting and decorating

12.1 General

TS-646 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.

- TS-647* Primed or undercoated woodwork and metalwork should not be left in an exposed or unsuitable situation for an 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.
- TS-648* Any external paints have to be UV-Resistant.
- TS-649* 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 refixed in position.
- TS-650* 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 painting operations including the provision of all necessary dust sheets, covers etc.
- TS-651* Brushes, pails, bottles 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 material.
- TS-652* The number of coats stated in this specification is the minimum, and the Contractor must apply sufficient coats to achieve a proper even finish to the approval of the Managing Official.

12.2 Materials

- TS-653* The decorating materials shall be obtained from approved manufacturers and shall be supplied in the manufacturers' sealed and branded containers.
- TS-654* All materials must be thoroughly stirred before use, unless not recommended by the manufacturer.
- TS-655* All paints shall be environmentally friendly and for the use in internal rooms.
- TS-656* Details of mixing and application shall be in accordance with the specifications of the manufacturers concerned and to the approval of the Managing Official.
- TS-657* The mixing of paints etc. of different brands before or during application will not be permitted. No dilution of painting materials shall be allowed except strictly as detailed by the manufacturers and as approved by the Managing Official.
- TS-658* Mordant solution shall be of approved manufacture.
- TS-659* Rust inhibitors shall be of approved manufacture.
- TS-660* Stopping for woodwork to receive clear finish shall be tinted to match surrounding woodwork, to the approval of the Managing Official.
- TS-661* Stopping for internal woodwork, plywood, hardboard, and fiberboard, shall be linseed oil putty, tinted to match the color of the undercoat.
- TS-662* Stopping for external woodwork shall be white lead paste and gold size well mixed.
- TS-663* Thinners shall be approved turpentine or white spirit.

TS-664 Priming paints shall be:

1. **For woodwork: Leadless grey priming paint in accordance with the recommendations of the decorative coating manufacturer.**
2. **For steelwork: red oxide priming paint.**
3. **For galvanized, zinc or aluminum alloy surfaces: grey zinc chromate priming paint.**
4. **For plaster, concrete and brickwork, ceiling boards etc.: alkali resisting priming paint in accordance with the recommendations of the decorative coating manufacturer.**

TS-665 Knotting shall be in accordance with BS 1336.

TS-666 Undercoating shall be:

1. **Zinc oxide based undercoating paint;**
2. **White lead based undercoating paint. Colors shall approximate to the finishing paint.**
3. **Synthetic alkyd based undercoating in accordance with the recommendations of the decorative coating manufacturer.**

TS-667 Finishing paints shall be:

1. **Zinc oxide based oil paint:**
2. **White lead based oil gloss finishing paint.**
3. **Synthetic alkyd-based finishing paint as approved by the Managing Official.**

TS-668 Petrifying liquid shall be used undiluted as supplied by the manufacturer. a small quantity of water paint of the finishing color may be mixed with the petrifying liquid.

TS-669 Water paint shall be an approved brand of washable oil-bound water paint. Thinning shall be done with petrifying liquid or fresh water only.

TS-670 Emulsion paint shall be of the Polyvinyl Acetate (PVA) type obtained from an approved manufacturer. The precise specification shall comply with the manufacturer's normal practice. In all cases thinning shall be done with thinners supplied by the manufacturer or fresh water only.

TS-671 Stain for woodwork shall be an approved brand of oil stain.

TS-672 Polyurethane lacquer for woodwork shall be in accordance with the recommendation of the manufacturer.

12.3 Preparation process

12.3.1 Internal plaster, fair faced concrete and blockwork

TS-673 Surfaces shall be allowed to dry out completely and cracks shall be cut out and made good with suitable hard plaster or cement and sand mix as appropriate, such repaired portions shall be allowed to dry out. No painting shall be carried out on plastering less than five weeks old.

- TS-674* Efflorescence shall be completely removed by rubbing down with dry coarse cloths followed by wiping down with damp cloths and allowed to dry. All surfaces shall be rubbed down with fine glass paper and brushed free of dust before applying any form of decoration.
- TS-675* Surfaces which are to receive water paint shall be treated with one coat of petrifying liquid applied by brush and allowed to dry for at least 24 hours before the application of water paint. A period of 24 hours or longer if necessary, shall be allowed between subsequent coats.
- TS-676* Fair faced concrete and/or cement and sand plastered surfaces which are to receive oil paint shall be given one thin coat of oil putty and allowed to dry for at least two days .
- TS-677* The surfaces shall then be rubbed down with fine glass paper and given a second thin coat of oil putty and when completely set The surfaces shall then be rubbed down with fine glass paper and given a second thin coat of oil putty and when completely set
- TS-678* All surfaces which are to receive oil paint shall be treated with one coat of alkali resisting priming paint applied by brush and allowed to completely harden.

12.3.2 Fiber acoustic boards etc.

- TS-679* Execution only by instructions and approval of the Managing Official in accordance with the recommendations of the manufacturer.
- TS-680* SOFT BOARDS: where used externally or under humid conditions will receive one coat of priming paint and one coat of undercoat on back face and edges.
- TS-681* SOFT BOARDS: where used internally will receive one coat of priming paint and one coat of emulsion paint on back, face and edges.
- TS-682* HARD BOARD: composite panels will be treated in the same way as soft boards under humid conditions.
- TS-683* ACOUSTIC BOARDS: will be treated on the face in the same way as plaster, but the paint may be applied by spray; the backs and edges should not be treated.

12.3.3 Steelwork including windows, louvers etc. Internally and externally

- TS-684* Execution only by instructions and approval of the Managing Official in accordance with the recommendations of the manufacturer.
- TS-685* If delivered galvanized, the surfaces shall be cleaned to remove grease and dirt before priming. Where rusting has occurred through damage to the galvanizing, such rust shall be removed by wire brushing back to clean metal and the galvanizing made good with a rust inhibiting agent.
- TS-686* The surface shall then be treated with one coat of mordant solution and one coat of zinc chromate priming paint.
- TS-687* If delivered primed, the 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, and reprimed. 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 red oxide priming paint after removal of rust.

- TS-688* If delivered unprimed and not galvanized, the surfaces shall be cleaned to remove grease and dirt, and wire brushed and scraped to remove all rust and scale before applying a red oxide priming paint.
- TS-689* Priming paint shall be brushed well into the surface and shall be allowed to dry and harden thoroughly before the application of subsequent coats.
- TS-690* Items of steelwork such as frames to roller shutters, covers to expansion joints etc., which are to be built into walls, shall first be primed.

12.3.4 Exposed service pipes

- TS-691* Copper and brass pipework shall have the surfaces slightly abraded with glass paper and white spirit or similar solvent and wiped clean. No priming paint will be necessary, the surfaces being finished in two coats of gloss paint.
- TS-692* Steel pipes will be treated as for steelwork with the exception that galvanized pipes are to be treated with a zinc-chromate priming paint.
- TS-693* Coated soil pipes shall be wiped clean and treated with two coats of knotting followed by priming paint as described below.

12.3.5 Woodwork required to be painted

- TS-694* Surfaces shall be cleaned to remove grease and dirt. The surface of teak shall be cleaned with white spirit to remove free oil. Tropical timber should be avoided The preparation process shall then be:
- KNOT: all knots shall be treated with shellac knotting
 - PRIME: one coat of primer shall be thoroughly applied by brush to all surfaces and when dry a further coat to be applied to end-grain surfaces.
 - STOP : when priming paint is hard , all cracks , holes , open joints etc. shall be made good with hard stopping and all open grain surfaces filled smooth with linseed oil putty or an approved filler and rubbed down with fine glass paper .
- TS-695* No joinery shall be primed until it has been approved by the Managing Official Priming shall be carried out on the site and not in the factory.
- TS-696* Items of carpentry work which are to be built into walls etc. shall be first treated by twice coating with creosote or other approved preservative. And shall be environmentally friendly and for the use in internal rooms.

12.3.6 Woodwork required to be not stained

- TS-697* Surfaces shall be cleaned to remove grease and dirt. The wood shall then be stopped, filled and rubbed down. In the case of teak free oil shall be removed by cleaning with white spirit.
- TS-698*

12.4 Finishing processes

12.4.1 Internal plaster

- TS-699** Where emulsion paint is specified three coats shall be applied by brush or sprayed in addition to any priming paint.
- TS-700** Where water paint is specified two coats shall be applied by brush or sprayed, in addition to the Petrifying liquid. The water paint shall be thinned to the consistency of thick cream.
- TS-701** Where oil paint is specified this shall be two or three coat work as detailed in the particular Specification, applied by roller or brush , but not by spray , to produce hard gloss , oil gloss , eggshell or flat finish As required .
- TS-702** The finishing coat of paint to walls and ceilings shall be applied after the completion and testing of the electrical installation. Any paint splashes on electrical fittings shall be carefully cleaned off.

12.4.2 Fiber Boards etc.

- TS-703** Both acoustic and plain soft or hard boards will be treated as for plaster, but the paint has to be applied by spray.
- TS-704** Water paint or emulsion paint shall be applied by brush to the specification of the manufacturers. Where a board is likely to be exposed to extreme humidity, i.e kitchen and external corridors and covered ways, an oil paint shall be used on the face after fixing.

12.4.3 Unplastered blockwork or concrete

- TS-705** As for internal plastered surfaces.
- TS-706** Externally a cement type paint may be used, and shall be applied keeping a constantly wet edge, in strict accordance with the manufacturer's instructions.

12.4.4 Steelwork and Exposed Service Pipes

- TS-707** Internally, apply one coat of hammer finished paint over two undercoats.
- TS-708** Non-ferrous pipes shall be finished in two coats of gloss paint.
- TS-709** Externally, apply two coats gloss paint over one undercoat.
- TS-710** Paints has to be avoided high maintenance and to apply the paint according to manufacturer recommendation.

12.5 Woodwork required to be stained and polyurethaned

- TS-711** The woodwork, internally and externally, shall be stained as directed on site, rubbed down, brushed off, and treated with two coats of polyurethane.

12.6 Protection of factory finished work

- TS-712* The contractor is to allow for protecting all factory finished doors, frames windows, suspended ceilings and the like at all times to ensure that factory finishes are not damaged and must make good or replace a defective component at his own expense.

12.7 Epoxy Painting for Outdoor Playground Concrete Base

12.7.1 Scope of Work

- TS-713* Provide all labor, materials, tools, and equipment necessary to prepare the concrete substrate and apply epoxy-based coating on the outdoor playground area, ensuring a safe, durable, weather-resistant, and aesthetically pleasing surface.

12.7.2 Materials

- TS-714* **Epoxy Primer:**
- TS-715* Type: Two-component, solvent-free or low-VOC epoxy primer
- TS-716* Function: Enhance adhesion and seal the concrete
- TS-717* Application rate: 0.2–0.3 kg/m² depending on substrate porosity
- TS-718* **Epoxy Top Coat (Colored):**
- TS-719* Type: Two-component outdoor-grade epoxy paint with UV-resistant polyurethane or aliphatic epoxy finish (if exposed to direct sunlight)
- TS-720* Thickness: Minimum dry film thickness 300–500 microns (multiple coats as required)
- TS-721* Slip Resistance: Add anti-slip aggregates or fine silica sand in top layer
- TS-722* Colors: As specified (e.g., red, blue, green – safe and vivid for playground use)
- TS-723* **Line Marking (If Required):**
- TS-724* Type: UV-resistant epoxy or polyurethane marking paint
- TS-725* Colors: Contrasting to base coat
- TS-726* Width: As per drawing or design (typical 50–100 mm)

12.7.3 Surface Preparation

- TS-727* Concrete base must be fully cured (minimum 28 days) and dry
- TS-728* Surface to be free from dust, grease, oils, laitance, or previous coatings
- TS-729* Surface roughening by mechanical grinding, shot blasting, or acid etching
- TS-730* Surface moisture content: <5% (test with moisture meter)
- TS-731* Repair cracks or defects using epoxy mortar or filler

12.7.4 Application Method

- TS-732* Apply epoxy primer using brush, roller, or airless spray
- TS-733* Allow primer to cure as per manufacturer instructions
- TS-734* Mix and apply epoxy top coat in two or more layers
- TS-735* Embed anti-slip additive into the first coat or apply in final coat
- TS-736* Apply line markings after top coat has cured
- TS-737* Follow manufacturer's re-coat intervals and curing time strictly

12.7.5 Environmental Conditions

- TS-738* Ambient temperature: 10°C to 35°C during application
- TS-739* Relative humidity: Max. 85%
- TS-740* No application during rain, fog, or when dew is likely
- TS-741* Ensure protection from dust and debris during curing

12.7.6 Testing and Quality Control

- TS-742* Visual inspection for uniform color, texture, and finish
- TS-743* Adhesion test as per ASTM D3359 or equivalent
- TS-744* Slip resistance test (e.g., BS 7976 or ASTM E303) – required for safety
- TS-745* Film thickness checks using dry film thickness gauge

12.7.7 Safety and Environmental

- TS-746* Use PPE including gloves, goggles, and respirators
- TS-747* Ensure adequate ventilation during application
- TS-748* Dispose of leftover materials and containers per local environmental regulations

12.7.8 Final Acceptance

- TS-749* The coated area should be smooth, non-slip, free of pinholes, cracks, or discoloration
- TS-750* Curing period: Minimum 3–7 days before allowing foot traffic or play equipment use
- TS-751* Approval required by project engineer or supervising authority.

12.8 Thermoplastic Paint for Playgrounds on Asphalt Base

12.8.1 Scope of Work

- TS-752* Provide all labor, materials, and equipment necessary for the supply and application of **preformed or molten thermoplastic markings** on asphalt surfaces in outdoor playgrounds, including surface preparation, layout, heating, and fixing.

12.8.2 Materials

Thermoplastic Paint Composition:

- TS-753* Type: Preformed sheets or hot-applied thermoplastic road marking material
- TS-754* Composition: Binder resins, pigments, glass beads (for reflectivity), and filler
- TS-755* Conformance: Should comply with EN 1436 / BS 3262 / AASHTO M249 or local standard
- TS-756* Colors: Bright and fade-resistant (e.g., red, yellow, blue, green, white)
- TS-757* Thickness: Minimum 2.0 mm – 4.0 mm depending on type (standard is ~3 mm)
- TS-758* Optional: Pre-mixed anti-slip aggregates or surface texturing for safety

Primer (as required):

- TS-759* Asphalt primer to improve adhesion, especially in cold or porous surfaces
- TS-760* Compatible with thermoplastic material used

12.8.3 Surface Preparation

- TS-761* Asphalt surface must be clean, dry, and free of dust, oils, loose particles, and moisture
- TS-762* No application on freshly laid asphalt; minimum curing time of 2–4 weeks
- TS-763* Use mechanical blowing, brushing, or pressure washing to clean the surface
- TS-764* Repair any cracks or depressions before applying markings

12.8.4 Application Method

Preformed Thermoplastic (Cold Installation):

- TS-765* Layout design and align according to drawings
- TS-766* Heat the surface and/or the preformed markings with propane torch or hot air gun
- TS-767* Apply heat until material melts and adheres fully
- TS-768* Press with roller to ensure bonding and embedment of glass beads if needed

Hot-Applied Thermoplastic (In Situ Application):

- TS-769* Heat thermoplastic in a pre-heater to 180–210°C (as per manufacturer specs)
- TS-770* Pour and screed material using manual or mechanical applicators
- TS-771* Add glass beads immediately for reflectivity and skid resistance
- TS-772* Allow to cool and harden (typically within 5–10 minutes)

12.8.5 Environmental Conditions

- TS-773* Surface temperature: Minimum 10°C and rising
- TS-774* Ambient temperature: 10–40°C
- TS-775* Do not apply during rain or when surface is damp
- TS-776* Avoid windy conditions that may interfere with heating

12.8.6 Finishing and Quality

- TS-777* Markings must be sharp, consistent in color and thickness, with smooth edges
- TS-778* Adherence should be firm with no lifting or bubbling
- TS-779* Slip resistance and wear resistance must be suitable for playground use
- TS-780* Optional: Add texture for tactile or decorative effects

12.8.7 Testing and Inspection

- TS-781* Visual inspection for edge definition, coverage, and color quality
- TS-782* Bond test to ensure proper adhesion to asphalt
- TS-783* Slip resistance testing (especially if play surface is elevated or sloped)
- TS-784* Thickness measurement using micrometer or depth gauge

12.8.8 Safety and Environmental Considerations

- TS-785* Use PPE: heat-resistant gloves, goggles, respirators for fume exposure
- TS-786* Ensure site safety during heating and application
- TS-787* Proper ventilation when using torch or gas equipment
- TS-788* Dispose of excess material and packaging according to regulations

12.8.9 Acceptance Criteria

- TS-789* All markings must conform to approved layout/design
- TS-790* No peeling, cracking, or discoloration within the warranty period
- TS-791* Fully hardened before allowing pedestrian/playground use (typically <30 minutes)

13 Glazing

13.1 Sheet glass

TS-792 Sheet glass shall be flat-drawn clear sheet glass, of the substances shown below.

Nominal Substance or thickness	Limits of thickness		Approximate Weight	Normal .Maximum Size
	mm	inch	lb/ft2	inch
20 oz	2.75-3.05	0.108-0.120	1 1/2	80x48
26 oz	3.1-3.50	0.122-0.138	1 3/4	80x48
32 oz	3.8-4.20	0.150-0.165	2	80x48
3/16 in	4.65-5.25	0.183-0.207	2 1/2	50 ft2 max width 84 in
7/32 in	5.3-5.80	0.209-0.228	3	50 ft2 max width 84 in
1/4 in	6.25-6.75	0.246-0.266	3 1/2	75 ft2 .max width 84 in

13.2 Plate glass

TS-793 Plate glass shall be cast, rolled or drawn glass ground and polished on both surfaces, of the thickness shown below.

Table 15. Limits for Clear Plate Glass

Nominal Substance or thickness	Limits of thickness		Approximate Weight	Normal .Maximum Size
	mm	inch	lb/ft2	inch
3/16	3.97-5.56	0.156-0.219	2 1/2	100x72
1/4	5.56-7.94	0.219-0.312	3 1/4	175x98
3/8	9.13-10.72	0.359-0.422	5	280x130
1/2	11.91-13.49	0.469-0.531	6 1/2	156x96

13.3 Obscured glass

TS-794 Obscured glass shall be figured rolled glass, and of the thicknesses shown below.

Nominal Substance or thickness	Limits of thickness		Approximate Weight	Normal .Maximum Size
	mm	inch	lb/ft2	inch
1/8	2.94-4.4	0.116-0.173 .	1 1/2	100x48
3/16	4.5 -6.1	0.177-0.240	2 1/2	100x48
1/4	6.0 -7.0	0.237-0.276	3 1/2	100x48

13.4 Wired glass

TS-795 Wired glass shall be polished Georgian wired having both surfaces ground and polished and with square mesh inserted during rolling, of the thicknesses shown below.

Table 16. Limits for Wired Glass

Nominal thickness	Limits of thickness		Approximate Weight	Normal .Maximum Size
	mm	inch	lb/ft ²	inch
1/4	5.5-7.2	0.216-0.283	3 1/2	130x72

13.5 Heat - absorbing glass

TS-796 Heat-absorbing glass shall be floated glass substantially opaque to infra-red radiations of the thicknesses shown below.

TS-797 Limits for Heat Absorbing Plate Glass

- **Nominal thickness:.. 6mm**
- **Light transmittance:.. 0.49**
- **Reflectance:..0.10**
- **Absorptance:..0.34**
- **Shading coefficient:..0.76**
- **Normal maximum size:..4500 x 2500mm**

13.6 Armor-plated glass

TS-798 Armor-plated glass shall be toughened safety glass made of heat-treated polished plate of the thickness shown below.

Table 17. Limits For Armor-plated Glass

Nominal thickness	Limits of thickness		Approximate Weight	Normal Maximum Size
	mm	Inch	lb/ft ²	inch
1/4	5.56-7.94	0.219-.312	3 1/2	2600x1520
3/8	9.13-10.72	0.359-0.422	5	3950x1520
1/2	11.91-13.49	0.469-0.531	6 1/2	3950x1520

13.7 Mirror glass

TS-799 Mirror glass shall be silvering Quality polished plate glass silvered on one side, copper-backed, varnished and painted of the thickness given in clause 2.02. Edges of mirrors shall be beveled.

13.8 Putty

TS-800 Putty for glazing to metal shall be tropical grade metallic glazing quality and shall be approved.

13.9 Glazing beads

- TS-801* Wooden glazing beads shall be of teak, splayed and rounded to the sizes shown in the Drawings and neatly metered and braded .No tropical timber shall be used.
- TS-802* Metal beads shall be supplied with metal windows and doors and these shall be sprung or screwed on according to design.

13.10 Glazing to wood without beads

- TS-803* The rebates shall be previously treated with one coat of priming paint and the bedding putty inserted. The glass shall be embedded in the putty and secured by sprigs .The front putty shall be inserted to form a triangular miter filling from the edge of the rebate to 2mm from the sight line. The bedding putty shall be trimmed off level with the sight line to form neat back putty.
- TS-804* When the putty has hardened sufficiently the painting shall be carried out and care shall be taken to seal the joint between putty and glass by painting up to the sight line.

13.11 Glazing to wood with beads

- TS-805* The rebates shall be previously treated with one coat of priming paint and the bedding putty inserted. The glass shall be embedded in the putty and secured by the beads.
- TS-806* The bedding putty shall be trimmed off level with the sight line to from neat back putty and the painting shall be carried out.

13.12 Glazing to metal without beads

- TS-807* The rebate shall be previously treated either by rust proofing or priming as described elsewhere and the bedding putty inserted. The glass shall be embedded in the putty and secured by pegs or .clips inserted in holes in the rebates.
- TS-808* The front putty shall be inserted to from a triangular mitred filling from the edge of the rebate to 2mm back from the sight line. The bedding putty shall be trimmed off level with the sight line to from a neat back putty. When the putty has hardened sufficiently the painting shall be carried out and care shall be taken to seal the joint between putty and glass by painting up to the sight line.

13.13 Glazing to metal with beads

- TS-809* The rebates shall be previously treated by rust proofing or priming as described elsewhere and the bedding putty inserted. The glass shall be embedded in the putty and secured by the Beads. The bedding putty shall be trimmed off level with the sight line to from neat back putty and painting shall be carried out.

13.14 Glazing without putty

TS-810 Where specified, wash leather, ribbon velvet, flannel, felt, or putty for internal glazing in conjunction with beads. The material should be fitted so that it covers all parts of the glass which will be covered by the rebate and bead.

13.15 Mirrors

TS-811 Mirrors shall be fixed to walls with compressive spacers, fiber washers and chromium plated dome - headed screws, screwed into prepared plugs let into walls and set flush with surrounding wall finish.

TS-812 Mirrors used as wardrobe doors or as wall linings are to be bedded with an approved mastic on a painted block - board backing not less than 12mm (1/2") thick to walls and 18mm (3/4") thick to doors. Glass sizes will be whole size to doors and minimum 900mm (3'0") wide to wall linings unless otherwise detailed, and backings continuous where possible.

TS-813 Joints in backings must coincide with joints in mirrors.

13.16 Cleaning, etc.

TS-814 The Contractor shall replace all scratched, cracked or broken glass and clean all glazing on both sides and all mirrors before handing over.

13.17 Tempered glass

13.17.1 Definitions

TS-815 Heat-treated glasses are classified as either fully tempered or heat strengthened. According to Federal Specification DD-G-1403B, fully tempered glass must have a surface compression of 10,000 psi or more or an edge compression of 9,700 psi or more. Heat-strength glass must have a surface compression between 3,500 and 10,000 psi, or an edge compression between 5,500 and 9,700 psi. The fracture characteristics of heat-strengthened glass vary widely from very much like annealed glass near the 3,500 psi level to similar to fully tempered glass at the 10,000 psi level.

13.17.2 Heat treatment principle

TS-816 Glass can fracture when its surfaces or edges are placed into tension. Under these conditions inherent surface or edge fissures may propagate into visible cracks.

TS-817 The basic principle employed in the heat-treating process is to create an initial condition of surface and edge compression. This condition is achieved by first heating the glass, then cooling the surfaces rapidly. This leaves the center glass thickness relatively hot compared to the surfaces. As the center thickness then cools, it forces the surfaces and edges into compression. Wind pressure, missile impact, thermal stresses or other applied loads must first overcome this compression before there is any possibility of fracture.

13.17.3 Strength

TS-818 Under wind pressure, tempered glass is approximately four times as strong as annealed glass. It resists breakage by small missiles traveling approximately twice as fast as missiles which break annealed glass. Tempered glass is also able to resist temperature differences (200 ° F - 300 ° F) which would cause annealed glass to crack.

	Annealed Glass	Tempered Glass
Typical Breaking Stress (large light 60 sec. load)	6,000 psi	24,000 psi
Typical Impact Velocity Causing Fracture (1/4" light 5 gm missile, impact normal to surface)	30 ft/sec	60 ft/sec

13.17.4 Safety

TS-819 Fully tempered glass is used in many applications because of its safety characteristics. Safety comes from strength and from a unique fracture pattern. Strength, which effectively resists wind pressure and impact, provides safety in many applications. When fully tempered glass breaks the glass fractures into small, relatively harmless fragments. This phenomenon called "dicing," markedly reduces the likelihood of injury to people as there are no jagged edges or sharp shards.

TS-820 Fully tempered glass is a safety glazing material when manufactured to meet the requirements of the ANSI Z97.1 Standard and Federal Standard CPSC 16 CFR 1201. Federal Standard CPSC 16 CFR 1201, as well as state and local codes, require safety glazing material where the glazing might reasonably be exposed to human impact. This includes doors, tub and shower enclosures, side lights, and certain windows. Applicable building codes should be checked for specific information and requirements.

13.17.5 Uses for tempered glass

TS-821 Fully tempered glass is used traditionally in place of other glass products in applications requiring increased strength and reduced likelihood of injury in the event of breakage. The building industry, motor vehicle industry and certain manufacturing industries find tempered glass is effective and economical in a wide range of applications. Fully tempered glass can satisfy federal, state and local building code requirements for safety glazing in such applications as doors, side lights, shower and tub enclosure, and interior partitions. It is also used in storm doors, patio-door assemblies, and escalator and stairway balustrades. As a glazing product it is used in windows and in spandrel areas (for wind pressure, small missile impact and thermal stress resistance). Special building applications include sloped glazing, racquetball courts, skylights (see below), and solar panels.

TS-822 Any conditions or requirements imposed in the applicable safety glazing laws and building codes limiting such special uses should be determined prior to glazing.

TS-823 The domestic motor vehicle industry employs tempered glass as side and rear windows in automobiles, trucks, and multi-purpose vehicles. Manufacturing industries use tempered glass in refrigerators, furniture, ovens, shelving, and fireplace screens.

TS-824 Tempered glass should not be used where building codes require wired glass for fire-spread resistance. Tempered glass should not be used, alone, where the objective is to provide security against forced entry or bullet passage. Combinations of annealed and tempered glass can be effective barriers against forced entry and bullet impact, if properly designed and constructed. When using tempered glass in fireplace screens, provisions must be made for expansion and edge insulation

13.17.6 Tempered glass in sloped glazing and skylights

TS-825 Because of its high resistance to thermal stresses and small missile impact, tempered glass is used in skylights and sloped glazing. On rare occasions when tempered glass in these applications fails, it may fail completely from the opening, individual fragments from tempered glass are relatively small and harmless. A number of these fragments may be loosely joined and fall in this manner. Such pieces do not have the sharp edges normally associated with broken glass but may have significant weight. Some building codes may require the use of screens under skylights. The use of screens may also be dictated by considering the risk of breakage and the resulting consequences.

13.17.7 Handling and installation

TS-826 Tempered glass should receive the same care as annealed glass. Unfortunately, familiarity with the greatly improved strength of tempered glass may mislead people to exert less care in handling it. Careless handling and improper installation sometimes produce edge damage. Delayed breakage can ensue when edge-damaged tempered glass is subjected to a moderate thermal or mechanical stress. Full penetration of the compression layer will likely produce instantaneous total fragmentation of tempered glass. Hence, tempered glass cannot be cut or modified following heat treatment.

13.17.8 Imperfections

TS-827 Inclusions in glass originate from impurities in the batch or cullet, or are combined from furnace refractories. Common forms of inclusions include aluminous stones, iron stones, and silicon. Nickel sulfide stones are uncommon, microscopic defects in glass, and may cause breakage. Delayed breakage may occur when a nickel sulfide stone is present near the center of the glass thickness.

TS-828 The tempering process rarely introduces imperfections into glass. The basic glass may contain bubbles, vents, chips, and inclusions which, if accepted or not revealed by inspection before tempering can cause breakage in the initial heating or final quench operations. If inclusions are not eliminated by self-destruction during the tempering process, in rare cases they may lead to failure at a later time.

13.17.9 Visual appearance

TS-829 Tempered glass possesses the basic optical qualities of annealed glass. The induced stress condition sometimes produces a slight bow in tempered glass lights. Tempered glass that has been manufactured in a vertical tempering oven contains small surface depressions resembling dimples along one edge. These marks are caused by the pointed metal tongs which support the glass during its passage through the oven. Glass which is passed horizontally through an oven may contain

a very slight surface wave caused by contact with the rollers. The waviness can sometimes be detected when viewing reflected images from a large distance. Finally, the air quench nozzles discharge air in a fixed, reciprocating or rotating motion. The area of air quench can be seen through polarized glass as arrays of iridescent spots or lines. Under some lighting conditions these patterns can be seen in ordinary light.

14 METAL WORKS- Fence works

14.1 14.1 Scope of Work

The work includes the supply, fabrication, delivery, and installation of galvanized metal fencing composed of tubular metal frames and perforated metal panels, complete with all accessories, surface treatment, fixings, foundations, and anchoring systems, as shown on drawings and described herein.

14.2 Materials

14.2.1 Steel Tubes:

- TS-830* Type: Hot-dip galvanized steel
- TS-831* Size: As per drawings (typical range: 40x40 mm to 100x100 mm)
- TS-832* Thickness: Minimum 2.0 mm for main frames and 1.5 mm for secondary supports
- TS-833* Galvanizing: Minimum 275 g/m² (according to EN ISO 1461 or ASTM A123)

14.2.2 Perforated Metal Panels:

- TS-834* Material: Galvanized steel or aluminum (if specified)
- TS-835* Sheet Thickness: Minimum 1.5 mm
- TS-836* Perforation Pattern: Round, square, or slot holes as per architectural intent
- TS-837* Open Area: Typically 30–50%
- TS-838* Edges: Rolled or framed to prevent injury and improve rigidity

14.2.3 Fasteners and Accessories:

- TS-839* Bolts, screws, washers, and rivets: Stainless steel or galvanized steel
- TS-840* Anchor bolts: Mechanical or chemical anchors suitable for concrete base
- TS-841* Gaskets or spacers: Neoprene or compatible non-corrosive material

14.3 Fabrication

- TS-842* All components shall be shop-fabricated to the maximum extent possible.

- TS-843* Welded joints shall be continuous and ground smooth.
- TS-844* Perforated panels shall be securely framed or edge-treated to ensure structural integrity.
- TS-845* Surfaces must be free of burrs, sharp edges, rust, and scale.

14.4 Finishing

- TS-846* Galvanizing: All steel components shall be hot-dip galvanized after fabrication.
- TS-847* Powder Coating (if specified): UV-resistant polyester powder, min. 60 µm thick, color as specified (e.g., RAL 7016)
- TS-848* Panels must be free of cracks, drips, or other coating defects.

14.5 Installation

14.5.1 Setting Out:

- TS-849* Fence lines and post locations to be set out according to drawings.
- TS-850* Levels and alignment to be maintained using string lines or laser levels.

14.5.2 Post Foundations:

- TS-851* Foundations to be cast-in-place concrete (Grade C25/30 or equivalent)
- TS-852* Minimum dimensions: 300 mm x 300 mm x 600 mm deep (or as per design)
- TS-853* Posts embedded min. 400 mm or as required for structural stability

14.6 Erection:

- TS-854* Posts installed plumb and level
- TS-855* Perforated panels fastened securely to posts or frames with anti-theft or tamper-resistant fixings
- TS-856* Expansion joints or thermal movement considerations applied for long runs

14.7 Final Adjustment and Cleaning:

- TS-857* All components aligned and tightened
- TS-858* Clean all surfaces and touch up minor damages with cold galvanizing paint
- TS-859* Remove protective films or coatings after final installation

14.8 Testing and Acceptance

- TS-860* Visual inspection of alignment, coating, and fixing integrity
- TS-861* Pull-out test for anchor bolts (if specified)
- TS-862* Approval by the supervising engineer prior to handover

15 Drainage

15.1 Scope

- TS-863* This Specification deals with the installation of the materials, fittings and equipment, the design and performance, the workmanship and the testing and commissioning of the below ground drainage.
- TS-864* This Specification is in addition to and will be read in conjunction with the Contract Drawings and relevant parts of the Contract Documents.

15.2 General

- TS-865* Works shall be constructed in accordance with BS CP 301: 1971 Building Drainage. The Contractor shall notify the Managing Official of discrepancies between BS CP 301 and the working drawings and specifications.
- TS-866* Pipes and fittings shall be jointed and laid in accordance with the manufacturer's recommendations. The Contractor shall notify the Managing Official of discrepancies between the manufacturer's recommendations and the design.
- TS-867* Unless otherwise stated, the provisions of the latest revised additions of relevant British Standards and Codes of Practice shall be held to be incorporated in the specification of materials and workmanship.
- TS-868* Drains shall be accurately laid, true to line and grade from point to point. Manholes shall be provided at changes of direction or gradient and at points of connection. Drain runs between manholes should be absolutely straight. Lines and falls shall be accurately set as shown on Drawings or as directed on Site.
- TS-869* Pipe work materials shall be as stated in the Particular Conditions or on the Drawings.
- TS-870* The Contractor shall perform all necessary excavation for drains, manholes, septic tanks, soak ways etc., uphold sides, level or .grade bottoms , return fill and ram and remove surplus spoil as directed .
- TS-871* The system shall be maintained in accordance with Clause 6 of CP 301.

15.3 Pipework

- TS-872* Excavation of any section of the work shall not start until a complete set of the pipes and components for that section is available.
- TS-873* The trench shall be as narrow as practicable but not less than the pipe diameter plus 300 mm from each side to permit adequate compaction of side fill. Adequate working space shall be left for pipe jointers and joint holes shall be formed where necessary.
- TS-874* The trench sides shall be kept vertical unless the approved use of a batter is unavoidable. In the latter case the sides of the trench shall be kept vertical up to 300mm above the top of the pipe. If over width excavation occurs at or below this level the trench shall be reformed using concrete to 300mm above the level of the top of the pipe or the Managing Official's approval shall be obtained for the proposed bedding for the wider trench condition.
- TS-875* Bedding material shall be:
- (a) Local karkar .
 - (b) Sand to BS 882 Zones 1 - 4.
- TS-876* Pipes and fittings shall be inspected before fixing, and defective items shall be rejected.
- TS-877* Pipes shall be laid with the socket ends against the flow and shall rest on a solid and even bearing for the full length of the barrel .
- TS-878* Trenches shall be back-filled only after drains have been tested to the satisfaction of the Managing Official.
- TS-879* Flexible pipes including pitch fiber pipes, UVC pipes, steel pipes and tubes and ductile iron pipes shall be laid on a granular or sand bed. The trench shall be excavated below the invert level of the pipe to depth that will allow a minimum thickness of 200mm of Sand as bedding material which shall extend to the full width of the trench.
- TS-880* In rocky ground a minimum of 200mm of granular or sand bed shall be used.
- TS-881* The bedding material shall be well tamped down on the trench bottom which shall be free from hard or soft spots.
- TS-882* The finished bottom shall be true to line and gradient.
- TS-883* Rigid pipes including vitrified clayware, cement pipes, grey iron pipes and concrete pipes shall either be laid on a granular or sand bed or on a concrete base in the trench bottom. The type of base provided shall depend on the nature of the trench formation and the presence of ground water.
- TS-884* Where the nature of the ground is such as to allow the trench formation to be trimmed to provide a uniform and solid bearing, pipes shall be laid upon the formation. Socket and joint holes shall be as short as practicable and shall be scraped or cut into the formation.
- TS-885* Where because of the nature of the ground or the presence of ground water pipes cannot be laid directly on the trench formation, the trench shall be excavated below the invert level of the pipe to a depth to allow a minimum thickness of 200mm of

granular bedding material which shall extend the full width of the trench. The bedding material, trench, etc., shall be as for flexible pipes.

- TS-886* Where pipes are to be laid with a concrete bed, bed and haunch or surrounds, the trench bottom shall be prepared as for the laying of pipes on a granular bed but with a layer of concrete at least 50mm thick. The pipes shall be supported clear of the trench bottom by blocks or cradles placed under the pipe and immediately behind each socket for short small pipes with a second block near the spigot end for long or large pipes.
- TS-887* The support should yield under load sufficiently to permit the barrel of the pipe to rest uniformly on its bed after the normal setting shrinkage of the concrete has occurred. The clearance under the barrel before placing the concrete should be not less than 100mm. The concrete bed or haunch should extend to 150mm on each side of the pipe.
- TS-888* Concrete shall not be laid until the drain has been approved by the Managing Official.
- TS-889* Where rigid pipes with flexible joints are employed with a concrete bed, haunch or surround a simple constructional flexible joint shall be provided in the concrete and at the face of a pipe joint at intervals of not more than 5 meters to reduce the natural rigidity of the concrete.
- TS-890* The first 300mm of filling above the top of pipes and the filling around the pipes shall be placed by hand over the pipe and compacted by hand in finished layers of 150mm to a maximum of 300mm and shall be selected material, carefully rammed around the pipes. The material shall be distributed equally to both sides of the pipe to buttress it to the sides of the trench. Subsequent filling shall be placed, rammed and watered if necessary in 300mm thick layers. Drains shall be kept free from earth, sand, surplus mortar and other obstructions during laying. Adequate cover shall be provided before using power compactors or heavy rollers.
- TS-891* Vitrified clay pipes and concrete pipes with more than 4.25 m of earth cover shall be laid on a 150mm thick bench of concrete and be haunched with concrete 150mm thick to at least the horizontal diameter of the pipe and above that level splayed tangentially to the extrados.
- TS-892* Where vitrified clay pipes and concrete pipes with more than 6 m of earth cover are used or where the pipes are laid in a heading or the cover is less than 1.2m if the pipes are laid in roads or 0.90 m elsewhere, the pipe shall be completely surrounded with concrete to a thickness of not less than 150mm.
- TS-893* The width of concrete beds shall be 150mm greater than the external diameter of the pipe on both sides.
- TS-894* Where drains run beneath buildings they shall be constructed of UPVC-SN8 pipe and shall be encased in concrete on bottom, top and both sides to a thickness of 150mm greater than the external diameter of the pipe and adequate flexibility in the pipeline shall be allowed.
- TS-895* The Managing Official shall be consulted if pipes are to be laid with less than 600mm of cover or within 150mm of the underside of a concrete slab.
- TS-896* The head of every drainage system shall be ventilated and such ventilating pipes shall, where possible, be fixed against the outside face of an external wall unless

otherwise shown on the Drawings and carried up to a height of 900mm above that part of the structure immediately adjacent to it. The ventilating pipe shall be fitted with a galvanized or copper wire balloon at the top.

- TS-897* Except where branches or other fittings occur, the top length of each ventilating stack shall consist of a complete length of pipe which shall be anchored 1.20 m from the top by means of wrought steel strap fixed as described elsewhere and painted to match the pipe. Any short length required to make up the length of the stack shall be fitted immediately below the top length.

15.4 UPVC pipes and fittings

- TS-898* UPVC-SN8 pipes and fittings shall comply with BS 4660.
- TS-899* All pipes and fittings on all soil, waste and vent pipes shall be in Unplasticised Polyvinyl Chloride, with solvent weld cement joints, to pipes and fittings.
- TS-900* All branch waste and vent pipes from basins and sinks to stacks, floor gullies, collection boxes and manholes shall be in modified UPVC-SN4 with seal ring joints suitable to receive high temperature water discharge.
- TS-901* Fittings and coupling for use with UPVC pipes shall be jointed with solvent cement in accordance with manufacturer recommendations.
- TS-902* Fittings and coupling for use with UPVC pipes on movement joints shall be jointed with an incorporate synthetic rubber rings in accordance with the manufacturer recommendations.
- TS-903* Slip on cover plates shall be provided as a finish to pipe work, up to and including 50mm diameter, emerging from a wall in occupied areas other than service voids. Samples shall be first submitted to the Managing Official for approval.
- TS-904* On pipe work up to and including 50 mm diameter union type fittings shall be provided to make up to outlets of basin, bath and sink wastes.
- TS-905* Access plates shall be fitted at the roof of each vertical stack at changes, to enable the complete disposal system to be internally cleaned and ridded.
- TS-906* Soil, waste and vent stacks above their highest branches shall be continued up words, at their full diameter, above roof level.

15.5 Safety

- TS-907* The Contractor shall provide, maintain and uphold safety measures adequate for the particular hazards of drainage works for all his employees. All safety measures taken by the Contractor should be approved by the Managing Official.
- TS-908* Such approval will not affect the full responsibility of the contractor toward the safety of all his employees, the supervision staff and any other third party existing on site.
- TS-909* The Contractor shall ensure that all timbering, shuttering, staging, strutting, ladders etc., used in drain trenches and pits are adequate for the duty involved .

15.6 Manholes

- TS-910* Manhole dimensions shall be as shown on Drawings.
- TS-911* Manholes shall be constructed from approved precast concrete rings.
- TS-912* Manholes, chambers, Septic tanks, disintegration and settling tanks and percolating pits shall be constructed in the positions and to the dimensions shown on the Drawings or as directed by the Managing Official . The method of execution of all work in connection with these shall be as elsewhere described in the appropriate trades.
- TS-913* Manhole base slabs shall be according to drawings, and .at least 150mm thick grade (A) concrete or as directed and approved by the Managing Official.
- TS-914* Manhole cover slabs shall be a minimum of 150mm thick suitably reinforced grade (A) concrete, where also approved precast covers can be used.
- TS-915* Precast concrete manholes shall comply with BS 556.
- TS-916* Manhole sections shall be jointed using a cement and sand mortar, 1 : 2 , proprietary bituminous or resin fillers . Where flexible fillers are used their shape, thickness and location in the joint shall be in accordance with the manufacturer's recommendations. The remainder of the joint shall be filled with a cement and sand mortar 1: 2, to prevent settlement of the sections with possible point contact and subsequent spalling of the concrete joint.
- TS-917* Precast concrete manholes used below water table level shall be surrounded with a minimum thickness of 150mm concrete which shall be not less than a 1:2:4 mix.
- TS-918* Sulphate resisting cements shall be used in concrete and mortar, or accepted epoxy paint should be made for all concrete and mortars facing the waste water.
- TS-919* Cast iron manhole covers and frames shall comply with BS 497 except that the bituminous based protective coating shall not flow or chip when exposed to temperatures in the range of 0°C to 76.7°C.
- TS-920* Manholes exceeding 1.00 meter deep internally shall have a minimum internal diameter of 80 cms.
- TS-921* Where required the channels in manhole bottoms shall be constructed of glazed earthenware channels jointed in a similar manner to the pipes. Alternatively when so described the channels shall be formed in fine concrete finished smooth. The channels shall be semi circular in section and the concrete shall then be carried up vertically for a distance of 80mm at each side and sloped back at a minimum fall of 1: 10.
- TS-922* The benching shall be of fine concrete and shall be rendered over in cement and sand (1: 3) mix. Pipes entering manholes shall not project beyond the face of the internal rendering. The invert of the pipes and the channels shall be continuous. All benching surfaces should be painted by approved epoxy paint.
- TS-923* Covers and frames shall comply with the following:
- GRADE A: Heavy duty covers suitable for heavy fast-moving wheeled traffic (25 tons)
 - GRADE B: Medium duty covers suitable where heavy commercial vehicles would be exceptional (8 tons).

- **GRADE C:** Light duty covers suitable for pedestrian traffic only (5 tons).

TS-924 Manhole covers situated inside buildings or on verandahs shall be as follows:

- Double seal type cover and frame or
- Frame with ground - fit airtight cover manufactured for use inside buildings.

TS-925 Manhole frames shall be bedded and pointed with cement and sand mortar and the rebates sealed with manhole grease.

TS-926 Step irons shall be located and comply with BS CP 301, Clause 3.12.5.1.

TS-927 Channels and benching shall comply with BS CP 301.

TS-928 Where cast iron inspection chambers are shown on the Drawings these are to comply with BS 1130 using caulked joints and gasket sealed covers set in concrete block manholes benched to top of cover level. The manhole cover required can be single seal in lieu of double seal.

15.7 Septic tanks

TS-929 Septic tanks shall be sized and constructed of reinforced concrete for all sides with a block layer around the tank and according to drawings and specification mentioned in the POQ as shown and constructed as stated in BS CP 302 unless otherwise stated.

TS-930 External Walls of septic tanks shall be at least 300mm thick.

TS-931 Where indicated on the drawings the Contractor shall provide an intercepting trap with cleaning arm and lever-locking stopper to be set in cement mortar in the intercepting manhole adjacent to the septic tank or inside the site boundary in the case of main drainage. The normal drop from inlet to outlet of trap shall be preserved. A fresh air inlet shall be taken to the intercepting manhole with 100mm cast iron drain pipes with an easy bend to a point just below ground level.

TS-932 Septic tanks shall meet the requirements of the local Authority.

15.8 Soakaways

TS-933 Soakaways shall be constructed in one of the following ways:

- Precast concrete rings to BS 556.
- 200mm (min) cast in situ concrete.

TS-934 Cover and base slabs shall be at least 150mm thick Grade (A) reinforced concrete, or precast covers according to Specification and as directed and approved by the Managing Official.

TS-935 Removable covers shall be as described for manhole covers.

TS-936 Soakaways shall be of the sizes and in the positions shown on the Drawings or as directed on site by the Managing Official.

TS-937 Soakaways constructed in cast in situ concrete shall have walls of at least 200mm thicknesses.

TS-938 Soakaways shall meet the requirements of the Local Authority.

15.9 Connections to existing manholes and drains

TS-939 When work is being undertaken on existing drains and manholes including the construction of new manholes, building in pipes, cutting through manhole walls, cutting out and reforming benching, completing pipe entries and making good the Contractor shall keep existing drains open to flow and reasonably free from debris at all times during the progress of works.

TS-940 On completion all work shall be in a watertight condition.

15.10 Cleaning, protection and testing of drains

TS-941 The Contractor shall remove all silt and foreign matter from drains and manholes and leave the whole in a clean and workable condition.

TS-942 In the event of delay between the laying of a drain and the placing of the first 300mm of back filling over the top of the pipe, precautions shall be taken to protect the pipes from damage arising from differential exposure to sun or wind.

TS-943 Lengths of drain, manholes and inspection chambers shall be capable of withstanding the test. The test shall be applied after laying and before back filling or placing concrete surround and bedding concrete.

TS-944 Leakage of the section under test, including sweating, which causes a drop in the test water level shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses.

TS-945 The test shall be repeated after back filling and any faults in the bedding or support of the pipe, inadequacies in design or accidental damage during, or subsequent to, back filling, shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses.

TS-946 Whenever possible testing shall be carried out from manhole to manhole.

TS-947 Testing shall not be started until at least 48 hours after completion of the last joint.

TS-948 Tests before back filling:

- The section shall be filled with water and after about one-hour test readings shall be taken.
- A test pressure of 1.2m head of water shall be applied at the high end of the section (but not less than 2.4m at the low end). Steeply graded mains shall be tested in sections.
- The loss of water over a period of 30 minutes shall be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the quantity required to maintain the original water level in the standpipe.
- The average quantity of water added shall not exceed 0.06 liters per hour per 100 linear meters per
- Millimeter of nominal bore of the drain.
- For sections of drain where the highest point is more than 1.2m below the water table the following infiltration test shall be undertaken.

- Inlets to the system shall be closed. Visual inspection at manholes or inspection chambers will reveal any flow the cause of which shall be investigated and the faults rectified.
- Tests for line, level and freedom from obstruction shall be applied by means of a mirror at one end of the drain and a lamp at the other.

TS-949 Final test:

- The water test shall be repeated in accordance with the requirements of the Local Authority or the Managing Official.

TS-950 Tests have to be carried out only in company of the This Specification deals with the installation of the materials, fittings and equipment, the design and performance, the workmanship and the testing and commissioning of the below ground drainage.

TS-951 This Specification is in addition to and will be read in conjunction with the Contract Drawings and relevant parts of the Contract Documents.

TS-952

15.11 General

TS-953 Works shall be constructed in accordance with BS CP 301: 1971 Building Drainage. The Contractor shall notify the Managing Official of discrepancies between BS CP 301 and the working drawings and specifications.

TS-954 Pipes and fittings shall be jointed and laid in accordance with the manufacturer's recommendations. The Contractor shall notify the Managing Official of discrepancies between the manufacturer's recommendations and the design.

TS-955 Unless otherwise stated, the provisions of the latest revised additions of relevant British Standards and Codes of Practice shall be held to be incorporated in the specification of materials and workmanship.

TS-956 Drains shall be accurately laid, true to line and grade from point to point. Manholes shall be provided at changes of direction or gradient and at points of connection. Drain runs between manholes should be absolutely straight. Lines and falls shall be accurately set as shown on Drawings or as directed on Site.

TS-957 Pipe work materials shall be as stated in the Particular Conditions or on the Drawings.

TS-958 The Contractor shall perform all necessary excavation for drains, manholes, septic tanks, soak ways etc., uphold sides, level or .grade bottoms , return fill and ram and remove surplus spoil as directed .

TS-959 The system shall be maintained in accordance with Clause 6 of CP 301.

15.12 Pipework

TS-960 Excavation of any section of the work shall not start until a complete set of the pipes and components for that section is available.

- TS-961* The trench shall be as narrow as practicable but not less than the pipe diameter plus 300 mm from each side to permit adequate compaction of side fill. Adequate working space shall be left for pipe jointers and joint holes shall be formed where necessary.
- TS-962* The trench sides shall be kept vertical unless the approved use of a batter is unavoidable. In the latter case the sides of the trench shall be kept vertical up to 300mm above the top of the pipe. If over width excavation occurs at or below this level the trench shall be reformed using concrete to 300mm above the level of the top of the pipe or the Managing Official's approval shall be obtained for the proposed bedding for the wider trench condition.
- TS-963* Bedding material shall be:
- (a) Local karkar .
 - (b) Sand to BS 882 Zones 1 - 4.
- TS-964* Pipes and fittings shall be inspected before fixing, and defective items shall be rejected.
- TS-965* Pipes shall be laid with the socket ends against the flow and shall rest on a solid and even bearing for the full length of the barrel .
- TS-966* Trenches shall be back-filled only after drains have been tested to the satisfaction of the Managing Official.
- TS-967* Flexible pipes including pitch fiber pipes, UVC pipes, steel pipes and tubes and ductile iron pipes shall be laid on a granular or sand bed. The trench shall be excavated below the invert level of the pipe to depth that will allow a minimum thickness of 200mm of Sand as bedding material which shall extend to the full width of the trench.
- TS-968* In rocky ground a minimum of 200mm of granular or sand bed shall be used.
- TS-969* The bedding material shall be well tamped down on the trench bottom which shall be free from hard or soft spots.
- TS-970* The finished bottom shall be true to line and gradient.
- TS-971* Rigid pipes including vitrified clayware, cement pipes, grey iron pipes and concrete pipes shall either be laid on a granular or sand bed or on a concrete base in the trench bottom. The type of base provided shall depend on the nature of the trench formation and the presence of ground water.
- TS-972* Where the nature of the ground is such as to allow the trench formation to be trimmed to provide a uniform and solid bearing, pipes shall be laid upon the formation. Socket and joint holes shall be as short as practicable and shall be scraped or cut into the formation.
- TS-973* Where because of the nature of the ground or the presence of ground water pipes cannot be laid directly on the trench formation, the trench shall be excavated below the invert level of the pipe to a depth to allow a minimum thickness of 200mm of granular bedding material which shall extend the full width of the trench. The bedding material, trench, etc., shall be as for flexible pipes.
- TS-974* Where pipes are to be laid with a concrete bed, bed and haunch or surrounds, the trench bottom shall be prepared as for the laying of pipes on a granular bed but with

a layer of concrete at least 50mm thick. The pipes shall be supported clear of the trench bottom by blocks or cradles placed under the pipe and immediately behind each socket for short small pipes with a second block near the spigot end for long or large pipes.

- TS-975* The support should yield under load sufficiently to permit the barrel of the pipe to rest uniformly on its bed after the normal setting shrinkage of the concrete has occurred. The clearance under the barrel before placing the concrete should be not less than 100mm. The concrete bed or haunch should extend to 150mm on each side of the pipe.
- TS-976* Concrete shall not be laid until the drain has been approved by the Managing Official.
- TS-977* Where rigid pipes with flexible joints are employed with a concrete bed, haunch or surround a simple constructional flexible joint shall be provided in the concrete and at the face of a pipe joint at intervals of not more than 5 meters to reduce the natural rigidity of the concrete.
- TS-978* The first 300mm of filling above the top of pipes and the filling around the pipes shall be placed by hand over the pipe and compacted by hand in finished layers of 150mm to a maximum of 300mm and shall be selected material, carefully rammed around the pipes. The material shall be distributed equally to both sides of the pipe to buttress it to the sides of the trench. Subsequent filling shall be placed, rammed and watered if necessary in 300mm thick layers. Drains shall be kept free from earth, sand, surplus mortar and other obstructions during laying. Adequate cover shall be provided before using power compactors or heavy rollers.
- TS-979* Vitrified clay pipes and concrete pipes with more than 4.25 m of earth cover shall be laid on a 150mm thick bench of concrete and be haunched with concrete 150mm thick to at least the horizontal diameter of the pipe and above that level splayed tangentially to the extrados.
- TS-980* Where vitrified clay pipes and concrete pipes with more than 6 m of earth cover are used or where the pipes are laid in a heading or the cover is less than 1.2m if the pipes are laid in roads or 0.90 m elsewhere, the pipe shall be completely surrounded with concrete to a thickness of not less than 150mm.
- TS-981* The width of concrete beds shall be 150mm greater than the external diameter of the pipe on both sides.
- TS-982* Where drains run beneath buildings they shall be constructed of UPVC-SN8 pipe and shall be encased in concrete on bottom, top and both sides to a thickness of 150mm greater than the external diameter of the pipe and adequate flexibility in the pipeline shall be allowed.
- TS-983* The Managing Official shall be consulted if pipes are to be laid with less than 600mm of cover or within 150mm of the underside of a concrete slab.
- TS-984* The head of every drainage system shall be ventilated and such ventilating pipes shall, where possible, be fixed against the outside face of an external wall unless otherwise shown on the Drawings and carried up to a height of 900mm above that part of the structure immediately adjacent to it. The ventilating pipe shall be fitted with a galvanized or copper wire balloon at the top.

- TS-985* Except where branches or other fittings occur, the top length of each ventilating stack shall consist of a complete length of pipe which shall be anchored 1.20 m from the top by means of wrought steel strap fixed as described elsewhere and painted to match the pipe. Any short length required to make up the length of the stack shall be fitted immediately below the top length.

15.13 UPVC pipes and fittings

- TS-986* UPVC-SN8 pipes and fittings shall comply with BS 4660.
- TS-987* All pipes and fittings on all soil, waste and vent pipes shall be in Unplasticised Polyvinyl Chloride, with solvent weld cement joints, to pipes and fittings.
- TS-988* All branch waste and vent pipes from basins and sinks to stacks, floor gullies, collection boxes and manholes shall be in modified UPVC-SN4 with seal ring joints suitable to receive high temperature water discharge.
- TS-989* Fittings and coupling for use with UPVC pipes shall be jointed with solvent cement in accordance with manufacturer recommendations.
- TS-990* Fittings and coupling for use with UPVC pipes on movement joints shall be jointed with an incorporate synthetic rubber rings in accordance with the manufacturer recommendations.
- TS-991* Slip on cover plates shall be provided as a finish to pipe work, up to and including 50mm diameter, emerging from a wall in occupied areas other than service voids. Samples shall be first submitted to the Managing Official for approval.
- TS-992* On pipe work up to and including 50 mm diameter union type fittings shall be provided to make up to outlets of basin, bath and sink wastes.
- TS-993* Access plates shall be fitted at the roof of each vertical stack at changes, to enable the complete disposal system to be internally cleaned and ridded.
- TS-994* Soil, waste and vent stacks above their highest branches shall be continued upwards, at their full diameter, above roof level.

15.14 Safety

- TS-995* The Contractor shall provide, maintain and uphold safety measures adequate for the particular hazards of drainage works for all his employees. All safety measures taken by the Contractor should be approved by the Managing Official.
- TS-996* Such approval will not affect the full responsibility of the contractor toward the safety of all his employees, the supervision staff and any other third party existing on site.
- TS-997* The Contractor shall ensure that all timbering, shuttering, staging, strutting, ladders etc., used in drain trenches and pits are adequate for the duty involved .

15.15 Manholes

- TS-998* Manhole dimensions shall be as shown on Drawings.

- TS-999* Manholes shall be constructed from approved precast concrete rings.
- TS-1000* Manholes, chambers, Septic tanks, disintegration and settling tanks and percolating pits shall be constructed in the positions and to the dimensions shown on the Drawings or as directed by the Managing Official . The method of execution of all work in connection with these shall be as elsewhere described in the appropriate trades.
- TS-1001* Manhole base slabs shall be according to drawings, and .at least 150mm thick grade (A) concrete or as directed and approved by the Managing Official.
- TS-1002* Manhole cover slabs shall be a minimum of 150mm thick suitably reinforced grade (A) concrete, where also approved precast covers can be used.
- TS-1003* Precast concrete manholes shall comply with BS 556.
- TS-1004* Manhole sections shall be jointed using a cement and sand mortar, 1 : 2 , proprietary bituminous or resin fillers . Where flexible fillers are used their shape, thickness and location in the joint shall be in accordance with the manufacturer's recommendations. The remainder of the joint shall be filled with a cement and sand mortar 1: 2, to prevent settlement of the sections with possible point contact and subsequent spalling of the concrete joint.
- TS-1005* Precast concrete manholes used below water table level shall be surrounded with a minimum thickness of 150mm concrete which shall be not less than a 1:2:4 mix.
- TS-1006* Sulphate resisting cements shall be used in concrete and mortar, or accepted epoxy paint should be made for all concrete and mortars facing the waste water.
- TS-1007* Cast iron manhole covers and frames shall comply with BS 497 except that the bituminous based protective coating shall not flow or chip when exposed to temperatures in the range of 0OC to 76.7OC.
- TS-1008* Manholes exceeding 1.00 meter deep internally shall have a minimum internal diameter of 80 cms.
- TS-1009* Where required the channels in manhole bottoms shall be constructed of glazed earthenware channels jointed in a similar manner to the pipes. Alternatively when so described the channels shall be formed in fine concrete finished smooth. The channels shall be semi circular in section and the concrete shall then be carried up vertically for a distance of 80mm at each side and sloped back at a minimum fall of 1: 10.
- TS-1010* The benching shall be of fine concrete and shall be rendered over in cement and sand (1: 3) mix. Pipes entering manholes shall not project beyond the face of the internal rendering. The invert of the pipes and the channels shall be continuous. All benching surfaces should be painted by approved epoxy paint.
- TS-1011* Covers and frames shall comply with the following:
- GRADE A: Heavy duty covers suitable for heavy fast-moving wheeled traffic (25 tons)
 - GRADE B: Medium duty covers suitable where heavy commercial vehicles would be exceptional (8 tons).
 - GRADE C: Light duty covers suitable for pedestrian traffic only (5 tons).
- TS-1012* Manhole covers situated inside buildings or on verandahs shall be as follows:
- Double seal type cover and frame or

- Frame with ground - fit airtight cover manufactured for use inside buildings.

TS-1013 Manhole frames shall be bedded and pointed with cement and sand mortar and the rebates sealed with manhole grease.

TS-1014 Step irons shall be located and comply with BS CP 301, Clause 3.12.5.1.

TS-1015 Channels and benching shall comply with BS CP 301.

TS-1016 Where cast iron inspection chambers are shown on the Drawings these are to comply with BS 1130 using caulked joints and gasket sealed covers set in concrete block manholes benched to top of cover level. The manhole cover required can be single seal in lieu of double seal.

15.16 Septic tanks

TS-1017 Septic tanks shall be sized and constructed of reinforced concrete for all sides with a block layer around the tank and according to drawings and specification mentioned in the POQ as shown and constructed as stated in BS CP 302 unless otherwise stated.

TS-1018 External Walls of septic tanks shall be at least 300mm thick.

TS-1019 Where indicated on the drawings the Contractor shall provide an intercepting trap with cleaning arm and lever-locking stopper to be set in cement mortar in the intercepting manhole adjacent to the septic tank or inside the site boundary in the case of main drainage. The normal drop from inlet to outlet of trap shall be preserved. A fresh air inlet shall be taken to the intercepting manhole with 100mm cast iron drain pipes with an easy bend to a point just below ground level.

TS-1020 Septic tanks shall meet the requirements of the local Authority.

15.17 Soakaways

TS-1021 Soakaways shall be constructed in one of the following ways:

- Precast concrete rings to BS 556.
- 200mm (min) cast in situ concrete.

TS-1022 Cover and base slabs shall be at least 150mm thick Grade (A) reinforced concrete, or precast covers according to Specification and as directed and approved by the Managing Official.

TS-1023 Removable covers shall be as described for manhole covers.

TS-1024 Soakaways shall be of the sizes and in the positions shown on the Drawings or as directed on site by the Managing Official.

TS-1025 Soakaways constructed in cast in situ concrete shall have walls of at least 200mm thicknesses.

TS-1026 Soakaways shall meet the requirements of the Local Authority.

15.18 Connections to existing manholes and drains

TS-1027 When work is being undertaken on existing drains and manholes including the construction of new manholes, building in pipes, cutting through manhole walls, cutting out and reforming benching, completing pipe entries and making good the Contractor shall keep existing drains open to flow and reasonably free from debris at all times during the progress of works.

TS-1028 On completion all work shall be in a watertight condition.

15.19 Cleaning, protection and testing of drains

TS-1029 The Contractor shall remove all silt and foreign matter from drains and manholes and leave the whole in a clean and workable condition.

TS-1030 In the event of delay between the laying of a drain and the placing of the first 300mm of back filling over the top of the pipe, precautions shall be taken to protect the pipes from damage arising from differential exposure to sun or wind.

TS-1031 Lengths of drain, manholes and inspection chambers shall be capable of withstanding the test. The test shall be applied after laying and before back filling or placing concrete surround and bedding concrete.

TS-1032 Leakage of the section under test, including sweating, which causes a drop in the test water level shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses.

TS-1033 The test shall be repeated after back filling and any faults in the bedding or support of the pipe, inadequacies in design or accidental damage during, or subsequent to, back filling, shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses.

TS-1034 Whenever possible testing shall be carried out from manhole to manhole.

TS-1035 Testing shall not be started until at least 48 hours after completion of the last joint.

TS-1036 Tests before back filling:

- The section shall be filled with water and after about one-hour test readings shall be taken.
- A test pressure of 1.2m head of water shall be applied at the high end of the section (but not less than 2.4m at the low end). Steeply graded mains shall be tested in sections.
- The loss of water over a period of 30 minutes shall be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the quantity required to maintain the original water level in the standpipe.
- The average quantity of water added shall not exceed 0.06 liters per hour per 100 linear meters per
- Millimeter of nominal bore of the drain.
- For sections of drain where the highest point is more than 1.2m below the water table the following infiltration test shall be undertaken.
- Inlets to the system shall be closed. Visual inspection at manholes or inspection chambers will reveal any flow the cause of which shall be investigated and the faults rectified.

- Tests for line, level and freedom from obstruction shall be applied by means of a mirror at one end of the drain and a lamp at the other.

TS-1037 Final test:

- The water test shall be repeated in accordance with the requirements of the Local Authority or the Managing Official.

TS-1038 Tests have to be carried out only in company of the .

16 Mechanical works

16.1 Layout

TS-1039 The Layout of the fitting and pipe work is approximate and diagrammatic only. The Contractor shall be responsible for laying out the fittings and equipment together with the service pipe work to satisfaction of the Managing Official.

16.2 Pipe work and fittings for services

16.2.1 Piping

TS-1040 Each part of the piping systems shall be complete in all details and provided with all control valves and accessories necessary for satisfactory operation.

TS-1041 The drawings indicate generally the sizes of all main piping, and while the sizes are not to be decreased the Managing Official reserves the right to change the runs and sizing of piping to accommodate conditions arising during construction.

TS-1042 All pipe work, valves, fittings etc. are to be as detailed for various services in the Schedules.

TS-1043 All piping shall be grouped wherever practical and shall be erected to present a neat appearance. Pipes shall be parallel to each other and parallel or at right angles to structural members of the building and shall give maximum possible headroom .

TS-1044 All pipe drops shall be truly vertical, drain piping shall pitch down in direction of flow, and all pipework shall be installed with a continuous gradient to allow natural circulation, air venting and drainage. Levels are to be approved by the Managing Official.

TS-1045 Run outs shall be graded in such a manner as to prevent air traps being formed within them when the mains expand or contract.

TS-1046 Pipes erected in plant rooms, vertical shafts or false ceiling spaces shall be arranged to provide maximum access, and generally all pipe work installed in voids, shafts or false ceilings and in other places where subsequent access is likely to be difficult and where ease of dismantling is not required, shall have welded joints.

TS-1047 Sufficient space is to be allowed for accessibility for servicing. No joints shall be formed in the thickness of walls, floors or ceilings.

- TS-1048* Where pipes are to pass through reinforced concrete this must be ascertained before the concrete is cast and approval must be obtained for size of hole to be formed.
- TS-1049* The Contractor is responsible for ascertaining the thickness of plaster and other wall finishes, skirting heights, sill lengths and floor finishes and routing pipe work to suit.
- TS-1050* Where pipework is to be insulated , it shall be fitted in such a manner as to allow each pipe to be insulated the full circumference and also to allow the prescribed clearance, after insulation between the insulation and walls, floors, ceilings, other pipes or the insulation on other pipes , to any other surfaces.
- TS-1051* Where pipes pass through or near walls, partitions or in chases, sufficient space must be left for the complete insulation treatment to be continued without interruption.
- TS-1052* The Contractor shall be deemed to have included in his tender for work in setting pipes around all work and apparatus connected with other trades such as piers, wastes , drains , girders etc.
- TS-1053* All reductions in sizes of horizontal piping shall be installed with eccentric fittings to maintain a level bottom.
- TS-1054* Overflow and other warning pipes shall be fitted so that they discharge in obvious positions. Lightweight hinged weather flaps shall be provided which will close against wind pressure and open when discharging.
- TS-1055* Pipe connections to equipment and valves shall be flanged for sizes 65 mm and above and with unions for other sizes, and shall be arranged for easy dismantling and removal.
- TS-1056* All branches from mains shall be taken from the top of the main wherever practicable and shall be made in such a manner as to allow for expansion and contraction in both main and branch.
- TS-1057* All sets, double sets and springs shall be formed on long lengths of tube with as large a radius as possible and shall be free from distortion.
- TS-1058* The Contractor shall supply and install malleable iron unions for all pipes, up to and including 50 mm nominal bore to form removable joints at intervals of approximately 18 m and wherever difficulty in dismantling might occur.
- TS-1059* All pipework shall be free of corrosion and without any signs of scaling pitting or excessive weathering, to the satisfaction of the Managing Official.
- TS-1060* Pipes stored on site shall be kept clean and off the ground and where possible stored under cover. Pipes corroded beyond normal "stock rust" conditions shall not be used.
- TS-1061* The Contractor shall ensure that all tubes are free from internal obstructions. All burred and cut ends of pipes shall be well reamed and filed to ensure that the full bore of the pipes is maintained. The Contractor shall take special care to prevent dirt or rubbish entering the open ends of all pipework during storage and erection. Screwed iron caps or plugs or plastic caps shall be used for this purpose.

- TS-1062* Wood, rag, paper or other inadequate material will not be permitted. A valve fitted at an open pipe end shall not be considered adequate protection. Should any stoppage in the circulation occur after the various systems have been put into operation owing to non-compliance with these requirements the Contractor shall attend and rectify the matter at his own expense. Further information regarding flushing out of pipework system is given elsewhere in the Specification.
- TS-1063* The Contractor will ensure that at no part of any one system does he include, either in contact or at a distance, dissimilar metals which will promote chemical or electro-chemical action, causing a weakening or failure of the service. This applies not only to the internal surfaces but also the external surfaces of all pipes, fittings, valves, plant, vessels, pumps and any other item of equipment in the installation.
- TS-1064* Where pipes are held in vices, as when screwing, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted.
- TS-1065* The average depth of the inverts of mains below ground level shall be 60 cm minimum. The Contractor shall mark out and accept the entire responsibility for the correct positioning of the trenches required, both as regards line and level, and shall collaborate to the best of his ability with the Main Contractor in order to ensure adherence to the program, and to avoid lengths of trench being opened up unnecessarily soon or remaining open unnecessarily long after the pipes have been satisfactorily tested. Depths of mains and branches must be approved by the Managing Official.
- TS-1066* Where piping is buried underground it shall be wrapped with PE (High density polyethylene protection insulation) of thickness 1.5 mm. factory applied. All wrapping shall be approved by the Managing Official before the trench is filled in.
- TS-1067* Any pipework which, in the opinion of the Managing Official, does not conform as to material and workmanship with this specification shall be removed and refixed at the expense of the Contractor.

16.2.2 Joints

- TS-1068* Reduction in pipe diameters shall be made by using one fitting only, be it reducing elbow, tee or coupling.
- TS-1069* Where standard fittings are not available in the configuration required reductions to the run and branch connections shall be made with reducing sockets. Bushes will not be permitted.
- TS-1070* Branch connections to mains may be employed where the sizes of the branch is two or more smaller than the size of the main. Generally sweep branches shall be made except for tees on headers, or where a sweep fitting would cause air to be trapped.
- TS-1071* Upon completion welded joints shall be thoroughly cleaned with a stiff wire brush and screwed joints shall have jointing compound removed.

16.2.3 Plastic piping

- TS-1072* Plastic pipes shall be used only if approved by the Managing Official (in all cases UPVC SN8 pipes must be used).

TS-1073 Cleaning fluids and solvent cements shall be suitable for use in the local ambient air conditions and operatives shall be fully trained in Their use by attendance at an installation course organized by the manufacturers of the particular piping system.

16.2.4 Valves and Cocks

TS-1074 All valves and cocks for the services in which they are installed shall comply with the requirements of the appropriate Water Authority, and the Contractor shall include for any testing and stamping which the Authorities may require.

TS-1075 Valves are to be provided as indicated and at all places necessary for the proper working, regulation, control and maintenance of the installation.

TS-1076 Valves shall be either screwed or flanged in accordance with the Specification for the pipe work into which they are installed and as directed by the Managing Official.

TS-1077 Where flanged valves are specified, flanges are to correspond to appropriate BS specified in respect of the piping.

TS-1078 Gate valves shall be used for shut-off purposes and globe valves shall be used for balancing purposes. All valves shall be designed for packing under pressure when fully open. Gate valves shall comply with BS 5154 or 5150. All valves must be approved by the Managing Official.

TS-1079 Taps and stop cocks shall comply with BS 1010 and shall be marked with the manufacturer's name or trade mark and the nominal size. All taps and stops cocks must be approved by the Managing Official.

TS-1080 Valves shall be marked with the manufacturer's name or trade mark , the .nominal size and the class number and must be approved by .the Managing Official.

TS-1081 Mixing valves shall comply with BS 1415 and shall be marked with the manufacturer's name and trade mark and the nominal size, and must be approved by the Managing Official.

16.3 Pipe installation

TS-1082 All piping shall be properly supported or suspended on stands, clamps, hangers, etc. of approved design. Supports shall be designed to permit free expansion and contractions while minimizing vibration. Pipes shall be anchored as directed by means of steel clamps securely fastened to the pipe and rigidly attached to the building structure.

TS-1083 Screw threads shall be cut clean and true and joints made tight without caulking. No bushing shall be used. Reducing fittings shall be used to change pipe size, and reductions to be made with eccentric reducers, short radius fittings shall not be used.

TS-1084 The drawings indicated generally the size and location of piping as designed for space conditions; ceilings heights and may not be changed until coordinated other contractors. If it is seemed necessary to modify the piping system the contractor shall size the pipes on the basic of 3-6 fps. Velocity and re-check pump heads which are presently indicative and for purposes of an estimate.

- TS-1085* Piping shall be properly graded to secure easy circulation and prevent noise and water hammer. As much pitch as space conditions allow must be given. Capped dirt pockets to be installed at all risers heel, low points, and other places where dirt may accumulate must be provided. Allowance must be made for proper provision for expansion and contractions in all portions of pipe work to prevent undue strain in piping or machines. Expansion joints to be installed as directed by the Managing Official.
- TS-1086* All fittings such as elbow, tees, bushes etc. shall be of best quality foreign made or local class "A" according local standard with smooth interior surfaces. Approved screw unions with bronze or steel bodies and ground brass taper or spherical joints shall be installed at traps instruments, etc. and where else directed to permit easy connection and disconnection.
- TS-1087* Final connection to equipment and Fixtures shall be made in manner that will permit the complete removal of any fixtures or any piece of equipment without cutting of pipe line.
- TS-1088* Each piece of pipe and each fitting shall be carefully inspected on the inside to see that there is no defective workmanship on the pipe or obstructions in the pipes or fitting. Joints in all screwed piping shall be made with red lead and boiled linseed oil completely covered the male threads.
- TS-1089* Straight Elbows, bushing, long screws, or bull head tees shall not be installed, and all officets shall be made with fittings. Pipes shall not be bent at any time.
- TS-1090* Pipe work shall be installed in manner to allow for ease of air escape and system draining it shall be endeavored to obtain this naturally by gravity. However, where conditions do not permit it an automatic air vent shall be installed at all air pocket locations and drain gate valve shall be supplied and installed at all low points and risers legs.

TS-1091 Materials for piping

Service	Material	Type
Domestic hot and cold water	Steel	Galvanized Schedule 40
Domestic water underground	Pex-pipe	Cross linked polyethylene
Vent, feed, expansion	Steel	Galvanized Schedule 40
Internal Sewage & Drain	HDPE	High-density polyethylene
External Sewage	UPVC (SN8)	Polyvinyl chloride resin
Gas pipe	Copper	Type K

- TS-1092* Joints shall be but welded single V type, elbow and fittings formed of welded cut pipe section will not be acceptable. No piping shall be hung from other piping and all hangers shall be of heavy construction suitable for the size of pipe being supported. All piping in the machine room shall be provided with rubber in shear vibration eliminating

16.3.2 Screwed joints

TS-1093 Screwed joints on steel piping shall be clean threaded, pulled up tightly and made with approved jointing compound and long strand hemp. After joints have been formed, all surplus hemp should be cut away and the joints wiped clean. Alternatively, P.T.F.E. Tap may be used. Where galvanized piping is used, care shall be taken to ensure that threads are carefully cut, so that the number of exposed threads is minimized.

16.3.3 Flanged joints

TS-1094 All flanged joints shall be flush and truly aligned and made with approved corrugated rings, compressed asbestos or composition joints. Flanges for connection to welded pipes shall be “slip on” or welding neck standard steel type made as indicated in the schedules. Flanges or unions shall be provided on straight runs at not greater than 12 meter intervals. Wherever possible, at piping connections to equipment, valves or other units requiring maintenance, servicing, or possible removal, the connecting joint shall be made by means of unions or flanges. Pressure rating or flanges shall match the pressure of the flanges on the equipment to which the pipe connected.

16.3.4 Unions

TS-1095 Unions are required on pipe 50 mm and under. Unions shall be ground taper joint type good for 8.37 Kg/sq. cm working pressure. Unions shall have bronze conical seats ground in. Flat unions shall not be used.

TS-1096 Temperature midway between the high and low limits of normal service. Bellows expansion joints shall be provided with guides to ensure that all movement is taken up in the designed manner. The manufacturer's recommendations shall be closely followed. Guides shall be secured rigidly and shall provide free movement for expansion without undue tolerance. Means for lubrication shall be provided where necessary.

16.3.5 Pipe Supports and Anchors

TS-1097 All supports for steel piping shall be ferrous. Supports for copper pipes shall be non-ferrous and chromium plated where chromium plated pipe is specified. Brackets or supports shall be set out so that they not obstruct the access to valves, flanges or other fittings requiring maintenance.

TS-1098 Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment valves and control valves. Piping shall be supported to allow for removal of equipment valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed. All channels, angles, plates, clamps, etc, necessary for the fastening of hangers shall be furnished and fitted by the contractor.

TS-1099 All hangers shall be properly sized for the pipe to be supported. Over-sized hangers shall not be permitted. Details of hangers and supports to be used by the contractor shall be submitted to the Managing Official for approval before fitting. All hangers shall be provided with lock nuts and have provision for vertical adjustment pipes. Parallel groups of pipes shall be supported by trapeze type hangers of steel

construction. Individual horizontal piping shall be supported by hangers consisting of malleable split rings with malleable iron sockets steel clevis type hangers, or roller hangers where specified or directed. Pipe standards with base flanges and adjustable type yokes shall be used for pipes supported from the floor. Vertical piping shall have wrought iron or steel clamps securely bolted on the piping with the end extensions bearing on the structure of the building.

TS-1100 Piping shall be anchored where required to localize expansion or to prevent strain on piping and branches. Anchors shall be entirely separate from hangers and shall be heavy forged or welded construction of approved design. Hangers for cold piping shall have hard wood inserts or high density insulation capable of withstanding the compression and allowing the hanger to support the pipe without any metal contact. No piping shall be hung from other piping and all hangers shall be of heavy construction suitable for the size of pipe being supported. All piping in the machine room shall be provided with rubber in shear vibration eliminating.

16.3.6 Pipe sleeves

TS-1101 All pipe openings through walls, partitions and slabs are to have sleeves having an interval diameter at least 1' larger than the outside diameter of the pipe or of the insulation passing through the sleeve. Pipes passing through external block work or concrete shall be provided with sleeves of galvanized standard weight steel pipe flush with walls and ceilings and extending one inch above finished floors. Pipes passing through internal partitions shall be provided with sleeves of gauge 22 galvanized sheet steel made flush with finished wall surfaces.

16.3.7 Flashing sleeves

TS-1102 Flashing sleeves are to be provided where pipes pass through waterproof membranes. Flashing sleeves details are to be submitted to the Managing Official for approval but generally they shall be provided with an integral flange set into the membrane. The associated pipe shall also have a flange and shield which shall extend beyond the insert and be sealed with approved mastic.

16.3.8 Pipe insulation protection saddles

TS-1103 Insulation shields shall be used to protect the insulation on all pipes. Insulation protection saddles shall be welded to insulated hot pipes at roller supports. Wherever fiber-glass pipe insulation is installed, alternative high density insulation of equal thickness shall be installed in lieu thereof. Where hangers and insulation shields are installed the insulation shields shall bear only an insulation material which is of such density that it will not compress, crush or deform. Saddles shall consist of gauge 10 galvanized steel plates. The plate shall be curved to fit the contour of the insulation and shall cover the lower 180 deg. of the surface. Saddles shall be secure to the insulation by means of steel bands.

16.3.9 Automatic air vents

TS-1104 Wherever possible, all water pipe work system is to have open venting. At all high points in the system where this is not possible an automatic air vent shall be fitted and connected to the nearest drain. Air vents shall be of the float type. Sizes and

working pressures shall be as indicated on the schedule, and/or in the bill of quantities. They shall be fitted with a suitable sized gate type lock shield valve.

16.3.10 Pipe work Underground Protection

TS-1105 Where pipe work is to be run underground it shall be wrapped with layer of PE (Poly Ethylene) applied by extrusion method 1.5 mm thickness wrapping from outside and fitting should be protected also ..

16.3.11 Union and Flanges

TS-1106 Shall be provided on both sides of each piece of equipment. Also when required to facilitate removal of valve for repair. Union shall be provided for all piping 2" and smaller. Flanges shall be provided for all piping 2.5" and larger.

16.3.12 Cleaning of pipe

TS-1107 During constructions, the contractor shall properly cap all lines so as to prevent the entrance of sand, dirt, etc... All pipe, fittings, valve etc. shall be cleaned of grease, dirt, scale, and foreign material before installation.

TS-1108 Before turning the project over to the Contracting Authority prior to start-up of any mechanical equipment, all piping system shall be thoroughly cleaned following the hereinafter specified instructions.

TS-1109 Piping shall be cleaned by operating system at normal operating pressure approximately 48 hours. At the end of the 48 hours period, contractor shall clean all strainers by removing baskets and flushing with clean water; Blowing down thru strainer blow down valve will not be acceptable.

16.3.13 Testing

TS-1110 The piping system shall be tested by accepted method and under 150 psi hydrostatic pressure. Test shall be maintained under inspection by Managing Official for a period of not less than 24 hours.

TS-1111 If leaks develop test shall be repeated after leaks are corrected. No part of piping system shall be covered or concealed until it has been tested inspected and approved by the Managing Official.

16.4 Insulation

TS-1112 All insulating materials required for general plumbing and equipment shall be furnished and installed according to this section of the specifications.

TS-1113 Insulation shall be installed in a smooth, clean, workmanlike manner and joints shall be tight and finished smooth.

TS-1114 All surfaces to be insulated shall be dry and free from loose scale, dirt, oil or water when insulation is applied.

- TS-1115* Insulation shall be applied in such a manner that there will be no air circulation within the insulation or between the insulation and the surface to which it is applied.
- TS-1116* Surface imperfections in the insulation such as clipped edges, small joints or cracks and small voids, or holes not over 25 sq.mm shall be filled with like insulating material or with insulating cement if approved by the Managing Official.
- TS-1117* Insulation for all services shall be continued through sleeves. The insulation on exposed risers shall extend through the floor.

16.5 Domestic water services

- TS-1118* Generally water shall be supplied from the City Main and will connect to the roof storage tanks. From the suction tanks water shall be pumped up to the tanks at roof level. Connection can also be made directly to the water network in the building if it is available continuously.
- TS-1119* The city water supply to building by $\phi 1"$ inch size galvanized steel seam less sch. 40 pipe wrapped from outside with layer of PE high density polyethylene insulated protection factory cover of thickness 1.5mm.
- TS-1120* Laid underground with all necessary fitting and work from main city water supply pipe price completed with $\phi 1"$ inch water meter, shut of valve, check valve and strainer work include.
- TS-1121* Fees for city municipality, sheet metal cabinet, excavation, back filling.
- TS-1122* All hot and cold water services shall be in galvanized steel sch. 40 pipe.
- TS-1123* The use of flexible connectors between services and sanitary fittings will NOT be permitted.

16.6 Tests at site

- TS-1124* Pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subject to pressures exceeding their rating.
- TS-1125* Tests shall be completed and approved before any insulation is applied or pipes, valves and fittings have been concealed. Tests shall be performed in the presence of and to the satisfaction of the Managing Official. Any leaks or defects uncovered by the tests shall be repaired and the system re-tested at no additional cost to the Employer.
- TS-1126* When the installation has been completed to the satisfaction of the Managing Official, it shall be tested in the following manner:
4. The entire system shall be slowly filled with water, allowing any trapped air to escape
 5. When all outlets are closed the system shall be checked for water tightness.
 6. Each outlet must be checked for rate of flow and correct operation.

16.7 Cleaning

TS-1127 The Contractor shall carefully clean out all cold water and hot water collectors, service pipes, sanitary fittings throughout, traps and wastes. The Contractor shall also overhaul and make good all flushing valves, check regulating valves, check taps including rewashering as necessary and leave all works in perfectly clean and working condition to the satisfaction of the Managing Official.

16.8 Sanitation and rainwater drainage

TS-1128 The soil and waste system shall be installed in accordance with this Specification and bill of quantities and must be approved by the Managing Official.

TS-1129 Soil, waste and ventilation pipe work and fittings fixed in open-to-sky areas shall be in cast iron or UPVC as shown on the Drawings or directed and approved by the Managing Official.

TS-1130 Soil, waste and ventilation pipe work and fittings fixed in internal ducts shall be in unplasticised P.V.C. and according to manufacturer's specification and as approved by the Managing Official.

TS-1131 Expansion joints and brackets shall be fixed in accordance with the manufacturer's recommendations where required

TS-1132 Rain water pipes and fittings shall be as shown on the Drawings, Bill Of Quantities and as directed by the Managing Official.

16.9 Testing

TS-1133 Tests shall be carried out at the Managing Official's request during installation in accordance with manufacturer's specifications and to the approval of the Managing Official.

16.9.2 General

TS-1134 The contractor shall submit to the Managing Official prior to the date of commencement of the tests his proposed test procedure. The procedure method and points of measurement and the method of calculation shall be approved by the Managing Official before any test is carried out.

TS-1135 The contractor shall supply skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus part of a system or on a complete system if the Managing Official requests such a test for determining specified or guaranteed data, as given in the specifications.

TS-1136 Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Managing Official at the expense of contractor.

TS-1137 In the event of any repair or any adjustment having to be made other than normal running adjustment, the tests shall be void and shall be repeated after the adjustment or repairs have been completed.

TS-1138 The tests shall not be made void due to circumstances beyond the contractor's control

TS-1139 All testing, balancing and final adjustment shall be in accordance with the provision of the appliance B.S code of practice.

16.9.3 Water supply systems

TS-1140 All water supply piping shall be tested under hydrostatic pressure of not less than 1.5 times (8Bar) working pressure p.s.i., maintained for twelve hours. This test shall be applied to separate lengths of pipe work before final connection of equipment and appliances but after all piping is completed. Systems shall also be flushed. Test shall be completed and approved before pipes, valves and fittings have been concealed. These systems shall be subject to a water test prior to being covered and also tested for water tightness before backfilling. On any section of the pipe under test, the head of water applied shall not be less than 3.00 meters and not greater than 6.00 meters. Tests shall be maintained for 20 minutes, and any defects shall be rectified and the test reapplied to the complete satisfaction of the Managing Official.

16.9.4 Drainage, Soil, Waste and Ventilation System

TS-1141 These systems shall be subjected to a water test prior to being covered and also tested for water tightness before backfilling. On any section of the pipe under test, the head of water applied shall not be less than 3.00 meters and not greater than 6.00 meters. Tests shall be maintained for 20 minutes, and any defects shall be rectified and the test re-applied to the complete satisfaction of the Managing Official.

16.9.5 Final testing

TS-1142 In addition to the above, final tests shall be carried out as directed by the Managing Official, just before final completion of the works and during the maintenance period.

16.10 Sanitary fittings

16.10.1 General

TS-1143 Supply and install all sanitary fixtures shown on the drawings and as specified in these specifications.

TS-1144 European fixtures shall be of the first quality with smooth glazed surfaces, free from wrap, cracks, checks, discoloration or other imperfections.

TS-1145 Fixtures shall be set in a neat, finished and uniform manner making the connection to all fixtures at right angles to the wall, unless otherwise directed by the Managing Official. Fixtures are not to be set until so directed by the Managing Official.

- TS-1146* Ample application of petroleum jelly shall be applied to all surfaces of exposed chromium plated piping, valves and fittings and stainless steel fixtures immediately after installation.
- TS-1147* All fixtures shall be set, true, level, and finished in an approved and uniform manner..
- TS-1148* Concealed brackets, hangers and plates shall have a shop coat of paint.
- TS-1149* All necessary supports for fixtures shall be installed before plaster work.
- TS-1150* All exposed piping and trim shall be chrome plated and fully protected during installation. Strap or padded wrenches shall be used on chrome pipe fittings and valves.
- TS-1151* All exposed metal parts in bathrooms shall be chromium plated and fully protected during installation.
- TS-1152* All valves in bathrooms shall be chrome plated recessed type.
- TS-1153* In the selection of the sanitary fixtures and their accessories, model numbers of manufacturer's catalogues are given. A model numbers is given to describe the type and the shape of the item requested and does not in any way limit the supply to the model listed. Any item of different make judged by the Managing Official to be similar in quality and manufacture will be approved. Catalogues will be available at the Contractor's office for reference.
- TS-1154* The location and disposition of all items shall be indicated on the relevant drawing
- TS-1155* All sanitary fittings shall be of an approved quality obtained from an approved manufacturer. Sanitary fittings and their connections, services, wastes , overflows etc. shall be located as shown on the Drawings and shall be designed and installed to the satisfaction of the Managing Official .
- TS-1156* Details of the fittings are as shown in the Particular Specification and Drawings or as directed by the Managing Official.
- TS-1157* All sanitary fittings noted in the Particular Specification shall be properly assembled and the Contractor shall include for all waste fittings, traps, taps, plugs, chains, seats, handles, levers, fixings and brackets required to suit the installation.
- TS-1158* All traps shall be of the correct size with a 3" deep seal and compression outlet connection.
- TS-1159* When fixing washbasins (ceramic – with metal down pipes!), silicon or flexible putty is to be used. All washbasins are to be solidly affixed to the walls (using dowels, as appropriate).

16.10.2 Pipes and Fittings

- TS-1160* Potable water main between city mains and water collector in floor water cabinet shall be galvanized steel sch. 40, heavy weight. Fittings shall be of seamless pipe with same characteristics as pipe.
- TS-1161* Domestic cold and hot water pipes shall be sch. 40. All pipe fittings (elbow, tees, crosses, unions, reducers, etc...) shall be galvanized forged steel of the same quality

and weight as the pipes. Pipes and fittings shall be suitable for threaded connections.

TS-1162 All drainage pipes 11/4" in diameter and larger shall be HDPE (High-density polyethylene) of approved quality.

TS-1163 All rain water pipes shall be UPVC-SN8 pipe. All fittings and accessories shall be of the same quality, and material of the pipe. All joints shall be rubber sealed stainless steel and plastic.

16.10.3 Local regulations

TS-1164 All works shall be carried out to comply with the current local public health regulations, the latest BS 5572/BS 8301 and current local by-laws and shall be to the entire satisfaction of the Managing Official.

16.11 Builders work

TS-1165 Normally pipes will be fixed on the surface of walls and the Contractor shall perform all cutting and pinning for holder bats or plugging and screwing for pipe clips.

TS-1166 Where pipes are required to be concealed in the walls etc., the contractor shall perform all cutting and subsequent making good. Pipes passing through walls and floors shall be sleeved with metal.

TS-1167 The expression 'Builders Work' shall mean work to be carried out by the Main Contractor under the direction of the Managing Official in connection with the plumbing installation.

TS-1168 The Contractor shall prepare accurate drawings giving details of all holes, fixings, bases, and other builders work requirements and shall be responsible for their accuracy. The cost of any unnecessary work due to failure to comply with this condition will be charged to the Contractor and deducted from his account when making payment. The cost of preparing builders work drawings shall be included in the tender price.

TS-1169 If, in order to progress the contract, the Managing Official has prepared certain details in connection with the builders work, the Contractor, when appointed, must immediately check these details against the architectural and structural drawings and if any additional work or alterations are required the Managing Official must be advised immediately.

TS-1170 The following is a summary of the work to be carried out by the Main Contractor:

- Cutting and forming of holes for pipes or pipe fixings through walls, floors, ceilings, partitions, roofs etc., and making good after the work is sufficiently advanced.
- Building of concrete and/or brick ducts in floors, walls...etc.
- Formation of concrete bases, plinths etc. for plant and equipment.
- Building of manholes pits etc.
- Excavation, forming of trenches for services etc., and the filling in of same after the pipes are laid.
- Cutting or forming of chases, recesses etc. in floors, walls...etc. for pipes and fittings, and making good.

- Excavation for and laying of pipes and ducts.
- The building in of brackets and supporting bars or other form of pipes after fixing unless specified to the contrary.
- Painting of all pipes after fixing unless otherwise specified
- Providing and building in of sleeves through slabs and walls

TS-1171 In general all holes through walls, floors and beams for pipes and ducts will be left out by the Main Contractor during the process of building.

TS-1172 Where pipes or fittings are fixed to concrete or woodwork by means of saddles or clips the Contractor shall himself execute the work necessary and shall include the cost of such work in the price given in the Form of Tender.

16.12 Electrical water heater

TS-1173 The contractor shall supply and install electrical hot water heater of capacity as indicated in drawings horizontal type. The heater install under the ceiling as indicated in the drawings.

TS-1174 Each heater shall be completed with all fitting such as valves, union, safety valve, non-return valve and all piping necessary for connection to city water, cold water and hot water electrical cable connected to heater coil with adjustable thermostat and electrical switch with indicated lamp.

16.13 Fans

16.13.1 General

TS-1175 Exhaust and return air fans shall be of approved quality and quite noise, supplied and installed by the contractor as shown on the drawings. The capacity, type and rating of the fans shall be as specified in the schedules. The fans motors and starters shall be in accordance with the specifications and electrical equipment.

16.13.2 Extractor Fans

TS-1176 The contractor shall supply and install as shown on the drawings a range of ventaxia extractors or equivalent of ratings as indicated on the drawings.

TS-1177 Fan shall be either centrifugal or propeller type direct drive suitable for window or wall mounting. Fans shall be designed to ensure lowest noise level, and each shall be supplied with its starter or switch and weatherproof hood. Fans shall be constructed from non corrodible materials. Fans shall be furnished with self acting louvers mounted on the face of fan.

TS-1178 The propeller will be strong and rigid giving large volinetric capacities and high efficiency, with non overloading characteristics and very quiet operation.

TS-1179 The motor to be squirrel cage induced type suitable for continuous operation.

TS-1180 For wall mounted fan the motor to be attached to the fan ring by three arms of pressed steel.

TS-1181 Rubber inserts to prevent transmission of motor noise.

16.14 VRV-VRF AIR CONDITIONING SYSTEM

16.14.1 INTRODUCTION

TS-1182 This section consists of the general rules that apply to the design, manufacture, shop testing, delivery to site, erecting, commissioning, site testing, maintaining and handing over the material, equipment plant and services required for the air conditioning system of the building.

TS-1183 The manufacturer of the air conditioning equipment shall have at least ten (10) years' experience in the design, manufacture, installation and commissioning and maintenance of HVAC equipment.

16.14.2 DESIGN CONDITIONS:

TS-1184 The units shall be selected for:

- Summer outdoor design condition: 35 C DBT and 26 C WBT
- Summer in door design condition: 24 C DBT and 17 C WBT
- Winter outdoor design condition: 4 C DBT and 2.5 C WBT
- Winter in door design condition: 22 C DBT

16.14.3 SCOPE OF WORK

TS-1185 The scope of work consist of supply and installation of an air-cooled Variable Refrigeration Volume/ Variable Refrigeration Flow (VRV/VRF) heat pump type multi split air conditioning system. The full hall will be air conditioned as indicated in the drawings and detailed technical specification of this document. The system shall include a Heat Reclaim Ventilation system along with required ductwork and outlets to provide 10 % fresh air into the conditioned area.

16.14.4 APPLICABLE PUBLICATIONS & STANDARDS

TS-1186 Standards and Publications of the following organizations form part of these Specifications to the extent indicated by the references thereto unless superseded by Part-II Detailed Technical Specifications.

BS	-British Standards
ASHRAE	- American Society of Heating Refrigeration and Air Conditioning Engineers
ASTM	- American Society for Testing Materials
NFPA	- National Fire Protection Association
ANSI	- American National Standards Institute
SMACNA	- Sheet Metal and Air Conditioning Contractor's National Association
ARI	- Air Conditioning and Refrigeration Institute
AMCA	-Air Moving and Conditioning Association
ASME	- American Society of Mechanical Engineers

DIN	-	Deutsches Institute for Normung
UL	-	Underwriters Laboratories
AFI	-	Air Filters Institute
IEC	-	International Electro-Technical Commission

16.14.5 COORDINATION

TS-1187 The Contractor shall coordinate the air conditioning installation with installation work of all trades involved in the project and avoid interference with lighting fixtures, piping, ducts, etc.

16.14.6 FIRE RETARDMENT

TS-1188 Material and equipment for fire retardant, shall be installed in accordance with NFPA standard

TS-1189 No. 90A, and No. 204.5 or as specified otherwise hereinafter.

16.14.7 REGULATIONS, CODES OF PRACTICE, SHOP DRAWINGS, ETC.

TS-1190 All work shall be carried out in keeping with the rules and regulations of the relevant local authorities and will comply with the latest codes of practice in this field. The minimum capacities, and plant lay out, given in the specifications, drawings and bills of quantities will serve only as a guide line. The contractor will be totally responsible for the ability of the system to achieve the conditions set out in these specifications, and as such will have to provide shop drawings, where necessary, for the approval of the Engineer.

TS-1191 The equipment supplied shall comply with the standards set out in these specifications & BOQ but will, in no way, be limited to this list. Any other specifications suggest will be considered provided they are no less onerous.

16.14.8 SUBMISSION FOR APPROVAL

TS-1192 The Contractor shall submit the following for the Engineer's approval

- Selection Data/Equipment Data
- Samples of Materials, component and Fixtures and Equipment
- Design analysis and calculations
- Detail and/or shop drawings
- Assembly, Erection and Installation Drawings and Manuals
- Schematic & Interconnection Diagrams
- Certificate of Compliance/Test Reports
- Operation and Maintenance Manuals
- Electrical power supply requirement.

TS-1193 Selection data shall be submitted and shall consist of engineering selection tables provided by the manufacturer. The Contractor shall indicate in these, the items selected and their designation for cooling/heating equipment. It shall be made quite clear as to which factors have been taken into account by the manufacturer to correct the listed gross capacity into the net capacity required, due to extreme

outside temperature, altitude, enthalpy of entering and leaving air, fan required, fan static pressure, fan RPM, fan motor and temperature differential between supply air entering and return air leaving the room.

16.14.9 POWER FACTOR IMPROVEMENT

TS-1194 Each motor of rating 5 KW and above shall be fitted in parallel with a power-factor improvement capacitor of optimum rating conforming to motor manufacturer's recommendations to avoid self- excitation and its harmful effects.

TS-1195 Capacitors shall be manufactured to IEC 70 and 70A and shall comprise an oil impregnated, self- healing metalized film dielectric, enclosed in an air-cooled, vacuum sealed metal case. Losses shall be less than 0.5 watts per KVA. Capacitors shall incorporate a disconnection system which will disconnect the capacitor internally from the terminal in the event the self-healing capacity is unable to clear a breakdown.

16.14.10 VIBRATION & NOISE

TS-1196 Vibration and noise control of equipment installed is of prime importance. The Contractor shall pay special attention to the problem of vibration and noise and is required to guarantee that the installation will not generate vibration or noise of the intensity to exceed the specified limits or cause annoyance to the occupants in the area.

16.14.11 AIR CONDITIONING SYSTEM

TS-1197 The system shall be a multi – split VRV inverter driven heat pump type air conditioners for application with R407C/R410A or R-134A refrigerants and interlocked with a heat reclaim ventilation (HRV) system to supply conditioned fresh air. It shall be composed of 4 - way cassette type indoor units, wall mounted type indoor units, and slim ceiling mounted duct type indoor unit as shown in the drawings, with a distributed refrigerant cycle, electrical components and enclosing cabinets. The outdoor units shall be of the multiple compressor cabinet integrated type with inverter controls and completely weather proofed for outdoor installation. Both indoor and outdoor units shall be properly assembled, internally piped and wired, tested and charged with the refrigerant at the factory. The HRV system shall exchange heat between the supplied fresh air and exhausted air in order to bring the outside air closer to the indoor temperature and humidity conditions, thus allowing the ventilation without increasing the cooling and heating load. The HRV system shall interlock with the operation of the VRV system without any dedicated HRV remote controllers. The central control unit shall be common to the VRV, thus helping to achieve the total control and management of air conditioning and ventilation.

16.14.12 INDOOR UNIT:

TS-1198 The indoor units shall be constructed of galvanized sheet steel, baked with synthetic resin paint, with a plastic air panel assembly. The refrigerant cycle shall be equipped with a heat exchanger, an electronic expansion valve, solenoid valves and flare connections. The fan shall be of the multi - blade centrifugal type, statically and dynamically balanced and directly drive by a motor of suitable capacity. The motor bearing shall be of the permanently lubricated type. The heat exchanger shall be of the multi-pass, cross finned tube type, equipped with highly efficient aluminum fins, mechanically bonded to seamless, oxygen free copper tubes. The coil shall be cleaned, dehydrated and tested for leakage at the factory. All indoor units shall be fitted with condensate drain pump kits & 25% efficient return air filters.

Concealed: False ceiling duct connection unit.
More than 80 Pa external static pressure.
Microprocessor temperature control.
Height not more than 300 mm.
Radial fan, vibration-free and quiet running. Protected by a thermal contact.
Standard drain pump up to 500 mm.
Fresh-air admixing can be admixed via a punched aperture.

Sound pressure not more than 40 dBA @ high speed.

Ducted: False ceiling duct connection unit.
More than 150 Pa external static pressure.
Microprocessor temperature control.
Radial fan, vibration-free and quiet running. Protected by a thermal contact.
Optional drain pump up to 500 mm.
Sound pressure not more than 48 dBA @ high speed.

Wall mounted: White, impact-resistant washable casing.
Casing with sound-absorbing, thermal insulation of PE foam.
Front air intake through a large surface area, washable, long-life filter. The air is discharged via an outlet with motorized, horizontally adjustable flaps.
Flaps close automatically, when the unit comes to a standstill.
Auto swing mechanism.
Microprocessor temperature control.
Cross flow fan , multiple steps, vibration-free and quiet running. Protected by a thermal contact.
Optional drain pump up to 1000 mm.
Sound pressure not more than 45 dBA @ high speed.

Ceiling mounted: White, impact-resistant washable casing.

Casing with sound-absorbing, thermal insulation of PE foam.
 Bottom air intake through a large surface area, washable, long-life filter.
 The air is discharged via an outlet with motorized, horizontally adjustable flaps.
 Microprocessor temperature control.
 Cross flow fan , multiple steps, vibration-free and quiet running.
 Protected by a thermal contact.
 Optional drain pump up to 600 mm.
 Sound pressure not more than 45 dBA @ high speed.

Cassette

Elegant, ceiling-mounted, ivory white, impact-resistant, washable decoration panel.
 Air suction through the panel below, which has an integrated, long-life air filter.
 The air is discharged via four outlets with motorized, air vanes, which can be horizontally and vertically adjusted between 0 -90°.
 Two sides can be closed off to facilitate corner installation.
 Turbo fan, phase controlled multiple steps , vibration-free and quiet running.
 Protected by a thermal contact.
 Fresh-air admixing can be admixed via a punched aperture.

 Microprocessor temperature control.
 Height not more than 300 mm.
 Fan motor thermal protection.
 Standard drain pump up to 750 mm.
 Sound pressure not more than 45 dBA @ high speed.

Control wiring:

A simple 2-wire shielded multiplex transmission system links each outdoor unit to multiple indoor units
 using one 2-wire, non-polar to simplify the wiring operation.

Pipes Connection:

Possibility of use either joints or headers.
 Connection sizes must be selected according to the system supplier recommendation.

Control:

Individual control for each indoor unit to be synchronized with the out door unit.
 Wired remote controller with digital display and function buttons.
 Equipped with real time clock to enable weekly and daily schedules.
 Possibility to be connected to a centralized controller or to a BMS system.

Pipes:

B208 type copper tube for refrigerant piping.

Units in mm

Pipe Outside Diameter	Pipe Wall thickness
6.4	0.8
9.5	0.8
12.7	0.8
15.9	1
19.1	1
22.2	1
25.4	1
28.6	1
34.9	1.3
41.3	1.7

Pipes Connection:

Possibility of use either joints or headers.

Connection sizes must be selected according to the system supplier recommendation and supervisor engineering approval

Installation

Installation must be according to the supervisor engineering approval and supplier recommendation.

Refrigerant: R-410A

16.14.13 OUTDOOR UNIT:

TS-1199 The VRV-VRF outdoor unit shall be integrally built multiple type with weatherproof construction suitable for roof top installation. The cabinet shall be constructed of galvanized steel sheet, baked with synthetic resin paint and weather proofed for coastal installation. The capacities of the units shall be carefully selected to match the grouped capacities of the indoor units. The service panel shall be easily removable for service access to the electrical components and the compressor section.

TS-1200 Each refrigeration cycle shall be equipped with highly efficient compressors, solenoid valves heat protected against breakdown by a quick response over current relays, high pressure switches, wrap around type oil heaters and a discharge gas thermistors. The outdoor fans shall be of the plastic propeller type and dynamically balanced. The heat exchanger shall be of the multi pass, cross finned tube type equipped with highly efficient aluminum fins, mechanically bonded to oxygen free copper tubes.

16.14.14 DUCT WORK

TS-1201 Distribution duct system shall consist of fresh air and exhaust air grills.

TS-1202 All duct work inside the building shall be insulated with 25mm thick glass wool insulation with aluminum foil covering fixed to the duct surface by GI duct pins

pasted to the outer duct surface and passing through the insulation blanket. All joints in the insulation blanket shall be sealed with aluminum foil backed duct tape of minimum of 75mm. The insulation shall be continued over all joint flanges volume control dampers and other duct fittings to a thickness of 25mm.

TS-1203 Duct connecting to air condition equipment shall be insulated with acoustic insulation for one meter run.

16.14.15 ELECTRICAL WORK

TS-1204 All equipments shall be installed accordance with the relevant British Standards or equivalent to the approval of the Engineer. Particular attention shall be paid to the protection of equipment during the construction period. The power supply shall be rated to 3 phase 400 V, 50 Hz.

16.14.16 Control Panel

TS-1205 The main Air conditioning control panel shall include but not limited to the following:

TS-1206 A positive acting timer to prevent short cycling of compressors and to delay restarting of compressors after shut down, high & low pressure cutoff, multi-step temperature controller, power & control circuit terminal blocks, circuit breaker, motor contactors, control relays, disconnect switch. On all units the source of control circuit power shall be completely independent of the unit power source.

16.14.17 Design Parameters

16.14.17.1 Internal condition:

TS-1207 24° ±1 Deg. C, relative humidity (RH) 50% -55%.

16.14.17.2 Noise criteria in reading rooms and office areas:

TS-1208 40 dB a max.

TS-1209 The noise level given above are due to the air conditioning equipment as well as air supply noises and are maximum values measured in decibels relative to 2*10⁻⁵ Newton/Meter Squared.

16.14.18 Guarantees

TS-1210 The contractor will guarantee that all the air conditioning equipment supplied and installed by him when operated in accordance with the given instructions shall have minimum capacities not less than those given in these specifications and drawings.

- TS-1211* Should it be proved that certain equipment fails to achieve the minimum performance specified, then the contractor will carry out any up grading or modifications at his own cost?

16.14.19 Minimum Capacities

- TS-1212* The minimum capacities shall be as stated in the associated bill of quantities. Capacities of all indoor units shall be achieved when operating with an air on coil condition of 24/17 DBC/WBC, & outdoor units with an air on condenser coil condition of 40 DBC. The capacities of the outdoor units shall be corrected for tube length & location of indoor units in respect to that of the outdoor units.

16.14.20 Electrical Installation

- TS-1213* The contractor shall undertake all the electrical work connected to the A/C system. The electrical work will conform to those set out in the BS 7671:1989.
- TS-1214* The system electrical power supply 3 phase, 4 wire, 50Hz, 400V will be terminated on switchgear and 230V, 50Hz will be terminated on socket outlets. It will be the responsibility of the contractor, to provide all the distribution and motor control equipment, as pertaining to the A/C system, and make all connections downstream from this point. The motor control panel shall be of the modular type incorporation short circuit and overload protection along with the contactors, similar to the "Telemecanique" "Optimal" range.
- TS-1215* Timers shall be incorporate, as directed by the engineer to control the operating periods of the motors, fans etc.
- TS-1216* The controls will have the same specifications as set out in the electrical specifications. All equipment's used shall be from a single manufacturer to ease future maintenance. All cable entrances to the main control panel and all other panels will be fitted with standard cable bushing to render the transition of the cable into the panel both dust and water proof.
- TS-1217* Samples of all electrical equipment to be used shall be submitted to the engineer, for approval prior to their incorporation in the works.

16.14.21 Additional Information:

- TS-1218* 16.14.23.1 All drawings are indicative of the system required. The contractor shall ascertain for himself that the equipment offered by him can be installed in the locations indicated.
- TS-1219* 16.14.23.2 Adequate space must be allowed for maintenance of the equipment such as removal of air filters for cleaning and cleaning of chiller tubes etc.
- TS-1220* 16.14.23.3 The contractor shall make certain that the equipment offered by him will operate as indicated in the attached schematic.
- TS-1221* 16.14.23.4 The contractor shall obtain the engineer's approval for the indicated ranges of all instruments to be incorporated in the project, prior to their use in

the works. This is applicable to all thermometers, pressure gauges, ammeters, etc.

16.14.22 Testing and Commissioning

TS-1222 16.14.24.1 The contractor shall commission and test the installation for a minimum period of seven (7) days to indicate to the engineer that the equipment installed achieves the minimum room conditions specified above. The tests shall be carried out during periods of maximum ambient temperature and loading. All conditioned areas shall be tested together.

TS-1223 16.14.24.2 A chart indicating the temperatures, humidity and the air flow at all supply and exhaust air diffusers, against the time of day, shall be prepared for each area, and submitted to the engineer on completion of the tests, prior to the application for the practical completion certificate for the system.

TS-1224 16.14.24.3 All controllers and thermostats shall be adjusted so that they operate correctly.

16.14.23 Makes of equipment offered

TS-1225 Makes of equipment offered shall have been commonly used in Palestine and having a local agent possessing adequate workshop facilities, experienced technical personnel operating in Palestine for a minimum of three years. Prior approval of the Engineer shall be obtained before placing orders for the supply of equipment.

16.14.24 Free Maintenance & Guarantees

TS-1226 The contractor shall maintain the complete system for the period stated in contract from the date of takeover of the system for beneficial use.

TS-1227 Any equipment which may prove defective during this period shall be replaced or repaired free of charge during this period.

TS-1228 Items of equipment repaired or replaced, during this period, shall be guaranteed for a further period of two (2) years from the date of repair or replacement.

17 Electrical installations

17.1 General

TS-1229 The Contractor shall supply all labor, materials and equipment necessary for the installation of medium voltage switchboards, sub-main cables and distribution

units, lighting and power, together with all other apparatus shown on the Drawings and as detailed in the Particular Specification, with the exception of those items stated specifically as being supplied by others.

- TS-1230* All works shall be carried out in a manner satisfactory to the Managing Official and all unspecified materials shall be of approved manufacture. The complete installation is to be to the entire satisfaction of the Managing Official.
- TS-1231* The whole of the electrical installation and all works appertaining thereto shall be carried out in strict accordance with the Regulations for the Electrical Equipment of Buildings current edition (including all amendments and supplements made and issued thereto) as issued by the Institution of Electrical Engineers, British or VDE Standards, and also to the national and local requirements.
- TS-1232* The Contractor shall further make good, repair, replace all defective work and clear away on completion and leave all installations in perfect working order and to the satisfaction of the Managing Official.
- TS-1233* Building works shall include the preparation of trenches and provision and laying in such trenches of asbestos cement or salt-glazed stoneware pipes, having easy bends to form ducts for entry of main cables. The numbers, sizes and locations of such pipes shall be as required by the Particular Specification.
- TS-1234* Manufacturer's Recommendations means the recommendations or instructions printed or in writing and current at the date of tender.
- TS-1235* The phrase "or other approved" means that commodities of different manufacture may be substituted if prior approval has been obtained.
- TS-1236* The Contractor shall be deemed to have included in his price for anything necessary to supply the installation described in the Specification, or as shown on the Drawings .If no figure is put against the item shown in the summary it shall be deemed to have been included elsewhere.
- TS-1237* The Contractor shall handle, store and fix each commodity in accordance with the manufacturer's recommendations. He shall inform the Managing Official if these conflicts with any other specified requirement and submit copies of manufacturers' recommendations to the Managing Official when requested to do so.
- TS-1238* When choice of manufacturer is allowed for any particular commodity the Contractor shall obtain the whole quantity required to complete the work from one manufacturer or obtain approval of any change in source of supply. He shall produce written evidence of sources of supply when requested to do so by the Managing Official.
- TS-1239* All the materials purchased for the work must operate satisfactorily at an ambient temperature of 50°C.
- TS-1240* All electrical switches, conduits, plugs are to be properly (vertically) aligned, no wall openings are to be left uncovered.
- TS-1241* Progress reports shall be made by the Contractor, to be inspected and approved by the Managing Official. Changes in plans or additional works shall be executed by written approval of the Managing Official.

17.2 Builders work

TS-1242 The following is a summary of the work to be carried out by the Contractor:

1. The cutting and forming of holes for conduits or pipes or conduit or pipe fixings through walls, floors, ceilings, partitions, roofs etc. and making good after the work is sufficiently advanced.
2. The building of concrete and/or brick ducts in floors, walls etc.
3. The building of manholes, pits etc.
4. The excavation, forming of trenches for services etc. and the filling in of same after the cables are laid.
5. Excavation forming for underground services of ducts and courses.
6. The cutting or forming of chases, recesses etc. in floors, walls etc. for conduits and fittings, and making good.
7. Excavation for and laying of cable carrying pipes.
8. The building in of brackets and supporting bars or other form of conduit or pipe suspensions.
9. The painting of all pipes, tubes and conduits etc. after fixing unless specified to the contrary.
10. The providing and building of sleeves through slabs and walls

TS-1243 All supplied materials should be local made if available – Class A and free from defects and having supervisor certificate from Palestinian Standard Institution (PSI).

TS-1244 Price to include submittal and obtaining approval of shop drawings, detailed and as-built drawings for all works as well as coordinating the same with the other services, activities and furniture complete ready for work in place and operable manner.

TS-1245 Price to include also submittal of catalogues and manufacturer's instructions.

TS-1246 Fixtures and appliances shall be measured in number. Supply and feeder cables, cable conduits and cable trays shall not be measured but included in DBs prices. Manholes handholds and the like shall be measured in number. All systems and devices shall be in lump sum including installations, testing and commissioning. Rates of fixtures and appliances shall include installations, wiring, switches, conduit works, carrying up all required tests and handling over to local Electric Authority. All systems equipment should be class A and approved by (PSI).

17.3 Testing

TS-1247 The Contractor shall provide all necessary testing equipment as required by the Supervision Consultants and the Managing Official to carry out tests as set out in the Regulations and as required by the relevant Electricity Authority. See also 2.10.3 Implementing documents, 2.13.1 Preliminary technical acceptance (Art. 41 - 42) and Acceptance of the works performed (Art. 64-65 and 91-92) of the tender specifications.

TS-1248 The Contractor shall also be responsible for the payment of fees to specialists and manufacturers, for testing and commissioning required to bring all such plant and equipment into fully efficient operation as part of the installation. See also 1.3.4.4 "Elements included in the price" of the tender specifications.

- TS-1249* The Contractor shall thoroughly test each section of the Contract Works all generally in accordance with I.E.E. and Electricity Authorities regulations, and except where otherwise specified the tests shall include the following.
- TS-1250* Insulation resistance tests to earth and between phases on all circuits and power consuming equipment by means of a 500-Volt insulation tester. During the test all lighting switches, except those controlling fluorescent fittings, shall be turned off and all lamps installed but no inductive apparatus shall be connected.
- TS-1251* All insulation tests shall be made between phases, between each phase and earth, and between earth and neutral with the controlling switch neutral link removed.
- TS-1252* Insulation tests shall be repeated between phases and between each phase and neutral with all switches off and all lamps removed.
- TS-1253* Insulation resistances below 5 megaohms will not be accepted.
- TS-1254* Earth continuity tests shall be made on each main, submain, circuit and sub circuit.
- TS-1255* Polarity of switches and continuity of ring main circuits shall be tested.
- TS-1256* Insulation resistance tests of all connected appliances shall be made
- TS-1257* Tests of the effectiveness of earthing including resistance of main earth shall be made.
- TS-1258* Any other tests the Managing Official may reasonably instruct the Contractor to make. Such will include readings of potential drop and current balance between phases at full load conditions at various points in the installation.
- TS-1259* The Contractor is to provide all necessary labor, materials, test media and instruments required and all instruments must carry a recent calibration certificate from an approved body.
- TS-1260* All tests are to be witnessed by the Managing Official, and triplicate test record certificates, signed by all test witnesses, are to be provided to the Managing Official as the work proceeds, upon request, or in any event before the commencement of the Maintenance Period.
- TS-1261* At least 7 days written notice is to be given of intention to perform any test.
- TS-1262* In addition to installation testing the Contractor is to carry out operation testing of all sections and is to clean, set, calibrate and fully commission, demonstrate and hand over the entire contract works in a thoroughly complete and operational state to the satisfaction of the Managing Official.

17.4 Main- switchgear and sub- main distribution equipment

- TS-1263* All main switchgear and sub-main distribution equipment to be provided and installed within the Contract shall comply with the relevant British IEC 61439-2.
- TS-1264* Main switchboards shall be 600 volt rating, of sheet steel construction of 2mm minimum thickness, finished in a suitable anti-rust cubicle type front access panels, epoxy-electrostatic painted (color to be approved by the Managing Official), complete with all necessary incoming main isolators, low bars, outgoing fuse switches, distribution units, interconnection accessories, cable glands and entries.

The main switchboard shall also be provided with a metering panel and all necessary interconnections as may be required by the Electricity Authority. Three ammeters and a voltmeter complete with an integral phase shift switch shall be provided and connected via the main incoming cable connections. The main switchboard shall also be provided with all necessary labels for each item of switchgear stating the area service duty or equipment controlled there from both in Arabic and English.

- TS-1265* All access panels; hinged doors etc. should be provided with rubber or similar gaskets to protect the interiors against ingress of dust.
- TS-1266* An 'as installed' diagram of the electrical distribution shall be provided within a glazed frame and fitted adjacent to the main switchboard.
- TS-1267* Switch fuses, isolating switches, fuse boards, miniature circuit breaker boards and main distribution panels are to be of the particular types, capacities and manufacture later specified in the Particular Specifications or as indicated on the Drawings and unless otherwise specified are to be generally in accordance with the following.
- TS-1268* Switch fuses are to be of the 600 Volt "on-load" pattern with the switch blades mounted on to a solid insulating bar arranged for quick make and break action.
- TS-1269* Fuses are to be H.R.C. type mounted independently of the switch mechanism.
- TS-1270* Switch operating handles are to be of the 'free handle type' interlocked so that the access door may not be opened unless the switch is 'Off ' but with a means to circumvent this feature. The switch 'On ' or 'Off ' positions are to be clearly marked.
- TS-1271* Miniature /mould case type circuit breakers shall have automatic tripping by means of a calibrated bi-metal mechanism for over-current protection and an electro-magnetic tripping device for short circuit protection. All three-phase circuit breakers shall have over-current and short circuit protection devices in each phase.
- TS-1272* These devices shall be interlocked with each oh the other phases, such that the operation of a trip in any one phase will automatically cause all three phases to be isolated from the supply.
- TS-1273* The Fuse /M.C.B. Boards shall be adequately and securely fixed to the surface of the building walls in the positions shown on the various Drawings by means of raw bolts or other metallic fixing devices as approved by the Managing Official. All fixing bolts that can be accommodated in the fixing holes shall be used.
- TS-1274* The positions of the Fuse M.C.B. Board as shown on the Contract Drawings shall be agreed with the Managing Official before erection of any Fuse /M.C.B. Board.
- TS-1275* The busbars of all Fuse /M.C.B. Boards shall be connected to the phases of the supply so that the standard arrangement of red, yellow, blue and neutral working from top to bottom of the Fuse /M.C.B. Boards is adhered to throughout the installation to ensure uniformity in phase coloring. The top busbar of the Fuseboard is to be tested to make sure it is fed from the red phase right the way back through the system to the source of supply.
- TS-1276* The Fuse /M.C.B. Boards shall be supplied with charts mounted inside their doors and /or across the phase barriers. These charts shall be completed by the Contractor to give a clear and permanent indication of :

1. The circuit reference of each fuseway /M.C.B.
2. The correct H.R.C. fuse /M.C.B. for each fuseway.
3. The title of the plant protected by each H.R.C. fuse /M.C.B.

TS-1277 Sweating sockets or facilities for crimped terminals are to be provided for incoming phase and neutral cables.

TS-1278 All live metal parts are to be enclosed by insulating material including when the fuse carriers are withdrawn, and the carriers are to be arranged to protect persons handling them from electric shock or burns.

17.5 Earthing

TS-1279 Earth leads and earth tapes shall be of high conductivity bare copper in internal dry conditions and where they are run underground or in damp locations they shall be tinned.

TS-1280 As far as possible they shall be continuous without joints, but where joints are unavoidable, they shall be bolted and soldered. All such joints shall be coated with anti-corrosive paint and wrapped with self -adhesive PVC tape.

TS-1281 Where earth leads and earth tapes are required to be buried, they shall be at a depth of not less than 500mm (1'8"). Where they are fixed to building surfaces they shall be fixed at intervals not exceeding 1.0 m (3'4") with copper or brass saddles of the spacing type. The saddles shall be tinned where necessary to correspond to the lead or tape being fixed.

TS-1282 An earth test link is to be provided adjacent to all switchboards. The link shall be a 13mm x 3mm copper strip secured across a 50mm (2") break in the earth lead or tape by high tensile steel bolts and nuts.

TS-1283 All earthing cables shall be installed in accordance with the relevant requirements called for in the Cables section of this specification.

TS-1284 All bonding leads in the form of cable having a standard conductor shall be terminated in 'sweated' sockets and shall be rigidly bolted to earthing terminals.

TS-1285 All earthing cables shall be insulated with a green PVC sheath. Where connection on the earth lead to the main earth is made with a standard cable, the earth lead shall be double insulated with PVC sheaths, the outer sheath being colored green.

TS-1286 Where a lightning protection scheme is installed the earth lead may be bonded to the lightning conductor earth.

TS-1287 The Main Contractor will execute any trenching and backfilling and erect and cement into position all electrode manholes to details provided by the Contractor.

TS-1288 Connections by means of copper earth tape shall be made between the main earth bars to the frame terminals of all items such as switchboards etc.

TS-1289 The main ground connection shall be to a grid of electrodes of galvanized water pipes buried in the ground, and shall provide a minimum ground resistance of 2 ohms.

TS-1290 The connections from the main ground to the switchboard shall be of 50 sq.mm copper cable.

17.6 Cables

- TS-1291* All cables shall be manufactured to comply with the relevant British Standards and are to be obtained from one of the approved manufacturers. All cables shall be XLPE, except that underground cables shall be N2xY.
- TS-1292* Data and Ethernet cables should be superior cables four pairs 24AWG.HFFR.IEC 61156-5.CAT6. 450MHZ.
- TS-1293* Loud speakers cable should be single pair with solid copper conductor 1.25mm diameter in flat configuration with poly ethylene insulation and PVC jacket. Conductors to have a maximum DC loop resistance at 20F of. 28 OHM/KM and a nominal capacity of 91 PF/M.
- TS-1294* Microphone cable should be single pair screened with standard copper conductor. 31/0.2mm with PVC insulation lapped copper screen and PVC jacket. Conductors to have a maximum DC loop resistance of 45.7 OHM/KM and a nominal capacity of 430PF/M.
- TS-1295* The minimum size of conductor used for lighting sub circuits shall be 1.5 sq.mm and for local ring main circuits 2.5 sq.mm.
- TS-1296* All cables shall be supplied to site on suitable drums with labels clearly indicating the origin and specification of cable.
- TS-1297* Where cables are installed underground the Contractor shall mark out trenches for excavation by the Main Contractor, according to the Drawings and as directed by the Managing Official.
- TS-1298* The Contractor shall install the cables on a smooth bed of sifted sand 10 cm thick (minimum), and then cover the cables with another layer of sand up to 10cm above the top of the cable, and provide and install interlocking concrete cable covers engraved 'Electricity' in both English and Arabic along the complete underground length of the cables.
- TS-1299* The cable clamps are to be fixed to the building structure by means of loose bolt type rawlbolts and by steel nuts and bolts to any other structure.
- TS-1300* All cables run within the site buildings are to have the serving removed and the single wire armoured cleaned bright and left bare throughout the entire length of the cable, or alternatively the cable is to be taped with 50mm (2") wide PVC tape half lapped. This is to minimize the fire risk of the compound serving on the cable.
- TS-1301* All cables shall be colored in accordance with the following:
- Red phase-Red
 - Yellow phase-Yellow
 - Blue phase-Blue
 - Neutral-Black

17.7 Lighting fittings:

- TS-1302* Lamps and Tubes: all lamps and tubes of the lighting have to be low energy system.

- TS-1303* The Contractor shall supply all lighting fittings unless otherwise specified in the Schedule of Lighting Fittings. The Contractor shall provide all the lamps for lighting fittings, which he supplies as part of the Contract.
- TS-1304* The Contractor shall allow for the installation of all the lighting fittings in the locations as shown on the Drawings. Where lighting fittings are recessed in ceiling panels he shall obtain from the Managing Official detailed drawings of the ceiling layout prior to commencement of fixing.
- TS-1305* Lighting fittings shall generally be fixed direct or suspended from the structural ceiling to heights as stated in the Particular Specification. In the case of wall mounted lighting fittings not above doorways or structural openings the mounting heights shall be as indicated on the Contract Drawings. In instances where they are mounted over doorways or structural openings they shall not be fixed more than 300mm (10") higher than the lintel of the doorway.
- TS-1306* Where fluorescent lighting fittings are required to be suspended this shall be done by means of a 1" link galvanized heavy jack chain of the welded link type, the chain being attached to standard conduit box hook plates fixed to conduit boxes.
- TS-1307* The conduit boxes from which any fluorescent lighting fitting is supported or suspended shall be securely fixed to the building structure by means of at least one 1/4" whitworth bolt , complete with flat washers, spring washer and full size nut or the equivalent diameter roundhead wood screw and /or toggle bolts of Rawlplug manufacture or other fixings as approved by the Managing Official .
- TS-1308* The supply to each lighting fitting shall be by means of 32/0.2mm 3-core circular, heat resistant butyle sheathed flexible 250 volt grade cable, to be connected to the circuit wiring by means of multiway P.V.C. connector blocks having brass mechanical screw clamp connections. Screwit type connectors will not be permitted. Taped and soldered joints will not be permitted.
- TS-1309* The third core, earth conductor of the flexible cable is to be securely earthed in the conduit box, socket or ceiling rose and the lighting fitting. These connections shall be effected in purpose made terminations and the fixing screws of the conduit box lid, hook plate or similar means not specifically intended as a conductor termination shall not be used for securing the earthing. The connection of the third core to the lighting fitting shall be effected in a similar manner as described above.
- TS-1310* The Contractor shall allow in his tender for all the necessary supports steelwork and other accessories required for the supporting and /or mounting of all the lighting fittings as shown on the Contract Drawings.
- TS-1311* Where fluorescent lighting fittings are mounted direct to purpose made lighting trucking, the lighting trunking manufacturer's purpose made fixings and supports are to be utilised for the mounting of the lighting fittings. The connection and earthing of the lighting fittings is to be effected as previously described herein.
- TS-1312* At every lighting point an earthing terminal shall be provided and connected to the earth-continuity conductor of the final sub-circuit.

17.7.2 Pendant lighting fittings

- TS-1313* The Contractor is to supply and install all plain pendant lighting fittings as shown on the Drawings.

TS-1314 All ceiling roses containing permanently 'live' terminals shall be of such a manufacture that 'live' terminals are completely shielded and contact cannot be made there with the normal replacement of the flexible pendant.

TS-1315 Every ceiling rose shall be provided with an earthing terminal.

17.8 Switches and switch lighting

TS-1316 The Contractor shall supply and install the lighting switches in accordance with the type specified. Where they are indicated on the Drawings, switches shall be of the two-way or intermediate type, and in some instances shall be ganged in various numbers in a single box with a common cover plate.

TS-1317 All switches shall have 15 Amp interiors for lighting circuit loads in excess of 600 watts.

TS-1318 The lighting switches shall be mounted at a height of 1.4m (4'-8") from finished floor level to the center of the switches unless deemed otherwise by the Managing Official. The switches shall be fixed by any fixing device approved by the Managing Official.

TS-1319 Where ceiling mounted cord operated "PULL" switches are called for on the Drawings they shall be positioned such that the cord will hang free at a distance of 75 mm (3") from any wall surface or door opening. The cords for such switches shall be of a length sufficient to reach a point 1.5m (5'0") above finished floor level.

TS-1320 All switches shall be wired in the live side of the circuit they control.

TS-1321 Where six or more switches are ganged together in one box with a common switch plate, the switch plate shall be engraved to indicate the area, row or points controlled.

17.9 Socket outlets

TS-1322 All socket outlets unless otherwise specified or indicated on the Contract Drawings shall be of the 16 Amp shuttered circular pin type complying with local standard.

TS-1323 The contacts shall be housed in a track resistant moulding, controlled where indicated on the Drawings by integral A.C. type single pole switch.

TS-1324 The finishes of socket outlet plates may vary depending upon the area and these will be as specified in the Particular Specification. However, socket outlets in plant rooms shall have steel front plates.

TS-1325 Mounting boxes shall be either of aluminium or enamelled steel for flush installations, or aluminium only for surface installations. All boxes shall incorporate an earthing terminal.

TS-1326 The Contractor shall supply and install all socket outlets in accordance with the types and ratings specified and /or indicated on the Contract Drawings.

TS-1327 The positions of all socket outlets as shown on the Contract Drawings must be checked with the Main Contractor, attention being given to type of wall finish required and the method of mounting thereon.

17.10 Telephones and audio equipment:

- TS-1328* The Contractor shall be responsible for the supply and installation of the necessary enclosers, cable trays and draw wires for a complete telephone installation throughout the premises.
- TS-1329* The Contractor shall ensure that the main cable entry duct is installed by the Main Contractor to the requirements of the local Telephone Company. In all cases the main duct shall have a minimum size of 10cm, be of plastic manufacture, and have no right angle bends.
- TS-1330* Each 2.5cm telephone conduit will serve no more than 4 telephone outlets.
- TS-1331* At the junction point of risers and conduits and at the main entry duct point the Contractor must ensure a clear wall space of at least 1 sq.m for the installation of the telephone company's distribution boxes.
- TS-1332* If it is a requirement of the local Telephone Company that the Contractor is to install the necessary telephone cables, the Contractor shall liaise closely with the Telephone Company and obtain prior approval for any telephone cables installed.
- TS-1333* Horn type loud speaker should be weather proof with matching transformer 45W European made.
- TS-1334* Internal loud speakers should be 6/9W circular in a wooden box with matching transformer European made.
- TS-1335* Audio amplifier 360W with charger and at least four outlets, built in CD and cassette player and recorder with prerecorded tones (piano), daily – weekly go off bill timer unit, tuner, rack cabinet 14U metal with aluminum and glass door for housing the system. European made.

17.11 Maintenance tools, keys and spare equipment

- TS-1336* The Contractor is to provide two sets of any special tools and keys necessary for the maintenance of the items of equipment supplied under the Contract.
- TS-1337* Spare items of equipment shall only be supplied where particularly specified, as for fuses.
- TS-1338* All keys, tools and spare equipment are to be handed over to the Employer, with a detailed list of all items. The Contractor is to obtain two receipted copies of the list and forward one to the Managing Official.

17.12 Outside lighting (all lighting fixtures shall be low energy systems bulbs and tubes)

- TS-1339* The Contractor shall supply and install an outside lighting system as shown on the Drawings and in accordance with the Schedule of Lighting Fittings.
- TS-1340* The Contractor shall be responsible for the supply and erection of the lighting columns, and shall also be responsible for advising the Main Contractor of the

routes of the trenches for the mains cables to each column and the siting of the holes for the column bases.

- TS-1341* The excavation and backfilling of the trenches and the concreting in of the column bases shall be carried out by the Main Contractor.
- TS-1342* Each column shall be fitted with O.C.C. Bs manufacture connecting to the lighting units mounted on the column.
- TS-1343* The termination of the cables to each column and the fusing of each column shall be as detailed in the Drawings.
- TS-1344* Wiring to floodlights mounted on the building shall be routed on the inside of the building. Cables fixed to the outside face of the building will only be permitted at the discretion of the Managing Official.