DETAILED DESIGN REPORT
ON
CENTRAL TELECOMMUNICATION RESEARCH LABORATORIES
ISLAMABAD
CONSTRUCTION PROJECT
IN
THE ISLAMIC REPUBLIC OF PAKISTAN
(BUILDINGS)

II TECHNICAL SPECIFICATIONS

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CENTRAL TELECOMMUNICATION RESEARCH LABORATORIES

ISLAMABAD

TECHNICAL SPECIFICATIONS

PART I

FOR

CIVIL AND BUILDING WORKS

NIPPON SŌGŌ ARCHITECTS' AND ENGINEERS' OFFICE CORP., LTD.

(NSK) TOKYO JAPAN

国際協力事業団
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TECHNICAL SPECIFICATIONS
PART I
FOR
CIVIL AND BUILDING WORKS
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PRELIMINARY

P-1 STANDARDS, SPECIFICATIONS, BYE-LAWS

In various places throughout this specifications reference is made to the Standards, Specifications and Bye-laws issued by the Japanese Standards Association, the American Society for Testing Materials, the British Standards Institution, the General Services Administration, various Ministries and Departments of the Government of Pakistan, and other Authorities. These references shall in every case be deemed to include the latest edition of issue of such Standards, Specifications, and Bye-laws, including all revisions, amendments and addenda subsequently issued.

P-2 ABBREVIATIONS FOR STANDARDS, ETC.

The following abbreviations for Standards, Specifications, Bye-laws, etc., and the names of institutions issuing same are used throughout this specification:

PPWD	PPWD Specifications by the Pakistan Public Works Department
BS	British Standards by the British Standards Institution
JIS	Japanese Industrial Standards by the Japanese Standards Association
ASTM	ASTM Standards by the American Society for Testing Materials
FS	Federal Specifications by the General Service Administration (U.S.A.)
ASA	ASA Specifications by the American Standards Association
AA	Aluminum Association (U.S.A.)

P-3 UNIT SYSTEM

Metric system is used to give dimentions that is measurement, volume, weight, etc., throughout this specification.

SECTION 1

TEMPORARY CONSTRUCTION AND FACILITIES

1.1 SCOPE OF WORK

1.1.1 Extent: The work required under this section consists of providing all temporary construction and facilities necessary to complete the work as indicated on drawings and described in specifications.

1.2 SURVEYING AND FIELD LAYOUT

1.2.1 Surveying: Prior to commencing the work, surveying of the building site shall be performed. Submit reports of survey as required by the Engineer.

1.2.2 Bench Mark: In accordance with drawings, the Contractor shall set up the bench marks and indicate exact positions of the building in the presence of the Engineer. Keep bench marks and indicated positions of the building from disturbance during construction.

1.3 PROJECT SIGNS

1.3.1 Provide project signs and locate on site where indicated or directed. The extent of lettering on sign shall be as directed by the Engineer.

1.4 TEMPORARY FIELD OFFICE AND SHEDS

1.4.1 Office: The Contractor shall provide and maintain a suitable temporary field office at the project site for his own use and the use of the Engineer. The office shall contain a minimum of 30 sq.m of floor space to be used the by Engineer; it shall be provided with adequate heat, window cooler electric lighting, toilet and lavatory, and office facilities such as desk, chair, locker, drawing board and book shelf. Locate office where indicated or directed and remove when the work is completed. Telephone shall be used conveniently by the Engineer at his will.

1.4.2 Sheds: The Contractor shall provide and maintain sheds for storing construction materials. Especially cement, plaster and other similar materials shall be protected from rain water and moisture.

1.5 SCAFFOLDS, STAGING AND SAFETY DEVICES

1.5.1 Provide, erect, maintain and remove all scaffolding, staging, platforms, temporary runways, temporary flooring, guards, railings, stairs, etc., so as to insure convenience and safety for performing the works and supervisions at the site. The construction, inspection and maintenance of the above items shall comply with all safety codes and regulations as applicable to the project.

1.6 CONSTRUCTION EQUIPMENT AND TOOLS

1.6.1 Construction Equipment and Tools: The Contractor shall provide items of equipment and tools that best meet the job requirements, and maintain the same in good working conditions so as to be used effectively and to eliminate accidents.

1.6.2 Construction Facilities: Such facilities as for electric power, lighting, water supply and drainage shall be provided to meet the job requirements.

1.7 REMOVAL OF TEMPORARY WORK

1.7.1 The Contractor shall remove all the temporary works upon completion of the construction.

1.8 WATCHMAN

1.8.1 The Contractor shall employ a responsible watchman to guard the site and premises of the project at all times, except during regular working hours. The watchman service shall be continuous from beginning of work until final acceptance by the Owner.

SECTION 2

EXCAVATING, FILLING AND GRADING

2.1 SCOPE OF WORK

2.1.1 Extent: The work required under this section consists of all excavating, filling, rough grading and related items necessary to complete the work indicated on drawings and described in specifications.

(a) In general the items of work to be performed under this section shall include but is not limited to: clearing and grubbing, excavation for building and structures, backfilling, filling, fill compaction as indicated on drawings. In addition, perform all excavation, clearing, grubbing, filling, fill compaction and rough grading for curbs and drives which are indicated outside the property lines or contract limit lines.

(b) Excavated material that is suitable shall be used for fills and backfills indicated or required. All surplus excavated material shall be used for site grading or leveling as indicated on drawings or directed by the Engineer, and shall not be removed from the site.

(c) The Contractor shall accept the site as he finds it and remove all trash and rubbish from site prior to starting excavation.

(d) Where adjacent lawn or surfaced areas within the project site, but outside the contract limits for grading, are disturbed as a result of building operations or storage of materials under this Contract, they shall be cleaned of all debris and restored to original grades and condition.

2.1.2 Work not Included: The following item of related work is specified and included in other section of this specification.

(a) Excavation and backfilling for utility lines.

2.2 EXCAVATION FOR BUILDINGS AND STRUCTURES

2.2.1 Planning: The Contractor shall submit three (3) copies of excavation planning drawings for approval of the Engineer. The drawings

shall indicate the dimensions, procedures and methods of excavation.

2.2.2 Dimensions: Excavate to elevations and dimensions indicated; allow additional space as required for construction operations and inspecting foundations.

2.2.3 Obstructions: Completely remove all existing walls, slabs, curbs, paving, floors, steps, footings, piers and other construction from under new foundations; remove such obstructions elsewhere within building lines to a depth of 15 cm below the level of excavation indicated on drawings. In surfaced and planted areas, remove all existing walls, curbs, paving and other obstructions to a depth of 60 cm below finished grades.

2.2.4 Suitable Bearings for Foundations: If suitable bearing is not encountered after the plate loading test specified hereinafter, the Contractor shall not proceed further until instructions of the Engineer are given.

2.2.5 Drainage: The Contractor shall control the grading around buildings so that ground is pitched to prevent water from running into the excavated areas or damaging the structures. Maintain all pits and trenches where footings are to be placed, free from water at all times. Provide all pumping required to keep excavated spaces clear of water during construction. Should any springs or running water be encountered in the excavation, the Engineer shall be notified and the Contractor shall provide free discharge of it by trenches and drain to an appropriate point of disposal as directed.

2.2.6 Footing Trenches: Where soil conditions will permit, footing trenches may be excavated to the exact dimensions of the concrete, and side forms omitted. Place footings and foundations upon undisturbed and firm bottoms; fill with concrete any excess cut under footings and foundations.

2.3 DISPOSITION OF UTILITIES

2.3.1 Rules and regulations governing the respective utilities shall be observed in executing all work under this section.

2.3.2 Active utilities shown on drawings shall be adequately protected from damage and removed or relocated only as indicated or specified. Where active utilities are encountered but are not shown on drawings, the Engineer shall be advised; the work shall be adequately protected, supported, or relocated as directed by the Engineer.

2.3.3 Inactive and abandoned utilities encountered in excavating and grading operations shall be reported to the Engineer; they shall be removed, plugged or capped as directed by the Engineer. In absence of specific requirements, plug or cap such utility lines at least 1 m outside of new building walls.

2.4 FILL UNDER FLOOR SLABS ON GRADE

2.4.1 Where fill is required to raise the subgrade for concrete floor or terrace slabs to the elevations indicated on drawings, such fills shall be of earth placed and compacted as specified. Earth shall be used for fills not exceeding 30 cm deep. The quality of material for fills shall be approved by the Engineer. The placing and compaction of fill under slabs after foundation walls are in place shall be coordinated with the backfilling against the outside of the walls, or walls shall be adequately braced to prevent damage.

2.4.2 Before depositing fill, remove all vegetation and other unsuitable material from areas to receive fill. Do not deposit fill until the subgrade has been checked and approved by the Engineer. In no case shall fill be placed on a subgrade that is muddy, frozen, or that contains frost. Deposit fill material in horizontal layers not exceeding 30 cm in depth before compacting. Spread fill evenly and compact each layer by uniformly rolling, pneumatic tamping or by other approved equipment. If necessary, soil shall be moistened, or allowed to dry to the correct moisture content before compaction. The finished compacted areas shall be brought to a reasonable true and even plane at the required elevations and shall be approved by the Engineer prior to further construction operations thereon.

2.5 BACKFILLING FOR BUILDINGS AND STRUCTURES

2.5.1 Backfill against foundation walls only after the slab has been

poured to support the top of the wall and approval of the Engineer has been obtained. Place and compact backfill so as to minimize settlement and avoid damage to the walls and to waterproofing and other work in place.

2.5.2 Before placing fill, remove all debris subject to termite attack, rot or corrosion, and all other deleterious materials from areas to be backfilled. Deposit backfill in layers not more than 30 cm thick. All fill material shall be reasonably free from roots, plaster, bats and unsuitable materials. Place the fill material in successful horizontal layers, in loose depth as specified, for the full width of the cross section. Thoroughly compact each layer by rolling or pneumatic tamping after a light sprinkling with water. The finished subgrade shall be brought to elevations indicated and sloped to drain water away from the building walls. Fill to required elevations any areas where settlement occurs.

2.6 SITE GRADING

2.6.1 Grades: Do all cutting, filling, compacting of fills and rough grading required to bring the entire project area, outside of buildings, to subgrades as follows:

(a) For surfaced areas, roadways, parking areas, service courts, steps, and walks to the underside of the respective surfacing or base course, as fixed by the finished grades therefor.

(b) For lawn and planted areas, to 7 cm - 12 cm below finished grade.

2.6.2 Fills: Where fill is required to raise the existing grades outside of building areas to the new subgrade elevation indicated on drawings, such fill shall be of earth, placed and compacted as specified. The quality of fill material shall be approved by the Engineer.

(a) Remove all debris subject to termite attack, rot or corrosion, and all other deleterious materials from areas to be filled. Prior to placing fill material, the surface of the ground shall be scarified to a depth of 15 cm and the moisture content of the loosened material shall be such that it will

readily bond with the first layer of fill material.

(b) Material for fill shall be reasonably free from roots, wood or other organic material.

(c) Compaction shall be accomplished by the use of power rollers, sheep foot rollers, machine tampers, or other mechanical equipments approved by the Engineer. If necessary, soil shall be moistened, or allowed to dry to the correct moisture content before compaction. Do not deposit any fill on a subgrade that is muddy.

2.6.3 Rough Grading: Rough grading of all areas within the project, including excavated and filled sections and adjacent transition areas shall be reasonably smooth, compacted, and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from either blade-grader or scraper operations, except as otherwise specified. The finished subgrade surface generally shall be not more than 15 cm above or below the established grade or approved cross section, with due allowance for topsoil, sod and pavement depths; the tolerance for areas within 3 m of buildings and all areas to be paved, shall not exceed 4 cm above or below the established subgrade. All ditches, swales and gutters shall be finished to drain readily. Unless otherwise indicated on drawings, the subgrade shall be evenly sloped to provide drainage away from building walls in all directions at a grade not less than 1 cm per m. Provide roundings at top and bottom of banks and at other breaks in grade.

2.6.4 Protection: Protect newly graded areas from the actions of the elements. Any settlement or washing that occurs prior to acceptance of the work shall be repaired, and grades re-established to the required elevations and slopes. Fill to required subgrade levels any areas where settlement occurs.

2.7 DISPOSAL OF SURPLUS MATERIALS

2.7.1 All surplus excavated materials shall be used for site grading or leveling as indicated on drawings or directed by the Engineer, and shall not be removed from the site.

2.8 PLATE LOADING TEST OF SOIL

2.8.1 The Contractor shall previously submit his written propositions of the date, the procedure and the method of the test to the Engineer for approval. The location and the depth of the test point is indicated on drawings. The test shall be done under the supervision of the Engineer.

2.8.2 The size of a loading plate shall be 30 cm by 30 cm square, and the load shall be increased to 4.5 tons. The test load shall be applied in increment of approximately 0.9 tons, and each load increment shall be maintained until the rate of settlement is 1/100 milimeter per 15 minutes.

2.8.3 The Contractor shall immediately submit five (5) copies of the test report to the Engineer.

SECTION 3

CONCRETE WORK

3.1 SCOPE OF WORK

3.1.1 Extent: The work required under this section consists of all concrete work and related items necessary to complete the work indicated on drawings and described in specifications.

3.1.2 Work not Included: The following items of related work are specified and included in other sections of this specification:

(a) Concrete fill or setting beds for ceramic tile and terrazzo tile.

(b) Hangers for attaching suspended ceilings to concrete slabs.

(c) Inserts and pipe sleeves for mechanical, electrical and plumbing work.

(d) Anchors for masonry and stone work secured to concrete; metal slots to receive anchors.

3.2 SHOP DRAWINGS

3.2.1 General: Submit three (3) copies of shop drawings for reinforcing steel and formwork to the Engineer for approval. Obtain approval of drawings prior to fabricating any material or proceeding with the work.

(a) Reinforcing Steel Drawings: Shop drawings for reinforcing steel shall indicate bending diagrams; assembly diagrams, splicing and laps of rods; shapes, dimension and details of bar reinforcing and accessories. Unless otherwise indicated, drawings shall be prepared in accordance with the drawing S-2. Scaled dimensions from structural drawings shall not be used in determining the lengths of reinforcing rods.

(b) Formwork Drawings: Shop drawings of formwork for all reinforced concrete constructions shall be submitted for approval. Shop drawings shall be completed in all respects and shall show the general arrangement, sizes and grades of lumber, panels, alignments, etc. They shall indicate schedules of placement, construction and control joints with their methods

of forming; locations of inserts, tees, sleeves, and other items. The Contractor shall also submit for approval drawings or description of the method of shoring and reshoring and other horizontal concrete members.

3.3 SAMPLES

3.3.1 The Contractor shall provide, at his own expense, samples of the cement, aggregates and reinforcements he proposes to use, as the requirement of the Engineer.

(a) Sampling and testing of aggregates shall be as required by BS882 and in accordance with BS812. All sampling shall be done in the presence of the Engineer.

3.3.2 Submit samples in duplicate of the following materials to the Engineer for approval. Approval must be obtained prior to delivery of fabrication.

(a) Expansion joint fillers
(b) Form ties
(c) Metal accessories
(d) Clushed stone for use in filling under "floor slabs on earth"

3.4 MATERIALS AND ACCESSORIES

3.4.1 Portland Cement: Ordinary portland cement of conforming to BS 12. Each bag shall contain 50 kg net ±1%. The Contractor shall submit two (2) copies of the manufacturer's monthly certificate to the Engineer, every month. No cement with any solidification, in a broken bag or which is too moist shall not be used.

3.4.2 Aggregates: The aggregates for use in the production of concrete shall be naturally-occurring materials, crushed or uncrushed, and shall generally conform to BS 882. For convenience, part of Clause 5 of BS 882 (Grading) including Tables 1, 2 and 3 are reproduced herein.

(a) Coarse Aggregate: The grading of coarse aggregate, when analysed by the method given for sieve analysis in BS 812 shall be within the limits given in Table 1.

(b) Fine Aggregate: The grading of a fine aggregate, when analysed 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 percent may be applied to the percentages underlined.

This tolerance may be split up; for example, it could be 1 percent on each of three sieves and 2 percent on another, or 4 percent on one sieve and 1 percent on another. The fine aggregate shall be described as fine aggregate of the grading zone into which it falls, e.g. BS 882, Grading Zone 1.

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.

Table 1. Coarse Aggregate

Percentage by weight passing BS sieves					
BS 410 test sieve	Nominal Size of Graded Aggregate	Nominal Size of Single-Sized Aggregate			
	20 mm to 5 mm	40 mm	20 mm	14 mm	10 mm
63.0 mm	-	100	-	-	-
37.5	100	85 - 100	100	-	-
20.0	95 - 100	0 - 25	85 - 100	100	-
14.0	-	-	-	85 - 100	100
10.0	30 - 60	0 - 5	0 - 25	0 - 50	85 - 100
2.36	-	-	-	-	0 - 5

*:BS 410 "Test sieves" Part 1, "Fine and medium test sieves (Wovon wire)"

Part 2, "Coarse test sieves (Perforated plates)"

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
10.0 mm	100	100	100	100
5.0	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
600 μm	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*

Note: * For crushed stone sands, the permissible limit is increased to 20%. The 5% tolerance permitted by 3.4.2(b) may, in addition, be applied to.

All-in aggregate to BS 882, Table 3, and crushed stone sand shall not be used for reinforced concrete but may be used for Type C concrete if approved by the Engineer. 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 Engineer.

(c) All-in Aggregate: The grading of an all-in aggregate, when analysed by the method of sieve analysis described in BS 812, shall be in accordance with Table 3.

Table 3. All in Aggregate

BS 410 test sieve	Percentage by weight passing BS sieves 20 mm nominal size
75.0 mm	-
37.5	100
20.0	95 - 100
5.0	35 - 55
600 μm	10 - 35
150	0 - 6

3.4.3 Water: Water shall be free from earth, vegetable, organic and inorganic impurities, particularly the sulphates and any other substances likely to cause efflorescence, or salts which interfere with setting of mortars and prove harmful to the work. Water shall be without any colour or brackish taste and should generally be fit for drinking. P.H. value of water shall range between 6 and 8.

3.4.4 Steel Reinforcement: Reinforcing steel shall meet the following specifications:

(a) Reinforcing Bars: Bars with a diameter of 16 mm and over shall be deformed in accordance with JIS G3112 and formed of BS 4449; high tensile steel, or JIS G3112; SD35. Bars with a diameter of up to and including 13 mm shall be plain bars in compliance with BS 4449; mild steel with guaranteed yield stress: 2,400 kg/sq.cm, or JIS G3112; SR24.

(b) Manufacturer's test certificates for all types of reinforcement shall be supplied.

In the case of being required by the Engineer, the Contractor shall provide specimens for the tensil tests and the bending tests for each different size and type of bar and test those specimens in accordance with JIS G3112, at his own expense.

3.4.5 Anchor Bolts: Anchor bolts used in connections of concrete with platforms for microwave test antennas shall meet the following specifications:

material	:	JIS G3101; SS41,
form and finish	:	JIS B1180; the 2nd grade finish
accuracy of forming screw threads	:	JIS B0209 or JIS B0211; the 3rd class

Anchor bolts shall conform to JIS B1180 generally, and be galvanized where legs are shown to be exposed to outside of finished concrete surfaces on drawings.

3.4.6 Expansion Joint Filler and Sealer: Polystyrene foamboard shall be "Styroform" by Asahi Dow Chemical Co., Ltd. or equal. Joint fillers shall extend to full depth of protection concrete and have thickness of 2.5 cm. Joint sealer shall be of asphalt fitting for waterproofing and confirming to JIS A6011 - the 4th class.

3.4.7 Accessories: Include all spacers, chairs, bolsters, ties, and other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place. Metal accessories shall be galvanized where legs will be exposed in finished concrete surfaces.

3.4.8 Waterproofing Admixtures: Similar to "Magner liquid No. 2" as manufactured by Magner Industry Co., Ltd. Mix in accordance with directions of manufacturer, using admixture to each bag of cement. Use waterproofing admixture in mortar for waterproofing mortar indicated.

3.5 DELIVERY AND STORAGE OF MATERIALS

3.5.1 The cement shall be delivered to the Site by the Contractor in the original sealed and branded bags and shall be stored in a proper manner off the ground and in fully closed room with good roofing to prevent deterioration. Each batch shall be stacked separately and used in the order of delivery. Do not pile up more than ten bags. No cement shall be used which has been manufactured more than twelve (12) months prior to its proposed use on the site.

3.5.2 The choice and preparation of sites for stockpiling of aggregates, the number and sizes of stockpiles and the method adopted to prevent segregation of component sizes shall be agreed with the Engineer. Coarse aggregate shall be stockpiled in three separate gradings; 38-19 mm, 19-10 mm and 10-5 mm. When aggregates of different gradings are stockpiled close together, the stockpiles shall be separated by bulkheads.

Stockpiles are to be on concrete or other hard surface sufficiently sloped so that water is not retained in the base of the stockpiles. 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. 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 each bin such that a mix of the

desired gradation is obtained consistently and the whole operation is conducted to the satisfaction of the Engineer.

3.5.3 All reinforcement shall be stored in a proper manner, off the ground, and with good device to avoid getting wet. Protect all reinforcement and other materials until used.

3.6 TYPE OF FORMS AND EXPOSED FINISHES - (Other than floors)

3.6.1 Fair Faced Finish: Fair faced finish shall be used for all interior and exterior vertical and overhead concrete surfaces that will be exposed as finished work. Obtain by using steel forms or by lining forms with 5 mm thick tempered pressedwood or 6 mm thick water-resistant plywood. Sheets shall be as large as possible with smooth even edges and installed with close joints. Joint marks and fins shall be ground off and surfaces left smooth, dense and free from honeycombing, prominent grain marking and bulges or depressions more than 3 mm in 1.2 m. Surfaces shall then be patched as hereinafter specified, leaving the surface finish uniformly smooth and washed clean.

3.6.2 Common Finish: Common concrete finish shall be used for all other concrete. Obtain by using clean, straight lumber of 12 mm thick, water-resistant plywood of 12 mm thick, or metal forms. Concrete having a common finish shall have honeycombing and minor defects patched.

3.6.3 Cleaning Finished Exposed Concrete Surfaces: In the event that efflorescence, stains, oil, grease, or any unsightly accumulation of foreign materials are visible on the exposed exterior and/or interior surfaces of finished concrete, the Engineer may require remedial action to remove these blemishes. Such action may cover all exposed concrete, or, when irregular lapping can be avoided, only such parts as are affected by the stains or other unsightly appearances. Cleaning shall proceed as follows:

(a) Remove oil and grease with detergents and scrubbing, and thoroughly wash with water. While the surface is wet, apply a grout coat of cement and fine sand mixed 1 to 1-1/2 with white cement added as directed to attain desired colour.

Immediately float surface with cork or other suitable floats to fill any holes. While the grout is plastic, finish with a sponge rubber float, removing excess grout. This shall be done when grout will not be pulled from holes.
Allow surface to dry thoroughly, then rub with dry burlap to remove all dry loose grout. Complete all cleaning on any section in one day, leaving no loose grout on the surface overnight.

3.7 CONSTRUCTION OF FORMS

3.7.1 Construct forms to slopes, lines and dimensions shown, plumb and straight and sufficiently tight to prevent leakage; securely brace and shore forms to prevent displacement and to safely support construction loads. Provide access openings for cleaning and inspecting forms and reinforcing prior to depositing concrete. Do not coat forms with material that will stain or cause injury to exposed concrete surfaces or to plaster applied direct to concrete. Keep wood forms wet as necessary to prevent shrinkage. Construct forms for beams, girders and lintels so that sides may be removed without disturbing bottom of form or its support.

3.7.2 Where soil conditions will permit excavation to accurate sizes without bracing, side forms for footings may be omitted and the sides of excavation lined with waterproof paper, or 0.15 mm thick polyethylene film.

3.7.3 In any event, the maximum permissible deflection under all loads shall not exceed 5 mm or 1/600 of the span, whichever is less.

3.8 FORM TIES

3.8.1 Form ties used for exposed concrete surfaces shall be of type approved by the Engineer. They shall have a minimum working strength when fully assembled of at least 1,200 kg. Ties shall be so adjustable in length as to permit complete tightening of forms and of such type as to leave no metal closer than 38 mm to the surface. They shall not be fitted with any lugs, cones, washers or other device to act as a spreader within the forms, or for any other

purpose which will leave a hole or depression larger than 22 mm in diameter or a depression back of the exposed surface of the concrete. Wire ties will not be permitted.

3.8.2 Tie rods that are to be entirely removed from the walls shall be loosened 24 hours after the concrete in poured. All but a sufficient number of ties to hold the forms in place may be removed at that time.

3.9 WETTING AND OILING FORMS

3.9.1 The inside surface of wood board forms shall be soaked with clean water prior to placing concrete. Plywood or pressedwood forms, except as otherwise specified herein, shall be treated with an approved form oil or lacquer. If oil is used, all excess oil shall be wiped off with rags to leave the surface of the forms just oily to the touch. Concrete shall not be placed in any form until inspected by the Engineer and permission is given to start placing. Where plaster bond finish is required, forms shall not be oiled.

3.10 PLACING REINFORCEMENT

3.10.1 Place reinforcement accurately in position shown, securely fasten with mild steel wire and support to prevent displacement before or during pouring. Cleaning, bending, placing and splicing of reinforcement shall be done in accordance with requirements of BS 4466 and approved shop drawings.

3.10.2 Accurate spacings between reinforcements and forms shall be maintained by spacers of metal, wood or mortal.

3.11 INSERTS AND FASTENING DEVICES FOR OTHER WORK

3.11.1 Provide for installation of inserts, conduit, pipe sleeves, drains, hangers, metal ties, anchors, bolts, angle guards, dowels, thimbles, anchor slots, metal reglets, nailing strips, blocking, grounds and other fastening devices required for attachment of other works. Properly locate in cooperation with other trades and secure in position before concrete is poured. Where openings are left in concrete for the passage of ducts, the openings shall be made

slightly larger than the duct size as directed by the Engineer. Where boxes are required for floor type door closers, they shall be accurately located and, where required, the base slab shall be cutout to receive the boxes prior to placing the cement floor topping. Do not install sleeves in any concrete girder, beam, joist or column except after approval of the Engineer.

3.11.2 Sufficient time between erection of forms and placing of concrete shall be given to the various trades to permit the proper installation of their work. See drawings and other sections of the specifications for extent, location and details of items to be embedded or placed in concrete.

3.11.3 All sleeves, chases, inserts, hangers, etc., which are provided and placed in the forms by the various trades shall be maintained in position and protected until the concreting is completed. Hangers, where required, shall be anchored to the main reinforcing bars.

3.12 QUALITY OF CONCRETE

3.12.1 Concrete shall be a mixture of cement, aggregates and water as specified respectively hereinbefore.
The mix proportions, workability and strengths of the various types of concrete shall conform to Table 4.
The terms contained in Table 4 are defined as follows:

(a) 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. 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. The absorption of the aggregates shall be determined in accordance with BS 812.

(b) 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.

Table 4. General Requirements for Types of Concrete

Type of Concrete	A	B	C
Water/cement ratio	0.50 - 0.55	0.60 - 0.65	-
Aggregate/cement ratio	4.5 - 5.5	7.5 - 10.0	10.0 - 13.0
Fine/total aggregate ratio	35% - 45%	30% - 45%	-
Cement, kg/cu.m of concrete	350 - 400	200 - 250	150 - 200
Slump, cm	2.5 - 5	5 - 10	5 - 10
Preliminary test cubes*, min. compr. strength at 28 days kg/sq.cm	300	175	90
Works test cubes*, min. compr. strength at 28 days kg/sq.cm	250	150	70
Method of compaction of concrete when placed	Vibrated	Vibrated or rodded	Rodded or tamped

Note: * The strengths specified are for ordinary Portland cement to BS 12.

(c) 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.

(d) Slump: The slump of the freshly mixed concrete shall be determined in accordance with Part 2 of BS 1881. At least one morning and one afternoon test shall be made and whenever directed by the Engineer.

(e) 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 BS 1881.
Works Test Cubes shall be those used for control during construction and shall be made and tested in accordance with BS 1881.

(f) Admixtures intended to accelerate the hardening of the concrete or to produce higher than normal strength at early

periods or AE agent will not be permitted unless so specified or prior approval is obtained from the Engineer.

3.12.2 Use of Concrete: Each type of concrete shall be used for the purposes stated below:

Table 5. Use of Concrete

Type of Concrete	Purpose
A	Structural members of all buildings including the open corridor and the canopy,
B	Floor slabs on earth, external pavings, foundations for building equipments, manhole bottoms, protection concrete on waterproofing,
C	Levelling under and filling under and around foundations and drains, lapped concrete under footing,

Concrete indicated on drawings but not scheduled for type shall be as directed by the Engineer.

3.12.3 Adjustment of Mix Proportions: The Contractor when tendering, having knowledge of the source and type of cement, aggregates, 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 drawings and required by the specification. In any event the aggregate/cement ratio and the water/cement ratio shall not exceed the upper limits specified in Table 4 above 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. As soon as possible after signature of the Contract, the Contractor shall prepare such trial mixes as required to satisfy the Engineer that the specified concrete strengths will be obtained using the materials and mix proportions as herein before specified. The proportions of cement shall be increased if necessary to obtain the strengths required.

3.13 CONTROL TESTS FOR CONCRETE

3.13.1 Extents of Tests: C.E. Laboratory (Central Engineering Laboratory, Islamabad, of Capital Development Authority.) will take samples and make tests for the Preliminary and Works Cube Tests.
The test for slump of concrete on site shall be made as described in 3.12.1(d) of this specification. Except tests for strength of concrete, the Contractor shall make available on site the following minimum approved equipment kept in good condition at all times:

(a) Eighteen (18) 15 cm cube
(b) Slump cone
(c) Set of BS sieves or equivalent
(d) Balance
(e) Thermometer
(f) Measuring cylinder
(g) Other accessories as required

All testing on site shall be done in the presence of the Engineer or his authorized representative.

3.13.2 The frequency of testing shall be as noted hereinafter and whenever required by the Engineer.

(a) Preliminary Test: From each trial mix, six (6) Preliminary Test Cubes shall be made and tested two (2) at seven (7) days and four (4) at 28 days, the test at seven (7) days being intended to give and 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% of the average of the strength test results, the test is to be discarded and a further trial mix shall be 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 Engineer shall be designated job mixes and used as a basis for actual concrete production.

(b) Works Test: The Works Test Cubes shall be made as follows for types A concrete, whichever is more frequent:

(1) At least three times weekly per mixing plant

(2) At least once for each individual part of the structure

(3) At least once per 100 cu.m of concrete

For type B and C concrete the rate shall be once per each 100 cu.m or fraction thereof. At least six (6) cubes shall be made at one time. Two (2) of the six (6) cubes are to be tested at seven (7) days. The remaining four (4) 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.

3.13.3 When the result of the seven-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 Contractor's expense and shall not proceed further without the written permission of the Engineer. The Contractor shall then, in accordance with the instructions of the Engineer, take cores out from suspect portions of the works and test them or make in-situ loading tests at those portions, under the supervision of the Engineer. Concrete judged by the Engineer to be defective shall be forthwith cut out, removed and replaced by the Contractor at his own expense. In the event of strengths consistently higher than those specified being obtained, a reduction in the number of tests may be authorized by the Engineer. Notwithstanding anything contained hereinbefore, the Engineer may at any time request samples for testing at C.E. Laboratory.

3.13.4 The Contractor shall immediately submit three (3) copies of each test report to the Engineer.

3.14 BATCHING AND MIXING OF CONCRETE

3.14.1 All concrete shall be batched by weight and mixed mechanically. Upon the written permission of the Engineer, batching of aggregate for concrete by volume may be allowed.

3.14.2 All concrete shall be batched and mixed on the site.

3.14.3 Batching and mixing shall be as follows:

(a) 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 Engineer and shall be kept in good condition while in use on the Works. Checks are to be made as required by the Engineer to determine that the weighing devices are registering correctly.

(b) Batching Aggregate by Volume: When batching aggregates by volume is allowed, as and when required, the cement shall be batched by the number of bags 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.

(c) Location of Plant: The location of the batching and mixing plant shall be agreed with the Engineer.

3.14.4 Concrete shall be mixed in a batch mixer of a type approved by the Engineer and in good condition having a drum rotating about a horizontal or inclined axis. Continuous mixers shall not be used. Each mixer is to be fitted with a water measuring device having an accuracy within one percent (1%) of the quantity of water required for the batch. The water measuring device shall be such that its accuracy is not affected by variations in the water supply pressure. The batch shall be so charged into the mixer that some water (about 10%) enters the drum in advance of the cement and aggregates. Water shall then be added gradually while the drum is in motion such that all required water shall be in the drum by the end of the first quarter of the all mixing time. The concrete shall be mixed until a mixture of uniform colour and consistency is obtained. Mixing time measured from the instant when water is introduced into the mixer drum containing all solids shall be 70 seconds or more.

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.

3.14.5 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, it shall be rotated with clean aggregate and water prior to production of new concrete. 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.

3.15 DEPOSITING CONCRETE

3.15.1 Preparation: Before placing concrete, all debris and water shall be removed from the places to be occupied by the concrete. Wood forms shall be thoroughly wetted or oiled, and the reinforcement cleaned of oil or other coatings. Formwork and the placement of reinforcement, pipes, sleeves, conduit, hangers, anchors and other inserts shall be inspected and approved by the Engineer.

3.15.2 Placing: Concrete shall be rapidly handled from mixer to forms and deposited as nearly as possible in its final position to avoid segregation due to rehandling or flowing. Concrete shall be spaded and worked by hand and vibrated to assure close contact with all surfaces of forms and reinforcement and leveled off at proper grade to receive finish. No concrete that has partially hardened or been contaminated by foreign material shall be deposited in the work, nor shall retempered concrete be used. All concrete shall be placed upon clean, damp surfaces, free from water, and never upon soft mud or dry porous earth. Concrete in bearing walls and columns shall be placed and allowed to settle one (1) hour before placing concrete superimposed thereon.

3.15.3 Vibration: Concrete shall be placed with the aid of mechanical vibrating equipment. Vibration shall be applied directly to the concrete unless otherwise approved by the Engineer. The intensity

of vibration shall be sufficient to cause flow or settlement of the concrete into place.

Vibration shall be applied at the point of deposit and in the area of freshly placed concrete. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures but shall not be long enough to cause segregation of the mix. To secure even and dense surfaces, free from aggregate pockets or honeycomb, vibration shall be supplemented by hand spading in the corners and angles of forms and along form surfaces while the concrete is plastic under the vibratory action. Caution must be exercised when using vibrators and hand spades to prevent any injury to the inside face of the forms or any movement of the reinforcement.

3.16 CONSTRUCTION JOINTS

3.16.1 Construction joints shall be formed as indicated on drawings, or as approved or directed by the Engineer. Dowels and keys shall be used where indicated or required.

3.16.2 The rate and method of placing concrete and the arrangement of construction joint bulkheads shall be such that the concrete between construction joints shall be placed in a continuous operation.

3.16.3 Joints in reinforced slabs, joists, beams and girders shall be perpendicular to the axis or surface of the member jointed and at about the center of the span.

3.16.4 Construction joints in walls or columns shall generally be at the top of floor, or may be at the under surface of girder except directed by the Engineer.

3.16.5 A temporary wood bulkhead shall be erected so that the jointing will follow a vertical plane at right angles with the direction of the main reinforcement. To this bulkhead fasten a wood strip 5 cm thick and of width equal to one-third the depth of the concrete slab to form a tongue and grooved joint.

3.16.6 Before concreting is resumed, the surfaces of previously placed concrete shall be roughened, cleaned, wetted and slushed with grout immediately before additional concrete is placed. Grout shall be 1-part portland cement and 2-parts sand.

3.17 WEATHER CONDITIONS

3.17.1 The placing or depositing of all concrete shall be discontinued when a descending air temperature in the shade falls below 5°C on a falling thermometer, and shall not be resumed until an ascending air temperature in the shade reaches 3°C. When the shade temperature is about 37°C and rising, special precautions shall be observed during concreting to the satisfaction of the Engineer regarding the cooling of aggregates, the maintenance of the correct water-cement ratio, and the proper supervision of the work. Concreting shall not be permitted when the shade temperature is above 43°C.

3.17.2 Records shall be kept by the Contractor to show the date of placements, the mix used and the air temperature at time of concreting for the various portions of the work. These records shall be available to the Engineer when requested.

3.18 PROTECTION AND CURING

3.18.1 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. The Engineer 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.

3.18.2 Concrete shall be cured for at least seven (7) days and as required by the Engineer. Concrete and cement finishes shall be sprayed during the curing period as frequently as drying conditions may require. Cover the surfaces of the concrete and the cement finishes with cotton mats, canvases or other approved membranes

within 24 hours after placing or finishing and maintain in good condition until the installation of parmanent floor covering unless otherwise directed. Covering shall be of a type that will not stain or discolour finished concrete surfaces. 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, otherwise protected during the curing period.

3.19 REMOVAL OF FORMS

3.19.1 Forms shall be removed without damage to concrete and in a manner to insure complete safety of the structure. Leave shoring in place until concrete member will safely support its own weight plus any live loads that may be placed upon it.

3.19.2 Upon removal of forms, the Engineer shall be notified by the Contractor in order that an inspection of the newly stripped surfaces may be made prior to patching.

3.19.3 Freshly stripped surfaces shall not be pointed up or touched in any manner before having been inspected by the Engineer.

3.19.4 Unless otherwise noted or specified, the minimum periods that formwork will remain in position before striking shall normally be as follows:

Table 6

	Portions	Periods of whichever shorter		
		Number of days*1		Compr. strength*3
		Case 1*2	Case 2*2	
Bulk-head	Foundations Columns Girders and Beams, sides Walls	3 days	5 days	50 kg/sq.cm
	Girders and Beams, soffits Suspended slabs, soffits	6 days	10 days	50% of the design compr. strength
Shor-ing	Under Girder or Beams	28 days		equal to the design compr. strength
	Under Slabs	17 days	25 days	85% of the design compr. strength

Note:

*1. Periods commencing from the last day on which concrete was placed in the part of the structure concerned.

*2. During the period from placing concrete to removing the form, the average temperature is:
Case 1: above 15°C
Case 2: 15°C or below

*3. At the option of the Contractor, provide dummy specimens of concretes of each portions, and test them in accordance with 3.12.1(e) of this specification. If above-mentioned compressive strength is obtained, the form may be removed.

3.20 RE-SHORING

3.20.1 Re-shorings are undesirable in general. To support girders, re-shoring shall not be done. Re-shoring shall be done rapidly, with no harmful shock or vibration, and before pouring concrete of the next floor. In areas where heavy live and dead loads occurs, shores shall be increased as directed by the Engineer.

3.21 PATCHING FORMED SURFACES OF EXPOSED CONCRETE

3.21.1 After the forms have been removed, all concrete surfaces shall be inspected and any pour joints, voids, stone pockets or other defective areas permitted by the Engineer to be patched, and all tie holes, shall be patched before the concrete is thoroughly dry. Defective areas shall be chipped away to a depth of not less than 25 mm with the edges perpendicular to the surface. The area to be patched and a space at least 15 cm wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. Do not fill or patch construction joints, unless specifically authorized by the Engineer. Do not patch any concrete in freezing weather.

3.21.2 A grout of equal parts of portland cement and sand with sufficient water to produce a brushing consistency shall then be well brushed into the surface, followed immediately by the patching mortar. The patch shall be made of the same material and of the same proportions as used for the concrete except that the coarse aggregate shall be omitted. The amount of mixing water shall be as little as consistent with the requirements of handling and placing. The mortar shall be retempered without the addition of water by allowing it to stand for a period of one hour during which time it shall be mixed with a trowel to prevent setting.

3.21.3 The mortar shall be thoroughly compacted into place and screeded off so as to leave the patch slightly higher than the surrounding surface. It shall then be left undisturbed for a period of one to two hours to permit initial shrinkage before being finally finished. The patch shall be finished in such manner as to match the adjoining surface. Tie holes left by withdrawal of rods or the holes left by removal of ends of ties shall be filled solid with mortar after first being thoroughly wetted. For holes passing entirely through the wall, a plunger-type grease gun or other device shall be used to force the mortar through the wall.

3.21.4 Unexposed formed surfaces of concrete shall be patched as directed by the Engineer.

3.21.5 At the option of the Contractor, the bonding of the patching mortar to the acceptable concrete after necessary cutting and removal of porous or otherwise unacceptable concrete is completed may be done by the use of and approved bonding agent applied in accordance with the printed instructions of the manufacturer. Filling and finishing of the patch shall be completed as hereinbefore specified.

3.22 FLOOR SLABS ON EARTH

3.22.1 Concrete floor slabs on earth shall be placed over a well compacted subgrade. Over subgrade, place clushed stone, thickness of clushed stone shall be 15 cm unless otherwise shown. Roll or tamp fill until thoroughly compacted. Over clushed stone fill lay 0.15 mm thick polyethylene film; lap joints 15 cm. Film shall be factory fabricated into large sheets as directed. Stretch and weight edges and laps to maintain their positions until concrete is placed. Do not displace the film. Immediately place concrete of required thickness and strike off at proper levels to receive finishes specified.

3.23 EXPANSION JOINTS

Provide expansion joints at the location as indicated on drawings. Joints shall be filled with polystyrene foamboard, and foamboard shall be fixed at accurate position by dumpling of mortar. Prior to depositing finishing concrete, wood bars shall be placed on foamboard to prevent finishing concrete from entering into joints. After depositing concrete, those bars shall be removed and joint sealers shall be poured into joint.

SECTION 4

MASONRY

4.1 SCOPE OF WORK

4.1.1 Extent: The work required under this section consists of all masonry and related items necessary to complete the work indicated on drawings and described in specifications.

4.1.2 Work not Included: The following items of related work are specified and included in other sections of this specifications:

(a) Brick paving.

(b) Roof covering with burnt clay brick tiles.

4.2 SHOP DRAWINGS

4.2.1 Three (3) copies of all shop drawings shall be submitted to the Engineer for his approval. These drawings shall show in detail the construction of all points of the work, including reinforcement, masonry joints and lintels, exact dimensions, kind of material to be used, and all other pertinent information. Furnish shop drawings in sufficient time and with such details and accuracy that the Engineer can approve dimensions of door frames and other items in advance of the actual execution of the work.

4.3 SAMPLE MATERIALS AND PANELS

4.3.1 Samples of Material: Prior to installation, submit to the Engineer for approval three (3) individual samples showing the variations in each colour and texture.

(a) Burnt clay bricks.

(b) Concrete blocks.

(c) Anchors and ties for brick work.

4.3.2 Sample Wall Panels: When required by the Engineer, before the installation of designated masonry materials, erect at the job site sample wall panels of directed dimensions. Panels shall show the proposed colour range, texture, bond, mortar joint and workmanship

of masonry materials and shall be approved by the Engineer. The approved panels shall become the standards of comparison for such masonry work built of the materials that the approved panels include. The panels shall not be altered, moved or destroyed until the work is complete.

4.4 MASONRY MATERIALS

4.4.1 Burnt Clay Bricks: Unless otherwise specified in this specification, all bricks shall be made in Pakistan and shall conform to PPWD 5.1. Use first class bricks for walls to be exposed, and second class bricks for walls to be plastered. The sizes shall comply with the following Table:

Table of Sizes

Dimensions	Size (mm)	Size (inch)	Tolerance + or -	
			mm	inch
Length	225	9	3	1/8
Width	109	4-3/8	1.5	1/16
Height	67	2-11/16	1.5	1/16

4.4.2 Concrete Blocks: Unless otherwise specified in this specification, all concrete blocks shall be hollow concrete blocks similar to those made in Japan. They shall be "B-Type Ordinary Block" comforming to JIS A5406. If there are proper materials which can be available for concrete masonry work in Pakistan, they may be used with the Engineer's approval. In case of using them, methods for the masonry work shall comply with Pakistani methods. Sizes of hollow concrete block comforming to JIS A5406 comply with the following Table:

国際協力事業団蔵書

Table of Sizes

Dimensions (mm)			Tolerance + or - (mm)	
Length	Height	Thickness	Length and Thickness	Height
390	190	150	2	3
		100		

4.4.3 Deformed Concrete Blocks: Three types of deformed concrete blocks having same quality as "B-Type Ordinary Block" shall be used as follows.

(a) Units for Horizontal Reinforcement: Use the units at location where horizontal reinforcing bar is inserted.

(b) Units for Corners: Use the units at "L"-shape corners.

(c) Half Size Units: Use the units as required at the end of walls and at intersections.

Both (a) and (b) units shall have same sizes and tolerance as "B-Type Ordinary Block".

4.4.4 Anchors and Ties: Anchors and ties for brick masonry walls shall be used in cavity walls of Annex, and in double exterior walls of Main Building. They shall be of zinc-coated steel. Except for steel wire, zinc-coating shall conform to ASTM A153, or equal. Steel wire shall be zinc-coated in accordance with ASTM A116 Class 2 coating, or equal. Use dovetail anchors and slots for double wall. They shall be flexible type anchors, and the size and shape shall be decided with the Engineer's approval. Provide dovetail anchors and slots at both sides of each expansion joint a minimum of 6, in addition, provide at middle of two expansion joints a minimum of 3. The cavity wall ties shall be the butterfly twist type of not less than 5 mm diameter mild steel wire zinc-coated and similar to those described in BS 1243, or equal. The length of the ties shall be approximately 8 cm less than the total thickness of the wall. Ties shall be spaced in a staggered manner with a maximum spacing 90 cm horizontally and 45 cm vertically.

4.5 MORTAR MATERIALS

4.5.1 Portland Cement: See "CONCRETE WORK".

4.5.2 Sand: 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 given below.

Table of Gradings - Percentage Passing

BS 410 Test Sieve		Sand for Mortar
(mm mesh)	(inch mesh)	
2.36	0.1	100
1.18	0.048	100-50
0.6	0.024	80-30
0.3	0.012	45-15
0.15	0.006	10-2

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

4.5.3 Mixing Water: See "CONCRETE WORK".

4.6 STORAGE OF MATERIALS

4.6.1 Store materials under cover in a dry place and in a manner to prevent damage or intrusion of foreign matter. During freezing weather protect all masonry units with tarpaulins or other suitable material. Store masonry units under covers that will permit circulation of air and prevent excessive moisture absorption. Store cement in watertight sheds with elevated floors. Protect reinforcement from the element; immediately before placing, reinforcement shall be free from loose, ice or other foreign coatings that will destroy or reduce the bond.

4.7 TYPES OF MORTAR

4.7.1 Mortar for Pointing: Mortar shall be mixed in the proportions of 1 part portland cement and 3 parts sand, by volume.

4.7.2 Mortar for Burnt Clay Bricks: Mortar shall be mixed in the proportions of 1 part portland cement and 3 parts sand, by volume.

4.7.3 Mortar for Concrete Blocks: Mortar shall be mixed in the proportions of 1 part portland cement and 2-1/2 parts sand, by volume.

4.8 MIXING MORTAR

4.8.1 Mix cement and sand in a mechanical batch mixer for a minimum of 5 minutes. Adjust the consistency of the mortar to the satisfaction of the mason but add only as much water as is compatible with convenience in using the mortar. If the mortar begins to stiffen from evaporation or from absorption of a part of the mixing water, retemper the mortar immediately by adding water, and remix the mortar. All mortar shall be used within 1-1/2 hours of the initial mixing. It shall not be used after it has begun to set.

4.9 PRECAUTIONS AND GENERAL REQUIREMENTS

4.9.1 Do not lay masonry when the temperature of the outside air is below 5°C unless suitable means as approved by the Engineer are provided to heat materials, protect work from cold and frost and insure that mortar will harden without freezing.

4.9.2 Before closing up any pipe, duct or similar inaccessible spaces or shafts with masonry, remove all rubbish and sweep out the area to be enclosed.

4.9.3 The open space at expansion joints shall be kept free of mortar by using a continuous wood or metal strip temporarily set on the wall.

4.9.4 Where fresh masonry joins masonry that is partially set or totally set, clean the exposed surface of the set masonry and wet it lightly so as to obtain the best possible bond with the new work. Remove all loose units and mortar. If it is necessary to stop off a horizontal run of masonry, this shall be done by racking back one-half brick length in each course.

4.9.5 Fill spaces around jambs and heads of metal door frames solidly with mortar. Build-in anchors and clips for aluminum windows and doors.

4.9.6 The total height of wall in one day shall not exceed 1.2 m.

4.10 LAYING BRICKS

4.10.1 All bricks 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.

4.10.2 All burnt clay bricks shall be soaked with water before being used and the tops of walls left off shall be wetted before work is recommenced. The faces of walls shall be kept clean and free from mortar droppings and splashes.

4.10.3 Unless otherwise indicated or directed, the gauge shall be 4 courses including 4 mortar joints to approximately 30 cm for burnt clay brick walls.

4.10.4 Walls which are to be left unplastered shall have a fair face consisting of selected bricks pointed with a raked joint as the work proceeds using the same mortar mix as for the jointing.

4.10.5 Where necessary the exposed face of brickwork shall be rubbed down to show a smooth face and sharp square arrises.

4.10.6 Walls shall be carried up regularly without leaving any part more than one meter lower than another unless the permission of the Engineer is first obtained. Work which is left at different levels shall be racked back.

4.10.7 The courses of brickwork shall be properly levelled. The perpendicular joints shall be properly lined and jambs and other angles plumbed as the work proceeds.

4.10.8 All walls shall be thoroughly bonded in accordance with the best constructional practice. Broken bricks shall not be used except where required for bond.

4.11 PARTITION WALLS

4.11.1 General: Brick masonry partition walls shall be one brick thick either flat or on edge.

4.11.2 Hoop Iron: Partition walls shall be reinforced, it shall be done with 6 mm diameter 25 mm wide, 45 cm length hoop iron placed in courses not more than 30 cm apart and continued for 225 mm into the main wall on which the partition wall abuts. In case the wall exceeds 6 m or if the height exceeds 4.5 m, hoop iron shall be introduced at courses not more than 15 cm apart.

4.11.3 Method of Bonding: All brick masonry partition walls shall be bonded with the columns of the reinforced concrete construction frame by providing 6 mm diameter reinforcement protruding out of the columns at every 30 cm. The length of the bonding bars shall not be less than 30 cm with a hook of 25 mm diameter at the end and these bonding reinforcements shall be provided and paid for along with the main reinforcement of the columns and allowed to extend out through the holes provided in the form works for the columns.

4.12 CAVITY WALLS

4.12.1 Cavity walls shall be built to the dimensions shown on the drawings and the two thicknesses shall be bonded together with wall ties spaced 90 cm apart horizontally and approximately 45 cm apart vertically and staggered. Extra ties shall be provided at openings.

4.12.2 Keep cavity air space and cross ties of reinforcing free of mortar drippings by using a continuous wood or metal strip set up temporarily on wall anchors. Raise strip as the wall is built up.

4.12.3 Provide weep holes in horizontal joints of facing wall directly above wall flashings. Space weep holes 60 cm apart horizontally. Form holes by pressing short lengths of oil-soaked 8 mm diameter braided cotton sash cord into the mortar bed while soft. When the mortar has set, pull the cords from wall.

4.12.4 The cavity shall be kept clear by lifting screeds or other proper means approved by the Engineer and shall be left clean at completion.

4.13 LAYING CONCRETE BLOCKS

4.13.1 Set units plumb and true to line. All units shall be layed with level horizontal joints. Except where specified or shown otherwise, unit shall be laid in "Stack bond".

4.14 REINFORCEMENT

4.14.1 Steel Reinforcement for Concrete Blocks: All concrete block masonry walls shall be provided with steel reinforcement which is specified in "Concrete Work". Steel reinforcement for use at ordinary parts shall be 9 mm diameter plain bars and use 13 mm diameter plain bars at the end and intersection of walls. Space vertical reinforcement 80 cm apart on center and space horizontal reinforcement 1 meter apart on center. Ends of vertical reinforcement shall be 90° hook and that of horizontal reinforcement shall be 180° hook, except at the arc welding parts. The length of anchorage and lap joint shall comply with the following Table:

The Length of Anchorage and Lap Joint

Structural Type	Lap Joint	Anchorage	Length (min. mm)
Load-bearing wall	H.R. for corners H.R. for openings	V.R. H.R. for corners R. for openings	40 x d
Non-load-bearing wall	R. for openings	Main R. for exterior walls R. for openings	40 x d
Other reinforcement			25 x d

(Note) H.R.: Horizontal Reinforcement
V.R.: Vertical Reinforcement
d : Nominal diameter of steel bar

Intersection of each steel reinforcement shall be firmly bonded with bonding wire. Termination of horizontal reinforcement at corners shall be bent horizontally and shall be anchored around vertical reinforcement. When above-mentioned length of anchorage can not be reached at openings and ends of walls, the hooks of

horizontal reinforcements shall be firmly secured to vertical reinforcements located the ends of walls with bonding wire. Covering depth of mortal shall be not less than 20 mm.

4.14.2 Mortar Filling for Reinforcement: Vertical hollow between adjoining units shall be carefully filled with mortar, placing reinforcement plumb on the center of the hollow.

4.15 LINTEL

4.15.1 Lintels shall be laid over all openings in masonry walls. They shall be made from Cast-in-place reinforced concrete except as otherwise specified or indicated. In case of concrete block masonry lintels shall have length equal to the width of opening plus two adjacent units length and shall be same thickness and height as one unit, and all hollow parts of units which are located under lintels shall be filled with mortar. In case of brick masonry, sizes shall be as indicated on drawings. Details, reinforcement and its anchorage, etc., are shown and indicated on drawings.

4.16 RING BEAM

4.16.1 Ring beam shall be provided at the top of the masonry walls which can not reach to the structural beams. They shall be cast-in-place reinforced concrete. Main steel reinforcement at corners shall be bent horizontally and shall be anchored in intersecting beam. Anchor length shall be 40 times as many as diameter of bar. Details are shown and indicated on drawings.

4.17 POINTING AND CLEANING MASONRY

4.17.1 Point all holes in exposed masonry. Cut out defective joints and repoint them with mortar.

4.17.2 All exposed masonry shall be cleaned thoroughly. If the masonry is cleaned with an acid solution, all sash, metal lintels, louvers and other corrodible parts shall be thoroughly protected.

4.17.3 Upon completion of the work, all exposed surfaces of masonry units shall be washed thoroughly with clear water. Metal cleaning tools and brushes, or abrasive powders shall not be used.

4.17.4 Masonry units shall have all loose mortar cleaned off and all stains removed.

SECTION 5

WATERPROOFING

5.1 SCOPE OF WORK

5.1.1 Extent: The work required under this section consists of all waterproofing, and related items necessary to complete the work indicated on drawings and described in specifications.

5.1.2 Work not Included: The following items of related work are specified and included in other sections of this specifications:

(a) Cavity walls flashings.

(b) Cast iron roof drain.

(c) Concrete topping over waterproofing.

(d) Preparation of surfaces to receive membrane waterproofing.

5.2 SAMPLES

5.2.1 Submit samples in duplicate of the following materials to the Engineer for approval. Approval must be obtained prior to delivery:

(a) All kinds of Asphalt roofings to be used.

(b) Waterproofing admixture.

5.3 GENERAL REQUIREMENTS

5.3.1 The waterproofing work shall be performed by a Contractor who is regularly engaged and specializes in work of the character required by the Contract and in the application of the materials specified herein. Material shall be delivered to the site in manufacturer's original unopened containers with manufacturer's brand and name clearly marked thereon.

5.3.2 The materials and methods shall be as specified herein, unless they are contrary to the manufacturer's directions or to approved trade practice; or unless the Contractor believes they will not produce a watertight job which he will guarantee as required. Where any of the above conditions occur, the Contractor shall notify the Engineer in writing. Deviation from the procedure specified will be permitted only upon the Engineer's approval and providing the work is guaranteed by the Contractor.

5.4 BITUMINOUS MEMBRANE WATERPROOFING

5.4.1 Location and Extent: Provide bituminous membrane waterproofing at locations indicated on drawings and as specified herein. Waterproofing shall consist of 4 plies of asphalt felt. Use hot asphalt for cementing asphalt felt roofings.

5.4.2 Materials: Materials for bituminous membrane waterproofing shall be similar to as follows:

(a) Asphalt: Similar to "Nisshin S Compound 3" or equal, conforming to JIS A6011.

(b) Asphalt primer: Similar to "Nisshin Asphalt Primer" or equal.

(c) Asphalt-saturated felt roofing: Similar to "Nisshin Asphalt Roofing 35 kg Type" or equal, conforming to JIS A6006.

(d) Bitumenized non-woven fabric roofing: Similar to "Nisshin SP Vinylon 70" or equal.

(e) Perforated asphalt felt roofing: Similar to "Nisshin Alpha Roofing" or equal.

(f) Bitumenized loose fabric roofing: Similar to "Nisshin Nichibu Mesh 12 kg Type" or equal, conforming to JIS A6012.

(g) Asphalt coating: Similar to "Nisshin S Asbestos Coating" or equal.

* "Nisshin" means Nisshin Industry Co., Ltd.

5.4.3 Application: The work process shall be as tabulated below. Table 1 shall be applicable to waterproofing of roof decks, and Table 2 to that of fresh water reservoir. Application methods shall comply with manufacturer's specifications.

Table 1. Waterproofing of Roof Decks

Sequence	Materials	Quantity
1	Asphalt primer	0.3 ℓ/sq.m
* (2)	Perforated asphalt felt	-
3	Asphalt	** 1.2 kg/sq.m
4	Bitumenized non-woven fabric	-
5	Asphalt	** 1.0 kg/sq.m
6	Bitumenized non-woven fabric	-
7	Asphalt	** 1.0 kg/sq.m
8	Asphalt saturated felt	-
9	Asphalt	2.0 kg/sq.m

* Where membrane turns up or down on adjacent vertical surfaces, the "process (2)" shall be changed for "Table 3 A type".

* Where roof drain or other projection occurs, the "process (2)" shall be changed for "Table 3 B type".

** In above-mentioned cases, the quantity of asphalt shall be changed for "1.5 kg/sq.m".

Table 2. Waterproofing of Water Fresh Reservoir

Sequence	Materials	Quantity
1	Asphalt primer	0.3 ℓ/sq.m
2	Asphalt	* 1.5 kg/sq.m
3	Asphalt saturated felt	-
4	Asphalt	* 1.5 kg/sq.m
5	Bitumenized non-woven fabric	-
6	Asphalt	* 1.5 kg/sq.m
7	Bitumenized non-woven fabric	-
8	Asphalt	* 1.5 kg/sq.m
9	Asphalt saturated felt	-
10	Asphalt	1.5 kg/sq.m

* In case of vertical surface, the quantity of asphalt shall be changed for "2.0 kg/sq.m"

Table 3. Change Process

	Type A		Type B	
Sequence	Materials	Quantity	Materials	Quantity
1	Asphalt	1.5 kg/sq.m	Asphalt	1.5 kg/sq.m
2	Asphalt saturated felt	-	Bitumenized loose fabric	-
3	Asphalt	1.5 kg/sq.m	Asphalt	1.5 kg/sq.m
4	Bitumenized non-woven fabric	-	Bitumenized non-woven fabric	-

5.4.4 Protection: Protect waterproofing against injury until other floor or wall finishes, included in other sections of the specifications, have been applied over waterproofing.

5.5 WATERPROOF CEMENT FINISH

5.5.1 Location and Extent: Waterproof cement finish shall be applied to locations indicated on drawings.

5.5.2 Materials: Waterproofing admixtures shall be similar to "Magnar Liquid No. 2" as manufactured by Magna Industry Co., Ltd., or equal. Mix in accordance with directions of manufacturer, using admixture to each bag of cement. Other materials concerned shall be as specified in "CONCRETE WORK".

5.5.3 Application: Thickness of waterproof mortar shall be 30 mm on floors and 20 mm on walls. Application shall be as specified in "PLASTERING".

SECTION 6

PLASTERING

6.1 SCOPE OF WORK

6.1.1 Extent: The work required under this section consists of lathing, plastering, artificial stone and related items necessary to complete the work indicated on drawings and described in specifications.

6.1.2 Work not Included: The following items of related work are specified and included in other sections of these specifications:

(a) Metal wall framing to receive lath and plaster.

(b) Metal filler panels between window mullions and terminated ends of plastered partitions, including metal frames and cover plate over joints.

(c) Ceiling access panels.

6.2 DELIVERY AND PROTECTION OF MATERIALS

6.2.1 Deliver all manufactured materials in the original packages, containers, or bundles and bearing the name of the manufacturer and the brand. Except as otherwise specified herein, the mixing, installation and application of manufactured material shall be in strict accordance with the printed directions of the manufacturer.

6.2.2 Protect plaster, lath and all cementitious materials against dampness until used. Store materials off the ground, under cover and away from sweating walls and other damp surfaces. Protect metal accessories in manner to prevent rusting. Do not install rusted metal accessories in the work.

6.3 SAMPLES

6.3.1 Submit samples in duplicate of the following materials to the Engineer for approval. Approval must be obtained prior to delivery of fabrication:

(a) Gypsum lath boards.

(b) Sample panel of artificial stone scratching finish.

(c) All materials of artificial stone.

6.4 PLASTER MATERIALS

6.4.1 Portland Cement Plaster Materials:

(a) Portland Cement: See "CONCRETE WORK".

(b) White Portland Cement: White portland cement shall conform to JIS R5210, or equivalents conforming to BS.

(c) Sand: Sand shall comply with the following table.

Percentage by weight passing BS sieves						
BS 410 Test Sieve(mm) / Application	5.0	2.36	1.18	0.6	0.3	0.15
For floors, scratch coat, second coat, and dubbing out	100	100-60	85-35	60-20	35-10	10-2
For finish coat	-	100	100-50	80-30	45-15	10-2

(d) Water: See "CONCRETE WORK".

(e) Other Mixing Materials: Other mixing materials shall conform to JIS as follows, or equivalents conforming to BS.

(1) Hydrated Lime: JIS A6902.

(2) Plaster: JIS A6903 (Dolomite plaster)

(3) Fly-ash: JIS A6201.

6.4.2 Gypsum Plaster Materials:

(a) Gypsum Plaster: Gypsum plaster shall conform to JIS A6904. (Mixed gypsum plaster and g.p. for board) or equivalents conforming to BS.

Note: Gypsum plaster which have been left more than six (6) months after production shall not be used.

(b) Sand and Water: See "6.4.1."

(c) Fibers: Fibers shall be used as follows.

(1) Hair: Hair shall be of ox, goat or cow hair. It shall be long, clean, free from grease and dry.

(2) Vegetable Fibers: Suitable vegetable fibers e.g. chopped hemp, clean, dry and free from soil may be used.

6.5 GYPSUM LATH BOARDS

6.5.1 Extent: Gypsum lath boards shall be used as a plaster base for interior gypsum plaster surfaces.

6.5.2 Type: Lath board shall conform to JIS A6906, semi-perforated type 9 mm thick, 90 cm wide and 180 cm long, similar to "New Lath Board" as manufactured by Yoshino Sekko Co., Ltd., or equal.

6.5.3 Application: Apply lath boards with face side out, with long dimension at right angles to support and joints butted to a moderate contact. Cut and neatly fit at angles, around outlet boxes, pipes and other projection. Secure lath boards to metal support with special metal clips similar to "P-BHW, P-BW, P-BMW" as manufactured by Okumura Jubei Shoten Co., Ltd., or equal. Lath boards shall be fixed by using screws which are recommended by the manufacturer at adequate intervals.

6.6 ACCESSORIES

6.6.1 Dividing angles: Provide dividing angles between portland cement finish surfaces and adjoining other finish surfaces as indicated on drawings. They shall be manufacturer's stock type 22mm x 22mm x 2mm angles made of polyvinyl chloride similar to "Fukubi Angle" as manufactured by Fukubi Chemical Industry Co., Ltd., or equal.

6.7 PORTLAND CEMENT PLASTER

6.7.1 Thickness and Mix Proportions: Except as specified or indicated, the thickness of plaster and the mix proportion of portland cement plaster shall be as tabulated below:

Table 1. For Portland Cement Finish

Bed Surface		Scratch Coat	Dubbing out Second coat	Finish Coat	Thickness (mm)
		Cement:Sand	Cement:Sand	Cement:Sand	
Concrete	Floor	-	-	1:2.5	30
	Interior Wall	1:2.5	1:3	1:3	20
	Exterior Wall	1:2.5	1:3	1:3	25
	Ceiling	1:2.5	-	1:3	12
Masonry	Interior Wall	1:2.5	1:3	1:3	20
	Exterior Wall	1:2.5	1:3	1:3	25
Metal Lath Wire Lath	Interior Wall	1:3	1:3	1:3	18
	Exterior Wall and Others	1:2.5	1:3	1:3	18
	Ceiling	1:2.5	1:3	1:3	12

Table 2. For Waterproof Cement Finish and Base Coats

Application		Receiving Surface	Scratch Coat	Dubbing out Second Coat	Finish Coat	Thickness (mm)
			Cement:Sand	Cement:Sand	Cement:Sand	
Waterproof Cement Finish		Floor	* 1:2.5	-	* 1:3	30
		Interior Wall	1:2.5	* 1:2.5	* 1:3	20
		Exterior Wall	1:2.5	* 1:2.5	* 1:3	25
Mortar Base Coat	Carpet Vinyl asbestos tile Vinyl sheet	Floor	-	-	1:2.5	** 30
	Water-proof layer	Floor	-	-	1:2.5	20
		Rise	1:2.5	-	1:3	20

Notes:

1. "Thickness: shows the thickness of plaster as measured from face of concrete, masonry or lath to finished plaster surface. Mix proportions are indicated by volume.
2. Each coating thickness shall be decided by taking account of the total finish thickness.
3. * : Mix waterproof admixture.
4. **: Only in this case, "Thickness" shows total thickness including those of floor coverings.

6.7.2 Mixing: See "6.11.1".

6.7.3 Finishing Methods: Except as otherwise specified or indicated, finishing methods of portland cement plaster shall be as follows:

(a) Steel Trowel Finish: Base Coat for carpet, vinyl asbestos tile, vinyl sheet, asphalt waterproof layer, and painted finish.

Portland cement finish and waterproof cement finish.

(b) Wood Float Finish: Setting bed of ceramic tiles.

(c) Brushing Finish : Base coat of artificial stone scratching finish.

6.7.4 Applications:

(a) Scratch Coat: Cement and sand mortal shall be sufficiently rubbed in with float without leaving any depressions. Scratch-coat surface shall be properly roughened with such tools as metal combs. Surface shall be cured more than two (2) weeks, and next coating shall be applied after through development of cracks over scratch-coat surface. Dubbed out surface on concrete wall shall be cured more than one (1) week. Shortening of the curing time caused by weather conditions may be permitted by the Engineer's approval.

(b) Second Coat: Cement and mortar shall be applied by screeding over the reasonable level surface with wood float.

(c) Finish Coat: After confirming the preceding coat surface to be reasonably dry, finish coat cement mortar shall be uniformly applied thereon free from blemishes and irregularities. The work of steel trowel finish shall be started with wood float and finished with steel trowel, and the work of brushing finish shall be done with brush after the work of steel trowel finish. Wooden float finishing work shall be done by using only wood float.

(d) Floor Topping Finish (Portland cement finish): Floor cement and sand mortar shall be applied as soon as practicable after the floor concrete in place. After washing concrete surface, sufficient cement paste shall be applied and uniformly spread with such tools as broom before mortar laying. Cement and sand mortar of a stiff consistency with minimum water content shall be applied and compacted well by tapping with wooden plate or mallet untill water comes up on the surface. As soon as the surface moisture condition is found proper, straightedge

shall be applied over the surface, then followed by trowelling to finish smooth.

6.8 GYPSUM PLASTER

6.8.1 Thickness and Mix Proportions: Except as otherwise specified or indicated, plastering thickness and mix proportions of gypsum plaster by volume shall be as tabulated below:

Bed Surface		Coat	Gypsum plaster		Sand	Thickness (mm)	
			For base Coats	For finish Coat			
Ceiling Beam	Pretreatment (Portland Cement Plaster)					5	13
	Concrete	Brown Coat	1	-	2.0	6.5	
		Finish Coat	-	1	-	1.5	
Wall	Gypsum Lath Board	Scratch Coat	1	-	1	5.5	
		Brown Coat	1	-	1.5	6	
		Finish Coat	-	1	-	1.5	

6.8.2 Mixing: Mix gypsum plaster and sand dry in proportions specified herein before. Then add water in adequate quantity and thoroughly mix to proper consistency. After adding water, base coat plaster shall not be left more than three (3) hours, and finish coat plaster shall not be left more than two (2) hours.

6.8.3 Application:

(a) Pretreatment: Portland cement plaster shall be used for pretreatment. Mixing proportion of the plaster shall be one part cement and two parts sand. After portland cement plaster is rubbed in throughout the concrete bed surface, plaster surface shall be properly roughened with such tools as steel combs to secure good bond of next coat. Curing time of pretreatment shall be as described in "6.7.4(a)".

(b) Scratch coat, brown coat and finish coat: Curing time of scratch coat shall be more than one (1) week. Application of each coat shall be as described in "6.7.4".

6.9 ARTIFICIAL STONE

6.9.1 Artificial stone shall be provided where indicated on drawings.

(a) Preparation of surface and application of base coat shall be as same in "PORTLAND CEMENT PLASTER". Before base coat has set, apply bonding mortar of 1-part cement and 1-part sand thinly over base coat to form good bond.

(b) Mixing proportion of artificial stone finish shall be by volume as follows.

white portland cement	:	1
marble grain	:	1
gravel chips and coarse sand	:	2
pigment	:	as required

(c) Provide finish coat with sufficient material. Prior to final set, trowel smooth and then scratch surface with metal scratcher to produce scratching finish. Finished surfaces shall be of texture as selected from submitted sample plates.

6.10 PRECAUTIONS AND PREPARATION FOR PLASTER

6.10.1 Temperature and Ventilation: Maintain a minimum temperature of 3 degrees C. in spaces to be plastered for at least 7 days prior to plastering, during plastering and until plaster has cured. Protect plaster from freezing and from uneven or too rapid drying. Do not apply plaster to surfaces that contain frost. After plaster has set hard, provide and maintain free circulation of air to prevent sweat-outs.

6.10.2 Concrete Surface: Where plaster is applied direct to concrete surfaces, clean concrete of all dust, loose particles, grease, oil and efflorescence by wire brushing and washing.

6.10.3 Masonry Surfaces: Masonry surfaces to be plastered shall be clean and free from loose particles, grease, oil, acid, or similar foreign matter. When necessary, excessive suction of masonry

shall be reduced by wetting the masonry.

6.10.4 Sequence of Operation: Complete all plastering in rooms and spaces where acoustical treatment is required before acoustical material is installed. In rooms having mortar-set ceramic tile wainscots, do not apply finish coat of plaster on walls above wainscot until wainscot work has been completed. In rooms having terrazzo base and plaster walls, apply finish coat of plaster after terrazzo skirting has been completed.

6.10.5 Protection of Adjacent Surfaces: Where finished surfaces such as tile, terrazzo, stone, metal frames, metal windows, metal partitions have been installed in rooms prior to completion of plaster work, the finished surfaces shall be protected from damage during plastering. Protection shall consist of covering with a non-staining kraft paper or polyethylene sheet and joints sealed with tape or adhesive. Metal surfaces may be protected with a removable type of masking tape or an approved type of non-staining petroleum jelly mixed in accordance with manufacturer's directions. Maintain protection in place during plastering and remove when plaster work is completed.

6.10.6 Examination of Surfaces: Before plaster is applied, the surfaces to be plastered in each room or space shall be carefully examined whether there are any unsatisfactory conditions. Application of plaster shall not proceed until such unsatisfactory conditions have been corrected.

6.11 MIXING PLASTER

6.11.1 Mixing of plaster shall be done in mechanical type mixers, except that hand mixing may be used when approved by the Engineer. Provide a sufficient number of mixers to carry on the work. Measurements shall be by volume or weight as specified. Do not use any frozen, caked or lumpy materials, or material that has partially set. Retempered plaster that has partially set shall not be used. Clean mixer of all set or hardened material before materials for a new batch are loaded. Keep mixing tools and equipment clean. Mix

each batch separately. The mixing sequence and cycle of operations and time shall be in accordance with the material manufacturer's directions.

6.12 PATCHING

6.12.1 Upon completion, point-up plaster around trim and other work. Cut out and patch defective and damaged plaster. Patching of plaster shall match existing work in texture and finish and, at joining with plaster previously applied, shall finish flush and smooth.

SECTION 7

DOORS AND WINDOWS

GENERAL

7.1 SCOPE OF WORK

7.1.1 Extent: The work required under this section consists of all doors and windows and related items, including glass, glazing and finishing hardware, necessary to complete the work indicated on drawings and described in specifications.

7.1.2 Work not Included: The following items of related work are specified and included in other sections of this specification:

(a) Attachment of curtain rails.

(b) Lavatory compartments and hardware.

7.2 ACCEPTABLE MANUFACTURERS

Except as otherwise specified herein or specifically approved by the Engineer in writing, all metal doors and glasses to be used in interior metal doors shall be products of local manufacturers, and all aluminum windows, other glasses, and all finishing hardwares shall be products of Japanese manufacturers.

7.3 SHOP DRAWINGS, ETC.

7.3.1 Shop Drawings: Three (3) copies of all shop drawings shall be submitted to the Engineer for his approval. Obtain approval of drawings prior to proceeding with manufacturing. These drawings shall be at full scale as far as practical, and shall indicate: elevations of each type of window, door, and louver; full size sections, thickness and gauges of metal, thickness and sizes of fastenings; conditions at openings with various wall thickness and materials; typical and special details of construction; methods of assembling sections; proposed method of installation and anchoring; the size and spacing of anchors; finishes; thickness and type of

glass; method of glazing; mullion details, metal and glass entrance details; materials, finishes, sizes of parts, thickness, fastenings, clearances, installation details and location of hardware; method and materials for weatherstripping when specifically required; joints, connections and all other partinent informations.

7.3.2 Hardware Schedule: Submit three (3) copies of complete schedule of finish hardware. Schedule each item of hardware for each type of equipment. List hardware item number, manufacturer's number or symbol, and finish.

7.3.3 Hardware Manufacturer's Data: Submit complete data on the following:

(a) Specifications and installation data on: Lock sets, hinges, closers, and checking floor hinges used in this project.

7.4 SAMPLES

7.4.1 Submit samples in duplicate of the following to the Engineer for approval. Approval must be obtained prior to fabrication or delivery.

(a) Typical corner sections of windows, doors, louvers, and their frames.

(b) Sections of wall panels.

(c) Caulking compound.

(d) Colour range samples of aluminum anodizing.
These samples shall be used for comparison purposes during production finishing of aluminum items and shall consist of actual production sections large enough so that good comparisons can be made to establish allowable colour shade range of aluminum surfaces.

(e) Lever handle and wheel for sound-proof doors.

(f) Clear polished wire glass.

(g) Patterned glass.

(h) Glazing gaskets.

(i) Glazing sealant.

(j) Lock sets.

(k) Hinges.

(l) Closers.

(m) Checking floor hinges.

(n) Door stops.

(o) Locking devices for windows.

(p) Pull handles.

GLASS AND GLAZING

7.5 TYPE AND QUALITY OF GLASS

7.5.1 Clear Polished Plate Glass: Clear, polished both sides, glazing quality as manufactured by Nippon Sheet Glass Co., Ltd. or equal conforming to FS DD-G-451a or JIS R3202. Thickness shall be as indicated on drawings. Where edges are to be exposed, they shall be ground smooth and polished.

7.5.2 Tempered Plate Glass: Clear, polished both sides, similar to "Tuflite" as manufactured by Nippon Sheet Glass Co., Ltd. or equal, conforming to FS DD-G-451a or JIS R3206.
Use 12 mm thickness for all locations where tempered plate glass is indicated. Grind and polish exposed edges smooth.

7.5.3 Clear Sheet Glass: Window glass and heavy sheet glass as manufactured by Nippon Sheet Glass Co., Ltd. or equal, conforming to FS DD-G-451a or JIS R3201.

7.5.4 Clear Polished Wire Glass: Polished 6 mm thick, with diamond mesh similar to "Rhombic Wired Glass" as manufactured by Nippon Sheet Glass Co., Ltd. or equal, conforming to FS DD-G-451a or JIS R3204.

7.5.5 Patterned Glass: Similar to "Softpane" as manufactured by Nippon Sheet Glass Co., Ltd. or equal, conforming to FS DD-G-451a or JIS R3203.

7.6 MATERIALS FOR GLAZING

7.6.1 Putty: Putty for use in metal frames shall conform to JIS A5752 Glass Putty, or its equivalent. Use putty for glazing in metal frames as hereinafter specified.

7.6.2 Glazing Sealant: Glazing sealant shall be of the type and quality specified; it shall be used for glazing in stainless steel frames. All solvents, cleaning solutions and primers used in connection with the sealant shall be of type proven by tests to be compatible with the sealant used and of brands recommended by the sealant manufacturer. Follow manufacturers recommendations in handling and storing.

(a) One-Part Polysulfide Base Sealant: Sealant shall be a one-component, ready to use type, similar to "Weatherban Sealer" as manufactured by 3M Co. or equal. The sealant shall be curing type and shall comply with the published specifications of the manufacturer. Colour shall be light gray.

7.6.3 Glazing Beads or Glazing Channels: Glazing beads or channels for use in Aluminum window frames shall be comply with the following description, and manufacturer's recommendation.

(a) Glazing beads or channel conforming to JIS A5756, or equal.

(b) Glazing beads or channel made from synthetic rubber.

7.7 GLASS MANUFACTURER'S LABELS

7.7.1 Labels showing glass manufacturer's identity, type of glass, thickness, and quality will be required on each piece of glass. Labels must remain on glass until it has been set and inspected.

7.8 SIZES, DELIVERY AND STORAGE OF GLASS

7.8.1 The sizes of glass indicated on drawings are approximate only; determine the actual sizes required by measuring frames to receive the glass at the project site, or from guaranteed dimensions provided by the frame supplier. Dimensions for glass and glass holding surrounds shall be coordinated to provide the following minimum clearances:

(a) At perimeter edge of the glass on all four sides provide clearance equal to glass thickness for single glass.

(b) The sealer space between face of glass and fixed or applied glazing stops, both indoors and outdoors, shall be not less than 1.5 mm plus glass and sash tolerance, but a 3 mm minimum.

7.8.2 Deliver glass to site in suitable containers that will protect glass from the weather and from breakage. Carefully store material as directed in a safe place where breakage can be reduced to a minimum. Deliver sufficient glass to allow for normal breakage.

7.9 INSTALLATION OF GLASS

7.9.1 General Requirements: Apply putty, glazing compound, glazing sealant, and gaskets uniformly with accurately formed corners and bevels. Remove excess compound from glass and sash. Use only recommended thinners, cleaners and solvents. Do not cut or dilute putty, glazing compounds or sealants without approval from the Engineer. Make good contact with glass and frame when glazing and facing off. Do not set glass in steel frames until frames have been primed and paint is dry. Do not apply any compound or sealant at temperatures lower than 5°C or on a damp, dirty or dusty surface. After glazing, doors and ventilators in sash shall be fixed so they cannot be operated until compound has set. All putty, compounds and sealants shall be removed from patterned glass and other glass having a rough finish before it hardens. Remove any excess sealants from glass and adjoining surfaces during the working time of the material; within 2 to 3 hours.

7.9.2 Sash and Frame Preparation and Acceptance: Inspect all sash, frames and surrounds to be glazed under this section and notify the Engineer of any defects, improper materials or workmanship or other conditions which will affect satisfactory installation of glass. Do not proceed with glazing until such conditions have been corrected. Before starting glazing work, the glazier shall verify compliance with the requirements listed.

(a) That sash and frames are firmly anchored in proper position, plumb and square within 3 mm of nominal dimensions on approved shop drawings.

(b) That all rivet, screw, bolt or nail heads, welding fillets and other projections are removed from glazing rabbets to provide the specified clearances.

(c) That all corners and fabrication intersections are sealed and sash and frames are weathertight.

(d) That rabbets at sills weep to outside and all rabbets are of sufficient depth and width to receive the glass and provide the required overlap of the glass.

(e) That all sealing surfaces of carbon steel sash and frames are prime painted.

7.9.3 Preparation of Glass and Rabbets: Clean the sealing surfaces at perimeter of glass and the sealing surfaces of rabbets and stop beads before applying any glazing compound, sealant or gaskets. Use only the approved solvents and cleaning agents recommended by the compound manufacturer.

7.9.4 Positioning Glass: Center in glazing rabbet to maintain specified clearances at perimeter on all four sides. Maintain centered position of glass in rabbet and provide the required sealer thickness 3 mm minimum on both sides of glass.

7.9.5 Face Glazing: Face glazing shall be used for setting glass in metal frames. Use putty for face glazing in metal frames. Apply as follows:

(a) Apply ample back putty sealant to rabbet in which shims have been set, so that it will ooze out when pressing glass into position.

(b) Secure glass in place with suitable metal clips for metal frames.

(c) Face putty front pane edge in rabbet with sealant to form a smooth neat bevel 1.5 mm short of sight line and slopping away from glass. Miter bevel at corners. Strip all excess compound or sealant. Strip surplus back putty at a slight angle to slope away from glass.

7.9.6 Installation of Side-Light Tempered Glass: Secure tempered glass top, side and bottom edges to transom, mullion and base bars with polysulfide base sealant as indicated. Side edges butt against another tempered glass shall be caulked with sealing compound recommended by the glass manufacturer.

ALUMINUM WINDOWS

7.10 MATERIALS

7.10.1 Aluminum Alloys: Aluminum alloys shall be of uniform quality and free from defects impairing strength and durability, and shall meet the following requirements or equivalents:

(a) Extruded shapes, rods, bars, and tubing: JIS H4100 (similar to AA Alloy-6063).

(b) Sheets: JIS H4000, tempered as hard as consistent with required forming operations.

(c) Bolts, nuts, screws, and rivets: JIS H4120 (aluminum), JIS G4309 (stainless), or alloy with sufficiently high properties for the purpose.

7.10.2 Reinforcing Members: Reinforcing members, if used, shall be aluminum or stainless steel as hereinafter specified.

7.11 FINISHES FOR ALUMINUM

7.11.1 Pretreatments: Surfaces shall have a natural as-fabricated mill finish; in addition, exposed surfaces shall be reasonably uniform in colour, smooth, and free from serious tool marks and cuts.

7.11.2 Anodizing: Aluminum surfaces shall be provided with an anodized coating. The coating shall have a minimum film thickness of fourteen (14) micron. The coating shall be natural aluminum colour anodizing or coloured anodizing.

7.11.3 Protective Coating: After cleaning and finishing and prior to shipment, a clear, non-yellowing colourless coating shall be applied to all surfaces of aluminum. The coating as applied shall be of sufficient thickness to resist damage from alkaline mortar and plaster. Before application, remove all fabrication and finishing compounds, moisture, dirt accumulations, or steel wool fibers from aluminum surfaces.

7.12 PROTECTION OF ALUMINUM FROM DISSIMILAR MATERIALS

7.12.1 General: In addition to the protective coating specified hereinbefore, aluminum surfaces shall be prevented from direct contact

with dissimilar materials as follows:

(a) Dissimilar metals, except stainless steel, white bronze, and solid zinc, shall be painted with a heavy brush or spray coat of zinc-chromate primer and one coat of aluminum paint; or shall be painted with one heavy brush coat of alkali-resistant bituminous paint; or shall be separated from the aluminum by a heavy coat of mastic caulking compound, or by a non-absorptive tape or gasket.

(b) Dissimilar metals used in locations where drainage from them passes over aluminum shall be painted to prevent staining of aluminum.

(c) Aluminum surfaces in contact with mortar, concrete, plaster or other masonry materials, shall be given one heavy brush coat of bituminous paint.

(d) Aluminum surfaces in contact with wood, or other similarly absorptive materials which may become repeatedly wet, shall be given one heavy brush coat of bituminous paint.

7.13 GENERAL REQUIREMENTS FOR ALL WINDOWS

7.13.1 Sizes and Combinations: Furnish windows of sizes and combinations indicated; locate ventilators and fixed sections as detailed.

7.13.2 Construction and Workmanship: Construct windows to produce results specified and to assure neat appearance. Make permanent joints by welding, or by mechanical fastenings. Joints shall be of strength to maintain the structural value of members connected. Welded joints shall be solid, have excess metal removed, and dressed smooth on exposed and contact surfaces. The dressing shall be done so that no discoloration or roughness will show after finishing. When welding flux is used, it shall be completely removed immediately after the welding is completed. Joints formed with mechanical fastenings shall be closely fitted, sealed with mastic and made permanently watertight. Except as designated otherwise, frames, sash and ventilators shall be assembled at the plant, and shipped as a unit with hardware unattached.

7.13.3 Accessories: Furnish all necessary fastenings, clips, fins,

anchors, and other appurtenances necessary for complete installation of windows and operation of ventilators. Except as otherwise specified, anchors and fastenings shall be aluminum or non-magnetic stainless steel; steel anchors may be used, providing they are either phosphate treated and given two shop coats of paint or electro-galvanized after fabrication and coated as specified.

7.13.4 Provisions for Hardware: All necessary provisions shall be made for hardware. Provide reinforcing plate for hardware as required.

7.13.5 Provisions for Glazing: Sash shall be designed for securing glass with beads. Where vinyl, neoprene or synthetic rubber gaskets are used in connection with glazing beads, the colour of gaskets shall be as directed by the Engineer.

7.13.6 Weatherstripping: Provide weatherstripping for windows as specified hereinafter for individual window types. Weatherstripping shall be manufacturer's stock type, easily replaceable, and of a material that is compatible with the metal to which it will be in contact.

7.14 ALUMINUM SUB-SILLS - EXTERIOR

7.14.1 General: Sub-sills for windows shall be extruded aluminum of sizes and shapes shown and shall have the same finish as specified for the windows. Minimum thickness of metal shall be 3 mm. Except where multiple windows are shown, sills shall be full length for each wall opening. Where multiple windows occur in a single opening, sills shall be furnished in lengths as long as possible up to a maximum of 6 m. Locate joints in sills only where indicated or directed.

7.14.2 Expansion Joints: Provide open expansion joints at ends of sills and at intermediate joints; make joints approximately 4.5 mm wide at ends and 9 mm at intermediate joints. Provide sheet aluminum flashing 0.8 mm thick and 15 cm wide under intermediate joints.

7.14.3 Anchors: Provide galvanized steel anchors not less than 2.3 mm thick by 30 mm wide on underside of sills. Locate anchors 10 cm

on each side of each joint, 10 cm from each end and at intermediate points not exceeding 90 cm on centers.

7.14.4 Installation: Set anchors as detailed on approved shop or erection drawings. Install sills to proper slope in a bed of fresh mortar and secure to anchors from underside. Rake the bedding mortar at each end of sills to provide for caulking. After setting, protect sills immediately with board or other approved non-staining covering. Maintain protection in place until completion of masonry and plastering.

7.15 INSTALLATION OF WINDOWS

7.15.1 General: Windows shall be installed and adjusted by experienced and qualified window erectors and using only skilled mechanics. Aluminum windows shall be installed without forcing into prepared openings, unless detailed or specified otherwise. Install windows in accordance with manufacturer's instructions and the approved shop drawings. Set windows at the proper elevation and location, plumb, level and in alignment; properly brace frames to prevent distortion and misalignment. Protect window ventilators and operating parts against accumulation of cement, lime and other building materials by keeping window ventilators tightly closed and wired to frames. Protect aluminum from dissimilar materials as hereinbefore specified.

7.15.2 Mastic Sealant: All exterior metal to metal joints between members of doors and windows, frames, mullions, and covers shall be set in a mastic sealant of type recommended by the window manufacturer. Remove excess mastic before it hardens.

7.15.3 Anchors and Fastenings: Anchor window units to adjoining or adjacent construction as shown on approved shop drawings. Where windows are set in prepared masonry openings, place the necessary anchorage during progress of wall construction. Anchors and fastenings shall be built in to, anchored, or bolted to the jambs of openings, and shall be fastened securely to the windows or frames, and to the adjoining construction. Unless otherwise detailed, anchors shall be spaced not more than 45 cm apart on heads,

jambs and sills. All anchors shall have sufficient strength to hold the member firmly in position.

7.15.4 Adjustment After Installation: After windows have been installed, all window ventilators and hardware shall be adjusted to operate smoothly and to be weathertight when ventilators are closed and locked. Hardware and parts shall be lubricated as necessary. Adjustments shall be made before or after glazing as recommended by the manufacturer, and as follows:

(a) Horizontal sliding doors and windows shall be adjusted to slide freely.

(b) Where windows are weatherstripped, the weatherstripping shall make weathertight contact with frames when ventilators are closed and locked. The weatherstripping shall not cause binding of sash or prevent closing and locking of the ventilator.

STEEL DOORS AND FRAMES

7.16 MATERIALS

7.16.1 Except as otherwise specified or indicated, materials for steel doors and frames shall comply with the following requirements:

7.16.2 Steel: Steel for use steel doors and frames shall be as follows:

(a) Hot-rolled mild steel plate;

(b) Cold-rolled carbon steel sheets and strip;

(c) Rolled steel for general structure;

These shall be conform to the requirements of JIS or BS. Except as otherwise specified in this section, kind of steel to be used for each work shall be in accordance with manufacturer's directions with the Engineer's approval.

7.16.3 Stainless Steel: Stainless steel shall conform to JIS as follows:

Standards of Stainless Steel		
Type	Standards	For Use of
Plate	JIS G4305 (SUS 304,430) JIS G4306 (SUS 304,430) JIS G4307 (SUS 304,430)	Saddles, Rails, Facing Flames, etc.
Bars & Wires	JIS G4303 (SUS 302,304) JIS G4308 (SUS 302,304) JIS G4309 (SUS 304,316)	Volts, Screws, Ribbets, etc.

7.16.4 Other Materials: All other materials covered under this section shall conform to the requirements of BS, ASTM, and/or JIS.

7.17 KINDS AND THICKNESS OF MATERIALS

7.17.1 Except as otherwise specified or indicated, kinds and thickness of materials shall comply with the following Table.

Kinds and Thickness of Materials			
For Use of		Kinds	Thickness (mm)
Frame	Door saddle	SUS 430	2.0
	Frame in general, Mullion	Galvanized Sheet	2.3
	Transom		1.6
Door	Rail, Stile		1.6
	Panel plate		1.6
	Louver slat		1.6
	Auxiliary frame		2.3
General Item	Anchor		2.3
	Airtight stop	SUS 304	1.5
	Screw for bead	SUS 302,304,316	

7.18 SHOP FINISH

7.18.1 General: After fabrication, all surfaces of steel, except stainless steel, shall be cleaned, hot dipped-galvanized except when zinc-coated steel sheets are used, phosphate treated and followed with prime coats as specified in "PAINTING".

7.18.2 Prime Coat: The type of paint for prime coat shall be compatible with the type of paint specified for application on steel parts at the project site.

7.18.3 Finish of Stainless Steel: Exposed surfaces of all stainless steel shall be hair-line finished. Stainless steel shall not be painted as well as rails and rubbers.

7.19 GENERAL REQUIREMENTS

7.19.1 Sizes and Combinations: Furnish, doors, and louvers of sizes and combinations indicated; locate ventilators and fixed sections as indicated. Doors shall be 40 mm thick unless designated otherwise. The clearances for hinged doors shall be 3 mm at jambs and heads, 6 mm at meeting stiles of pairs of doors, and 6 mm at bottom unless indicated or specified otherwise. Glazed and/or louvered openings in windows and doors shall be as indicated on drawings.

7.19.2 Construction and Workmanship: Construct doors and louvers to produce results specified and to assure neat appearance. Make joints by welding, or by mechanical fastenings. Joints shall be of strength to maintain the structural value of members connected. Welded joints shall be solid, have excess metal removed, and dressed smooth on exposed and contact surfaces. Joints formed with mechanical fastenings shall be closely fitted and made permanently watertight.

7.19.3 Weather Seal for Doors: The top and bottom edges of all hollow metal doors shall be closed to provide a weather seal. This seal may be provided as part of the door construction or by the addition of inverted steel channels or other suitable shapes welded to the face sheets.

7.19.4 Provisions for Hardware: Mortise, reinforce, drill and tap doors at factory to receive all mortise type hardware. Provide reinforcing only for doors to receive surface applied hardware, except push plates, kick plates, map plates and armor plates; drilling and tapping for surface applied hardware will be done in the field. Provide metal reinforcing plates for locks and all mortised hardware; provide reinforcing plates for surface applied hardware as required. The gauges of metal for reinforcing plates shall comply with manufacturer's recommendations for the type of hardware used and the size and thickness of doors.

7.19.5 Louvers for Doors: Louvers indicated for interior doors shall be stationary type with a minimum of 60 percent of free air area. Make louvers for exterior doors weatherproof.

7.19.6 Accessories: Furnish all necessary fastenings, clips, fins, anchors, and other appurtenances necessary for complete installation of windows and doors. Except as specified otherwise, anchors and fastenings shall be steel, either hot-dipped galvanized or phosphate treated and painted.

7.20 FRAMES

7.20.1 Location and Type: All steel frames for doors, transoms, sidelights, mullions, interior glazed panels and interior louvered panels shall be formed of steel to sizes and shapes indicated. Frames shall be combination type with integral trim and fabricated with full welded unit or knock-down field assembled type construction at joints as indicated on approved shop drawings.

7.20.2 Reinforcement: Provide concealed steel reinforcements for hardware as required. The gauges of steel for reinforcement shall be in accordance with the manufacturer's recommendations for the type of hardware and the shapes and sizes of the frames.

7.20.3 Workmanship and Design: The finished work shall be strong and rigid, neat in appearance and free from defects. Fabricate moulded members straight and true with corner joints well formed, in true alignment and fastenings concealed where practicable. Provide plaster flanges and keys as detailed or required, for

frames located in plaster walls. Frames for use in exterior walls shall be provided with a caulking groove, 12 mm wide by 15 mm deep, with a closed back, to receive the caulking compound.

7.20.4 Forming Corner Joints: Joints for welded type frames shall be mitered or butted and continuously arc-welded for full depth and width of frame and trim. All contact edges shall be closed tight and all welds on exposed surfaces dressed smooth and flush. Joints for knockdown type frames shall be designed for simple field assembly of header to jamb members by concealed tenons, splice plates and bolts, or other type of concealed interlocking joint that will produce square and rigid corners and a tight fit; securely lock joints in place during erection and maintain alignment of adjoining members; provide anti-vibration lock nuts for all bolted connections.

7.20.5 Provisions for Hardware: Frames shall be prepared at the factory for the installation of hardware. Frames shall be mortised, reinforced, drilled and tapped to templates to receive all mortised hardware; frames to receive surface applied hardware shall be provided with reinforcing plates only. Provide cover boxes in back of all hardware cut-outs.

7.20.6 Location of Hardware: The location of hardware for steel frames and doors shall be as specified hereinafter unless otherwise indicated.

7.20.7 Mullions and Transom Bars: Mullions and transom bars shall be closed or tubular construction, and shall member with heads and jumbs and be secured thereto; use butt-welded joints for welded construction and concealed interlocking joints for knockdown construction. Reinforce the joints between members with concealed clip angles of the same thickness as frame. Provide adjustable floor anchors and spreader connections at bottom of mullions.

7.20.8 Structural Reinforcing Members: Where structural steel members are required at mullions, transoms or other locations, the structural steel shapes shall be provided as part of the frame assembly.

7.20.9 Wall Anchors: Provide metal anchors of shapes and size required for the adjoining type of wall construction. Fabricate jamb anchors of steel, not lighter than the gauge used for frame. Locate anchors on jambs near the top and bottom of each frame and at intermediate points not over 60 cm apart.

7.20.10 Floor Anchors: Provide floor clips of not less than 2.3 mm thick steel and fasten to bottom of each jamb member for anchoring frame to floor construction. Clips shall be fixed and drilled for 9 mm diameter anchor bolts, or its equivalents.

7.20.11 Frames with Louvers: Metal louvers in hollow metal frames shall be stationary type, fabricated of 1.6 mm thick steel. Secure louver blades to frames by welding.

7.21 FIRE DOORS AND FRAMES

7.21.1 General: Provide steel fire doors and frames at locations indicated on drawings.

7.21.2 Closing Arrangements: All fire doors shall be arranged to either remain in the normally closed position with suitable self-closing device or in the normally open position with a fusible element actuated mechanism which will close the door automatically in case of fire as indicated on drawings.

7.21.3 Asbestos Tape: Provide asbestos tape with suitable adhesive at bottom of fire doors as indicated on drawing. They shall be full length of the door's width and 3 mm thickness and shall conform to JIS R3451.

7.22 FULL GLAZED DOORS

7.22.1 General Requirements: Doors indicated on drawings with full glazed panels shall be formed with narrow or typical stiles and rails as indicated and shall comply with the type of construction as hereinafter specified, or shall comply with the manufacturer's recommendation.

7.22.2 Construction: Doors shall have stiles and rails formed of cold rolled steel, not less than 1.6 mm thickness. Joints between

stiles and rails shall be either mitered or butted and continuously face welded; they shall be of tubular construction and be reinforced with concealed U-shaped members in addition to welding.

7.22.3 Installation: Set frames in position, plumb, align and brace securely until permanent anchors are set. Anchor bottom of frames to floors with expansion bolts, or with power fasteners. Build wall anchors into walls, or secure to adjoining construction. Where frames require ceiling struts or other structural overhead bracing, they shall be anchored securely to ceilings, or structural framing above.

7.23 FLUSH DOORS

7.23.1 General Requirement: Doors indicated on drawings as flush doors including flush doors with glazed and louvered openings shall comply with the type of construction as hereinafter specified, or shall comply with the manufacturer's recommendations.

7.23.2 Door Construction:

(a) Construction: Construction doors of two outer steel sheets not less than 1.6 mm thickness, with edges welded and finished flush. Seams or joints will not be permitted on door faces or edges. Reinforce the outer face sheets with 2.3 mm thick interlocking vertical channels or Z-shaped members spaced not over 15 cm apart and spot welded to outer face sheets. Provide continuous reinforcing channels welded to face sheets at top and bottom of door.

7.24 AIRTIGHT DOORS AND FRAMES

7.24.1 Construction: Frames for doors indicated as airtight shall incorporate a continuous neoprene seal to prevent air leakage through the crevices between doors and frames.

7.25 SOUND-PROOF DOORS

7.25.1 Sound-proof doors shall be provided at anechoic room entrance. Special type hinges shall have sufficient durability to the door's weight. Wheel, handles and other hardwares shall have fully

capacity of the door's function. Details shall be as indicated on drawings.

7.26 METAL AND GLASS ENTRANCE

7.26.1 General Requirements: Metal and glass entrances indicated on drawings as entrance mainly consist of stainless steel sheets and plate glass shall comply with the type of construction as hereinafter specified.

7.26.2 Fabrication:

(a) Work shall be built by a manufacturer regularly engaged in production of Architectural Metal. Workmen shall be skilled at fabricating high grade ornamental metal work.

(b) Fabricate and assemble in as large sections in shop as consistent with shipping and field requirements.

(c) All miters and joints shall form flush, hairline joints.

(d) All joints between sections and all field splices shall produce strength to resist deformation and misalignment.

(e) Fabricate and install with concealed fastenings insofar as practiceable.

(f) Welding of stainless steel shall be on concealed sides to minimize pitting, discoloration, weld halo, or other surface imperfections after finishing. Welds shall thoroughly penetrate the material and produce a complete fusion of metal.

(g) Install concealed reinforcement to be inconspicuous in finished surfaces.

(h) Wire brushes used for shop or field work shall be made of noncorrosive wire.

(i) Insulate dissimilar metals against electrolysis or galvanic action.

7.26.3 Construction:

(a) Tempered glass doors and sidelights: Top and bottom rails shall be continuous fitting, fabricated from stainless steel with hair-line finish. Glass and glazing shall be as specified hereinbefore and hardware shall be as specified hereinafter.

(b) Frames, sidelights and transoms: Fabricate from stainless steel as detailed, with internal steel frame.

(1) Internal steel frame: Fully weld at intersection to develop rigidity and transfer design loads.

(2) Prepare for hardware.

(3) Finish shall be hair-line.

7.26.4 Glazing Moulding:

(a) Moulding for sidelights and transoms shall be as detailed.

(b) Mouldings shall be integral on outer face and loose on inner face. Loose mouldings shall be secured with oval headed screws.

Hardware:

(a) Hardware designated for metal and glass entrances shall be installed and/or fitted in the factory by the manufacturer of metal and glass entrances. Such hardware shall be in one shipment and labeled specifically for this project.

7.27 INSTALLATION OF DOORS

7.27.1 General: Doors shall be installed and adjusted by experienced and qualified erectors, and using only skilled mechanics. Install doors in accordance with approved shop or setting drawings, at the proper elevation and location, plumb, level and in alignment; properly brace frames to prevent distortion and misalignment. Protect doors ventilators and operating parts against accumulation of cement, lime and other building materials by keeping doors ventilators tightly closed and wired to frames. After installation and before glazing, doors shall be checked for operation and weathering.

7.27.2 Mastic Sealant: All exterior metal to metal joints between members of doors and windows, frames, mullions, and mullion covers shall be set in a mastic sealant of type recommended by the door manufacturer. Remove excess mastic before it hardens.

7.27.3 Anchors and Fastenings: Anchor door frames to masonry, or to other adjoining or adjacent construction as shown on details and approved shop drawings. Where doors are to be installed in direct

contact with masonry, the head and jamb members shall be designed to set into the masonry not less than 10 mm. Where doors and windows are set in prepared masonry openings, place the necessary anchorage or fins during progress of wall construction. Anchors and fastenings shall be built into, anchored, or bolted to the jambs of openings, and shall be fastened securely to the frames, and to the adjoining construction. Unless otherwise detailed, anchors shall be spaced not more than 45 cm apart on heads, jambs and sills. All anchors shall have sufficient strength to hold the member firmly in position.

7.27.4 Adjustment After Installation: After doors have been installed and before completion of glazing and painting, all doors ventilators and hardware shall be adjusted to operate smoothly and to be weathertight when ventilators are closed and locked. Hardware and parts shall be lubricated as necessary. Swinging doors shall be adjusted to operate freely.

FINISHING HARDWARE

7.28 MATERIALS

7.28.1 General:

(a) As much hardware as possible shall be by the same manufacturer to maintain continuity of finish and style and to simplify maintenance and replacement.

(b) Include all fastenings with exposed surfaces matching finish of adjacent metal parts of hardware.

(c) Furnish hardware to template and with proper fastening for use with metal frames, and with hollow metal doors.

(d) Use box type strike plates on metal frames.

(e) Screws used in the work covered by this section shall comply with manufacturer's recommendation.

(f) General requirements for lock sets.

(1) The lock case shall be of steel or equally strong and durable material so as to withstand with a reasonable factor of safety, the stresses and effect of wear and tear for extended periods of service. Mechanical parts

shall be of such material and design that they also meet the same criteria and are capable of withstanding normal rough usage for extended periods of service.

(2) Lock sets shall be equipped with both latchbolt and/or deadbolt (except dead locks).

(3) Lock sets shall be suitable for installation in metal doors.

(4) When installed in hollow metal doors, the lock set shall be capable of being equipped with an expansion brace type device to prevent the lock from vibrating or wobbling. This shall be in addition to the mounting screws in the face plate.

(5) Deadbolt of locks used in entrance doors shall be equipped with a hardened steel insert that will prevent sawing of the bolt to gain unauthorized entry.

(6) Lever handle spring mechanism shall be of such material and strength to prevent any sag or free play in the lever handle when in the neutral horizontal position.

(7) Cylinder lock set shall be capable of withstanding 100,000 repeated openings and closings without visible or detectable damage to or change in the mechanism, case or key and there shall be no visible or detectable change in the operation or function of the lock set.

(g) Hardware for window: Hardware shall be furnished by window manufacturer with his standard subject to compliance with specification requirements.

7.28.2 Finishes: Finishes of lock and latch sets, hinges for doors, overhead exposed closers, metal push plates, and all other hardware shall be in accordance with the manufacturer's directions.

7.28.3 Lock and Latch Sets: Lock and latch sets shall be as manufactured by Showa Lock Co., Ltd., or equal. Handles shall be of knob type.

(a) Furnish a mortise pin tumbler lock set for ordinary doors except otherwise specified. Operation of the dead bolt shall be by key from outside and by thumb turn from inside. (SHOWA No. 8725, or equal)

(b) Furnish a mortise latch set for doors of lavatory. Operation of latch shall be by knob from both sides.
(SHOWA No. 264, or equal)

7.28.4 Dead Locks: Dead locks shall be as manufactured by Showa Lock Co., Ltd., or equal.

(a) Furnish a mortise pin tumbler dead lock set for access doors of pipe shaft. Operation of the dead bolt shall be by key from outside.
(SHOWA No. 535-35D, or equal)

(b) Furnish a mortise pin tumbler dead lock set for tempered plate glass doors. Operation of the dead bolt shall be by key from both sides. This lock set shall be provided only for outside two tempered plate glass doors.
(SHOWA No. 325-G-26, or equal)

7.28.5 Hinges: Hinges shall be as manufactured by Showa Lock Co., Ltd., or equal.

(a) Hinges shall have oilite bearings for all doors except access doors.

(b) Hinges for metal doors except access doors shall be 127mm x 127mm full-mortise template type.
(SHOWA No. V350TBB, or equal)

(c) Hinges for access doors shall be 102mm x 102mm full-mortise template type.
(SHOWA No. V350TBB, or equal)

7.28.6 Closers: Closers shall be the product similar to "NEW STAR" as manufactured by Nippon Door Check Co., Ltd., or equal subject to compliance with the following specifications.

(a) Closer shall be of surface mounted, universal regular or parallel arm type with holding device which may be set to hold the door open at any point between 90 and 135 degrees.

(b) Holding device shall be automatically engaged and released when pressure is applied to the door.

(c) Closing mechanism shall be equipped with key-operated valves to control back check as well as closing and latching speed.

(d) For metal door: "NEW STAR" No. 83 or P-83 or equal shall be installed. (P: Parallel arm type)

7.28.7 Checking Floor Hinges: Checking floor hinges shall be the product similar to "NEW STAR" as manufactured by Nippon Door Check Co., Ltd., or equal subject to compliance with the following specifications:

(a) Checking floor hinges for fire doors shall be of double action type with holding devices which hold the door open at approx. 90 degrees. "NEW STAR" No. S-1550 or equal shall be used.

(b) Checking floor hinges for tempered glass doors shall have the same function as specified for regular doors. "NEW STAR" No. S-1300 or equal shall be used.

7.28.8 Fuse Device: Fuse device for fire door shall be a kind of door retainer which will function for fire protection to release the door to close by force of checking floor hinge, when the temperature reaches a certain degree.

7.28.9 Push Plates: Push plates shall be furnished by door manufacturer with his standards.

(a) Plate shall be stainless steel beveled on all edges.

7.28.10 Pulls: Pulls shall be furnished by door manufacturer with his standards.

7.28.11 Flush Bolts: Flush bolts shall be furnished by door manufacturer with his standards. In case that flush bolts are used for the doors without saddle, provide proper metal sockets for floor to receive bolts.

7.28.12 Door Stops: Door stops shall be furnished by door manufacturer with his standards.

(a) For all doors without closers, or checking floor hinges, furnish wall type door stops.

(b) Include fastening device appropriate for receiving surface.

(c) Floor type door stops shall be used when wall type door stops are not suitable.

7.28.13 Key Cabinet: Key cabinet shall be furnished by manufacturer approved by the Engineer.

(a) Cabinet shall be of sufficient capacity to accommodate all units plus 25%.

(b) Tag and file all keys in cabinet.

7.28.14 Hardware for Tempered Plate Glass Entrances: Hardware for tempered plate glass doors shall be furnished by door manufacturer with his standards except for lock sets and checking floor hinges.

(a) Ship lock sets and checking floor hinges to manufacturer of tempered plate glass doors. Ship in one shipment, labeled specifically for this project. These hardware will be fitted and installed by manufacturer of tempered plate glass doors.

7.28.15 Horizontal Sliding Window Hardware: Pull handles and locking devices shall be furnished. Locking device shall have the function that will prevent opening or removal of sash from outside when locked.

7.29 KEYING

7.29.1 Provide three (3) keys each for all locks. Die stamp each key with number of lock change and set symbol number or letter.

7.29.2 Cylinder locks shall be master keyed in each lock set type and three (3) master keys shall be furnished for each type.

7.30 PACKAGING AND IDENTIFICATION

7.30.1 Package each item of hardware separately in individual containers, complete with screws, keys, special wrenches, instructions, and installation templates necessary for accurately locating, setting, adjusting, and attaching hardware.

7.30.2 Mark each container with number of door or window to which hardware item is to be applied, and with item number corresponding with hardware item number listed in the Contractor's hardware schedule.

7.30.3 At the completion of the project, the Contractor shall turn over

to the Engineer all installation instructions, templates, and adjusting tools.

7.31 RECEIVING AND STORAGE

7.31.1 Provide adequately locked storage space with necessary open shelves, bins, and counters for assembling and grouping hardware before distribution and installation.

7.31.2 Properly tag, index, and file all keys in key cabinet as directed.

7.31.3 Hardware shall be checked after delivery to the project site before it is installed.

7.32 *LOCATION*

7.32.1 Before installation of any hardware, obtain the Engineer's verification of the positioning of each type of assembly. This will include the exact location of each element of hardware such as locks, bolts, push plates, pulls, closers and hinges.

7.32.2 Distances from the floor to center line to each hardware item shall be as tabulated below unless indicated or specified otherwise:

(a) Door locks: 1,000 mm from finish floor to center of strike.

(b) Door pulls: 1,000 mm from finish floor to center of grip.

(c) Push plates: 1,150 mm from finish floor to center of plate.

(d) Push-pull bars: 1,000 mm from finish floor to center of bar or center between bars and combination.

(e) Top hinges: To manufacturer's standard, but not greater than 250 mm from head of frame to center line of hinge.

(f) Bottom hinges: To manufacturer's standard, but not greater than 300 mm from finish floor to center line of hinge.

(g) Intermediate hinges: Equally spaced between top and bottom hinge. The space should not be more than 900 mm on center.

(h) Latches: 1,000 mm from finish floor to center of strike.

(i) Deadlocks only: 1,000 mm from finish floor to center of strike.

(j) Deadlocks with separate latch-set and/or pull: 1,300 mm from finish floor to center line of strike.

7.32.3 Hardware for Windows: Location of hardware shall be as standardized by the window manufacturer.

7.33 INSTALLATION

7.33.1 Install hardware accurately fitted, securely applied, and carefully adjusted. Install in accordance with manufacturer's instructions. Use care not to injure other work when installing.

7.33.2 Provide and use boring jigs, mortising tools and other special equipment and appliances as required for proper installation of hardware items.

7.33.3 When required, remove and replace doors so that door bottoms or tops may be painted.

7.33.4 Cover visible hardware with masking tape or heavy cloth until painting is completed.

7.34 GENERAL SCHEDULE OF HARDWARE FOR DOORS

Note 1:

Doors specified to have closers in this general schedule of hardware and at the same time not indicated to have them on drawings shall be furnished with door stops instead of closers.

Note 2:

Doors more than 2.5 m high and/or more than 1.2 m wide shall be equipped with 2 pairs of hinges.

7.34.1 Doors in General, Except as Specified Hereinafter:

(a) Metal single door:
1-1/2 pairs, butt hinges, 127mm x 127mm
1 lock, mortise pin tumbler lock
1 closer, overhead type (*)

(b) Metal single door of lavatory entrance:
1-1/2 pairs, butt hinges, 127mm x 127mm
1 latch, mortise latch
1 closer, overhead type

(c) Metal single door of pipe shaft's entrance:
1-1/2 pairs, butt hinges, 102mm x 102mm
1 lock, mortise pin tumbler dead lock

1 pull handle, concealed type

(d) Metal pair of doors:

3 pairs, butt hinges, 127mm x 127mm

1 lock, mortise pin tumbler lock

1 closer, overhead type (*)

1 pair, flush bolts

1 or 2 stop, wall type

(e) Fire door:

1 set checking floor hinge (for each leaf)

1 set fuse device

2 pull handles, concealed type

(f) Tempered plate glass door (for each leaf)

1 set checking floor hinge

2 locks, mortise pin tumbler dead lock for tempered glass doors

2 push plates

(*) All doors shall not be provided with closer. Refer to drawings in details.

7.35 GENERAL SCHEDULE OF HARDWARE FOR WINDOWS

7.35.1 Horizontal Sliding Windows:

(a) Window with one sliding unit (for each ventilator):

1 pull handle

1 set, locking device

(b) Window with two sliding units (for pair of ventilator):

2 pull handles

1 set, locking device

MISCELLANEOUS ITEMS

7.36 CAULKING

7.36.1 General: Joints between exterior walls and frames for exterior doors, windows, panels, etc., specified in this section shall be caulked with "Thiokol" rubber caulking. No caulking shall be done when the temperature is below 2°C.

7.36.2 Joint Preparation: Joint surface shall be clean, dry and free of

dust, oil, or grease. Follow caulking manufacturer's recommended procedure for joint preparation.

7.36.3 Caulking Work:

(a) The finished joint shall conform to the size, shape and color of the approved sample.

(b) Adjacent surfaces which have been soiled shall be cleaned immediately and work left in a neat, clean condition.

(c) All caulking work shall be in strict accordance with the manufacturer's instructions.

7.37 PROTECTION AND CLEANING

7.37.1 Protection of Doors and Windows: Care shall be used in handling doors and windows during transportation and at job site. Store upright doors and windows upright on pieces of lumber in a dry location, and under cover. After installation, protect doors and windows from damage during subsequent construction activities. Damaged work will be rejected and shall be replaced with new work.

7.37.2 Cleaning of Metal Doors and Windows: Metal surfaces of doors and windows shall be cleaned on both the inside and outside of all mortar, plaster, paint and other foreign matter to present a neat appearance and prevent fouling of weathering surfaces, weatherstripping or the operation of hardware. In addition, aluminum windows shall be washed off with a stiff-fiber brush, mild solution of nonalkali soap and water, and thoroughly rinsed with clear water. Where steel doors surfaces are abraded from handling, the area shall be wire brushed or steel wooled as required, and touched up with primer before finish painting. Where aluminum windows have become stained or discolored they shall be cleaned or have finish restored.

7.38 EXTRA MATERIALS FOR MAINTENANCE

7.38.1 Extra Glass: Upon completion of work, the Contractor shall deliver extra glass of same size, pattern, color and thickness as used on the job for use in future repair and maintenance work. Furnish glass in original boxes, properly marked, in quantity as

listed below:

(a) Tempered glass: One sheet.

7.38.2 Extra Hardware: Upon completion of work, the Contractor shall deliver extra hardware of same type, function, and finish as used on the job for use in future repair and maintenance work. Furnish hardware in original container, properly marked, in quantity as listed below:

(a)	Lock and latch sets:	
	(1) Mortise cylinder lock sets for interior doors	1
	(2) Mortise pin tumbler dead locks for access doors	1
	(3) Mortise pin tumbler dead locks for tempered plate glass doors	1
(b)	Hinges:	
	(1) Hinges for metal doors	10
	(2) Hinges for metal access doors	3
(c)	Overhead door closers:	
	(1) Door closers for metal doors	5
(d)	Checking floor hinges:	
	(1) Checking floor hinges for tempered plate glass doors	1
	(2) Checking floor hinges for fire doors	1
(e)	Metal fuses:	
	(1) Metal fuses for fire doors	20

SECTION 8

CERAMIC TILE

8.1 SCOPE OF WORK

8.1.1 Extent: The work required under this section consists of all ceramic tile, accessories and related items necessary to complete the work indicated on drawings and described in specifications.

8.2 SHOP DRAWINGS

8.2.1 Submit three (3) copies of shop drawings for tile work to the Engineer for approval. Obtain approval of drawings prior to proceeding with manufacturing.

8.3 SAMPLES

8.3.1 Submit samples in duplicate of the following materials to the Engineer for approval. Approval must be obtained prior to delivery.

(a) Ceramic mosaic sheets of each colour and type to be used.

(b) Glazed wall tiles of each colour and type to be used.

(c) Samples of each type of trim shape and each type of accessory to be used.

8.4 GENERAL REQUIREMENTS

8.4.1 Factory Mounting of Tile: Factory mounting into sheets of patterns shall be required for all ceramic mosaic tile.

8.4.2 Colours and Patterns: Colours and patterns of tile shall be as selected by the Engineer.

8.5 MATERIALS

8.5.1 Floor Tiles:

(a) Ceramic Mosaic Tile: Standard grade, unglazed dust-pressed porcelain type, similar to "Porcelain S Type Mosaic Tile" as manufactured by Ina Seito Co., Ltd., or equal; not less than 4 mm thick with square edges and 25mm x 25mm in face sizes, unless otherwise indicated. Provide all necessary shapes and trimmers of similar tile for curbs, depressions and corners.

8.5.2 Wall Tiles:

(a) Glazed Wall Tile: Standard grade glazed tile similar to "Ina Seito's Glazed Wall Tile" as manufactured by Ina Seito Co., Ltd., or equal; not less than 5 mm thick with cushion edges, a coloured or white glazed finish and 75mm x 75mm in nominal face sizes, unless otherwise indicated. Provide spacer lugs or other similar features on edges of tile.

(b) Wall Tile Trim Shapes: Provide trim shapes as required. Trim shapes shall be of same type, colour, thickness and finish as wall tile.

8.6 MATERIALS FOR SETTING TILE

8.6.1 Portland Cement: See "CONCRETE WORK".

8.6.2 White Cement: See "PLASTERING".

8.6.3 Hydrated Lime: See "PLASTERING".

8.6.4 Sand: See "PLASTERING".

8.6.5 Water: Clean and potable.

8.7 LAYING OUT WORK

8.7.1 Where possible, lay out work so that no tile less than half size occurs. For heights metrically stated, maintain full courses to produce nearest attainable heights without cutting tile. Align joints in wall tile vertically and horizontally except where other patterns are shown or specified. Align joints in floor tile at right angles to each other and straight with walls.

8.8 MIXING PROPORTIONS

8.8.1 Mixing proportions of scratch coat and setting bed shall be as tabulated below:

Type of Tile	Receiving Surface	Scratch Coat	Setting Bed	Thickness (mm)
		Cement:Sand	Cement:Sand	
Ceramic Mosaic Tile	Floor	-	1:2.5	25
	Interior Wall	1:2.5	1:3	20
	Exterior Wall	1:2.5	1:3	25
Glazed Wall Tile	Interior Wall	1:2.5	1:3	20
	Exterior Wall	1:2.5	1:3	25

8.9 INSTALLATION OF TILE

8.9.1 Tile on Horizontal Surfaces:

(a) Preparatory Work: Concrete surface shall be thoroughly cleaned and all coatings removed that might impair the bond. Surface shall be wetted and kept wet for 2 hours before laying tile. When ready to lay tile, sweep off excess water and brush neat cement grout over area ready to receive mortar setting bed.

(b) Setting Bed and Installation of Tile: Mortar setting bed (1:2.5 mix.) shall be spread true and even in plane, either levelled or uniformly sloped for drainage, as required. As large an area as can be covered with tile before the mortar has reached its initial set shall be placed at one operation. The thickness of the mortar setting bed shall be 25 mm. Neat cement coat shall be uniformly spread over the surfaces of the mortar setting beds immediately preceding the setting of the tile. The tile shall be placed upon, and firmly pressed and beaten into the mortar until exactly true and even with the finished floor tiles. The tiles or ceramic mosaic sheets shall be laid to straight edge at regular intervals. Tile nosing, coves, curbings, gutters, or other molded or shaped pieces shall be thoroughly backed up with mortar. As soon as the cement mortar bed have sufficiently set, the tiles shall be washed with clear water and the joints between the tile

grouted or pointed. All surplus grout or mortar shall be removed, before it has set or hardened, and the face of the tile and surrounding left clean.

8.9.2 Tile on Vertical Surfaces:

(a) Preparatory Work: Concrete or masonry surface shall be thoroughly cleaned and moistened directly before the scratch coat is applied.

(b) Setting Bed and Installation Tile: Scratch coat (1:2.5 mix.) shall be at least 6 mm thick or more. While still plastic, the scratch coat shall be deeply scored or scratched. Plumb or straightening-up coat shall be applied if necessary to make an even and true surface at the proper distance from the face of tile.

(1) Floating Method: The scratch coat shall be properly moistened before applying mortar setting bed (1:3 mix.). Mortar setting bed shall be applied only in such quantity as can be covered with tiles before the initial set of the mortar. After the mortar setting bed has been floated flush with the guide strip, a skim of neat portland cement shall be trowelled to the mortar setting bed, and to the back of each tile unit, immediately before the tiles are placed.

(c) General Requirements: As soon as the mortar setting bed has sufficiently hardened, the tile surfaces shall be well washed with clean water prior to grouting.

The grout or mortar for pointing all tile shall be forced into the joints by trowelling, or some suitable method, and finished flush and true. All surplus grout or mortar shall be removed, before it has set or hardened, and the face of tile left clean.

8.9.3 Total Thickness: Total thickness of scratch coat, setting bed and tile shall be as follows:

(a) Ceramic mosaic tile:

For floor ..... 30 mm

For interior wall .... 30 mm

For exterior wall .... 35 mm

(b) Glazed wall tile:

For interior wall .... 30 mm

For exterior wall .... 35 mm

8.10 EXTRA TILE FOR MAINTENANCE

8.10.1 Upon completion of work, the Contractor shall deliver extra tile of same size, pattern and colors as used on the job to the Employer for use in future repair and maintenance work. Furnish tile in original boxes, properly marked, in quantities as listed below and in types and colours as directed.

Glazed wall tile 2 square meter for each kind.

Ceramic mosaic tile 2 square meter for each kind.

8.11 CLEANING

8.11.1 Unless otherwise directed by the Engineer, acid solutions shall not be used for cleaning all tile surfaces. Upon completion of the work, all exposed surfaces of tiles shall be washed with soap powder and water, applied with a scrubbing brush, and then rinsed thoroughly with clear water. Metal cleaning tools and brushes, or abrasive powders shall not be used.

SECTION 9

MARBLE

9.1 SCOPE OF WORK

9.1.1 Extent: The work required under this section consists of all marble and related items necessary to complete the work indicated on drawings and described in specifications.

9.2 SHOP DRAWINGS

9.2.1 Submit three (3) copies of shop drawings to the Engineer for approval of all items of stonework. Obtain approval of drawings prior to proceeding with fabrication.

9.2.2 Shop drawings shall indicate the following: Type, classification, and producer's name for variety of stone; layout; elevations; sections; full size profiles of joints; large scale details; thicknesses; dimensions; finish and surface treatments; anchoring; joint compound; and all necessary connections to other work.

9.3 SAMPLES

9.3.1 Submit samples in duplicate of the following materials or assemblies to the Engineer for approval. Approval must be obtained prior to delivery of fabrication.

(a) Marble: Samples must be enough size to represent extremes and average of colour, markings, and characteristics which the Contractor proposes to furnish.

9.4 MATERIALS

9.4.1 General Requirements:

(a) Stone shall be sound and free from defects that would impair its strength, durability or appearance.

(b) The colour and texture shall be within the range of variations specified and as represented by the approved sample.

(c) The patching or hiding of defects shall not be permitted, unless specified otherwise. Any stone with chips or stains on the face to be exposed shall be corrected by redressing or

cleaning, or shall be replaced with new stone as determined by the Engineer.

(d) Natural variations in colour and markings that are characteristic of the quarry from which the stone obtained will be acceptable unless they impair its strength or durability, or mar its appearance.

9.4.2 Marble: Except as otherwise specified or indicated, all marble for flooring, wall facing, entrance steps and information counter shall be made in Pakistan.

9.4.3 Setting Materials:

(a) Portland Cement: See "CONCRETE WORK".

(b) White Portland Cement: See "PLASTERING".

(c) Sand: See "PLASTERING".

9.5 CUTTING AND FABRICATION

9.5.1 Thickness:

(a) Except as detailed otherwise, marble shall have the thickness listed for the following functions and locations:

(1) Standing marble, where one face only is finished, shall be 20 mm thick.

(2) Floor marble units shall be 25 mm thick.

(3) Entrance steps shall be 150 mm thick.

(4) Information counter shall be 190 mm thick.

9.5.2 Sizes:

(a) Unless otherwise specified or directed, sizes shall be 600mm x 900mm ∿ 900mm x 1,200mm.

9.5.3 Joints:

(a) Joints shall be closed joints unless otherwise shown or specified.

9.5.4 Fabrication:

(a) Cutting shall allow for finishing and jointing to bring work to dimensions shown on drawings.

(b) External corners shall have butt joints and exposed edges shall be finished.

(c) Internal corners shall have butt joints.

9.6 MORTAR

9.6.1 Mixing Mortar:

(a) Mortar shall be mixed in proportion of 1 part cement to 3 parts sand.

9.7 ANCHORING

9.7.1 Wall Facing:

(a) Anchor with at least the following number of anchors.

(1) 4 anchors on all pieces up to 1 sq.m.

(2) 2 additional anchors for each additional 0.5 sq.m.

(b) Anchors shall be 3.4 mm diameter brass wire or 3.2 mm diameter stainless steel wire.

(c) Base for Anchors: Base rods for brass anchors shall be of crisscrossing 9 mm diameter steel round bars fixed the surfaces of columns or walls on which marble units are applied. Vertical steel base rods shall be secured on the surfaces at intermediate points not more than 60 cm apart by welding to steel anchors embedded in concrete or masonry at points not exceeding 60 cm apart. Horizontal steel base rods shall be spaced at each horizontal stone joint, wired at vertical ones at each crossing point.

9.8 SETTING

9.8.1 General:

(a) No work shall be set in a temperature below 3°C.

(b) Wet receiving surface before applying mortar.

(c) Set stone square and true, with edges of face joints smooth and even.

(d) Use care in blending colour and veining of stone to produce a homogeneous effect.

(e) After setting and grouting, remove all surplus material from the face of the stone immediately.

9.8.2 Anchors and Dowels:

(a) Anchors, where required, shall be spaced not more than 90 cm on centers vertically or horizontally along edges of each slab or piece.

(b) Anchor each piece separately.

(c) Where shown or required, anchor adjoining pieces with dowels. Dowels shall be set with equal penetration into each connecting piece.

9.8.3 Standing Stone:

(a) For Exterior Wall: Set by grouting fully with mortar and by concealed anchors secured into wall backing.

(b) For Interior Wall: Mortar shall be applied along horizontal reinforcing bar. Anchor shall be same as for exterior wall.

9.8.4 Floor Stone:

(a) Clean structural slab thoroughly before wetting.

(b) After installing stiff mortar bed, tamp stone down to proper level. Lift stone and apply a paste of portland cement to back of stone. Reset and tamp lightly to insure good bond.

(c) Layout pattern of stone as shown or specified, with joint width shown or specified.

(d) Cut and grind edges around pipes and other projections.

9.9 PROTECTION

9.9.1 Protect stone from damage and staining after delivery to project site.

9.9.2 Protect installed work having projecting parts with nonstaining wood guards.

9.9.3 Protect stone flooring against traffic and other damage with nonstaining materials.

9.10 CLEANING AND FINISHING

9.10.1 After erection and completion of work, clean stone as recommended by producer, repoint any open joints, and replace any defective work.

9.10.2 Apply surface finish as recommended by producer.

SECTION 10

TERRAZZO

10.1 SCOPE OF WORK

10.1.1 Extent: The work required under this section consists of all terrazzo floors, skirtings, handrails and related items necessary to complete the work indicated on drawings and described in specifications.

10.2 METHODS OF INSTALLATION

10.2.1 Floated: Cast-in-place terrazzo applied on a waterproof membrane sheet and sand cushion placed over a hardened structural slab, shall be used at locations indicated on drawings; it shall have a minimum total thickness of 60 mm and a minimum topping thickness of 12 mm for standard topping.

10.3 SAMPLES

10.3.1 Submit samples in duplicate of the following materials to Engineer for approval. Approval must be obtained prior to delivery or fabrication.

(a) Each colour plate of terrazzo specified.

(b) Each type of divider strip specified.

(c) Precast terrazzo panels for skirtings and handrails.

10.4 MATERIALS

10.4.1 Portland Cement:

(a) Gray or white as required to match colour plates specified.

(b) See "CONCRETE WORK".

10.4.2 Sand:

(a) Clean hard natural sand. See "PLASTERING".

10.4.3 Marble Chips:

(a) Standard quarry products, of sizes, colours and kinds required by the colour plates specified.

10.4.5 Colour Pigment:

(a) Lime proof, non-fading mineral pigments; of colour and quantities required by the colour plates specified.

10.4.6 Waterproof Membrane Sheet:

(a) Asphalt-saturated felt (20 kg/42 sq.m) or polyethylene film not less than 0.15 mm thick conforming to JIS K6881.

10.4.7 Divider Strips for Floors: Use brass strips described in "MISCELLANEOUS METAL WORK" or glass strips approved by the Engineer.

10.4.8 Metal Reinforcement:

(a) 3.2 mm diameter welded wire fabric, 100 by 100 mm mesh; conforming to JIS G3551, or equal.

(b) Provide reinforcement for cast-in-place terrazzo floors at locations where reinforcing is specified.

10.5 TERRAZZO COMPOSITION AND COLOURS

10.5.1 Terrazzo topping shall be colours as selected by the Engineer from sample plates submitted by the Contractor.

10.5.2 The kind and size of marble chips and the kind of cement and mineral pigment shall be as approved by the Engineer.

10.6 PREPARATION OF STRUCTURAL SLABS

10.6.1 For Floated Terrazzo on Sand Cushion: Before placing the underbed for cast-in-place floated terrazzo floors, sweep slabs clean and remove any plaster, mortar and other foreign matter from slabs. Cover surface of slab with 5 mm thick layer of dry clean sand and screed off level. Cover sand cushion with impregnated felt or polyethylene film not less than 0.15 mm thick; lap joints at least 10 cm. Place wire mesh reinforcing evenly in each position divided by strips. Set divider strips in place at locations indicated.

10.7 UNDERBED

10.7.1 Mix: The underbed to receive terrazzo topping shall consist of 1-part portland cement and 3-parts sand; add water and thoroughly mix to proper consistency.

10.7.2 Placing Divider Strips: Prior to placing underbed, install divider strips with suitable anchors spacing as indicated or specified. Set strips accurately and straight on top of mortar ridges at proper height and with tight fitting joints at intersections.

10.7.3 Placing Underbed: The underbed for floors shall be spread and screeded to true, level or plumb surface, finishing not less than 12 mm below finished level for floors, except as indicated or specified otherwise.

10.8 TERRAZZO TOPPING

10.8.1 Mix: The topping mix shall be in proportions of 1-part portland cement to 3-parts marble chips, mixed dry; add mineral colour pigment in quantity required by formulas of colour plates specified.

10.8.2 Installation: Place topping after underbed has hardened sufficiently to withstand rolling, but not to exceed one day after placing. Saturate underbed with water, remove excess and then slush and broom surface with neat cement grout immediately ahead of topping mix; use same colour of cement and pigment as required for matrix. Place terrazzo topping to thickness specified and then sprinkle with wet marble chips of the composition and percentage required by the formula specified. Topping shall be uniform in composition and the same marble chips that appear on surface shall be used for entire thickness. Roll floors with heavy roller until superfluous cement and water have been extracted. Hand trowel to an even surface, exposing the lines of strips on a level with the topping.

10.8.3 Curing: Cure terrazzo topping by keeping it damp for a minimum of 7 days after placing.

10.8.4 Surfacing: After curing, perform initial and final grinding with carborundum stones proper to obtain the finish specified; use proper stones for initial grinding and final grinding. Do not reduce height below the height specified. Rub by hand all inaccessible places. During grinding or rubbing, group surfaces repeatedly with neat portland cement paste of creamy consistency,

filling all voids; use cement and colouring corresponding to topping mix for grouting. Final grinding shall produce surface of same texture as approved samples. The finished surface shall match approved samples. Terrazzo shall be level or straight. Protect walls, floors and other work adjacent to terrazzo from grinding stones and from splashing while grinding is in progress.

10.9 PRECAST TERRAZZO

10.9.1 Precast terrazzo panels shall be provided for terrazzo skirtings and terrazzo handrails.

10.9.2 Precast terrazzo panels shall be 1,200 mm long, 150 mm wide and 30 mm thick. They shall be manufactured by a compression and vibratory process in accurately constructed watertight moulds. After curing, exposed surfaces shall be ground, grouted and recured. All applicable requirements specified for cast-in-place terrazzo shall apply to precast work. Colour of precast terrazzo shall match adjacent cast-in-place work of same colour and pattern.

(a) Precast Terrazzo Skirtings: Set precast terrazzo panels for skirtings straight, level and plumb in solid bedding of cement mortar and with joints tightly fitted and filled flush with cement grout of approved colour. The finished work shall be clean and free from loose or broken pieces.

(b) Precast Terrazzo Handrails: Set precast terrazzo panels for handrails on top of balustrades in staircase 2.

10.10 CLEANING AND SEALING TERRAZZO

10.10.1 After final grinding, thoroughly clean all terrazzo surfaces, using a neutral type cleaning solution in accordance with the manufacturer's directions. After surfaces are dry, wash and rinse and apply a coat of penetrating sealing solution. Upon completion, machine buff terrazzo surfaces and leave in clean finished condition. Protect finished terrazzo surfaces from damage until acceptance by owner; do not use wax on finished terrazzo.

SECTION 11
RESILIENT FLOOR COVERINGS

11.1 SCOPE OF WORK

11.1.1 Extent: The work required under this section consists of all resilient floor coverings and related items necessary to complete the work indicated on drawings and described in specifications.

11.1.2 Work not Included: The following items of work are included in other sections of this specification:

(a) Saddles.

(b) Dividing strips.

(c) Safety tread nosings.

11.2 SHOP DRAWINGS

11.2.1 Submit three (3) copies of shop drawings to the Engineer for approval. Obtain approval of drawings prior to proceeding with fabrication.

11.2.2 Shop drawings shall indicate type of material, pattern, colour, weight or thickness, adhesives, fastening, installation details and all necessary connections to other work.

11.3 SAMPLES

11.3.1 Submit samples in duplicate of the following materials to the Engineer for approval. Approval must be obtained prior to fabrication or installation.

(a) Vinyl asbestos tile.

(b) Vinyl sheet.

(c) Vinyl skirting.

11.4 MATERIAL

11.4.1 General Requirements:

(a) Flooring shall be uniform in thickness and size.

(b) Tile shall be cut accurately with square, true edges.

(c) Plain colours shall be uniform throughout in colour.

(d) Variations from piece to piece with variegated colours shall not be so wide as to mar the decorative value of the floor.

11.4.2 Flooring:

(a) Vinyl Asbestos Tile: 2 mm thick, 30cm x 30cm, similar to "Machiko V" as manufactured by Toyo Linoleum Co., Ltd. or equal.

(b) Vinyl Sheet: 2.4 mm thick, 1.83 m wide, in 27 m long rolls, similar to "Linoleum" as manufactured by Toyo Linoleum Co., Ltd. or equal.

11.4.3 Skirtings:

(a) Vinyl Skirtings: Set-on cove, 2 mm thick, 75 mm high, long rolls, soft vinyl, similar to "Soft Vinyl Habaki" as manufactured by Toyo Linoleum Co., Ltd. or equal.

11.4.4 Adhesive: Type and brand as recommended by manufacturer of resilient flooring.

11.4.5 Wax: As recommended by resilient flooring manufacturer.

11.4.6 Cleaner: As recommended by resilient flooring manufacturer.

11.5 DELIVERY AND STORAGE

11.5.1 Deliver materials to project site in manufacturer's original unopened containers with manufacturer's brand name, colour, and pattern number clearly marked thereon.

11.5.2 Store materials carefully in conformity with manufacturer's recommendations.

11.6 INSPECTION OF SURFACES

11.6.1 Surfaces to receive resilient flooring shall be examined, and work shall not be started until defects have been corrected.

11.7 TOLERANCES

11.7.1 Surfaces receiving resilient flooring shall not vary more than 3 mm in any 2 m distance, nor more than 1.5 mm within any 30 cm distance.

(a) Any deviation from this tolerance of the surface receiving resilient flooring shall be filled with underlayment materials suitable for use under adhesive and resilient flooring specified herein.

11.8 PREPARATION OF SURFACES RECEIVING RESILIENT FLOORING AND SKIRTING

11.8.1 Surfaces receiving resilient flooring shall be broom clean, and free of paint, grease, wax, oil, dirt, and any material which will inhibit adhesive bond.

11.8.2 After surface is dry, fill minor remaining cracks and depressions with crack filler.

11.9 INSTALLATION

11.9.1 In spaces where resilient flooring is stored and is to be installed, maintain temperature at not less than 15°C for 24 hours before installing and at least 48 hours after installing.

11.9.2 Adhesives:

(a) Adhesive shall be mixed and installed in accordance with instructions of manufacturer.

(b) Cover area evenly and only to the extent which can be covered with resilient material in the recommended working time of the adhesive. Remove any adhesive which dries or films over.

(c) Apply with trowel notches according to recommendations of manufacturer. Clean and rework trowel notches as necessary to insure proper application of adhesive.

(d) Observe caution to prevent soiling walls, skirtings, and adjacent areas with adhesives.

11.9.3 Flooring:

(a) Except as required in irregularly shaped rooms, no tile shall be less than one half the width of field tile.

(b) Fit flooring with tight, aligned joints.

(c) Remove excess adhesive in accordance with manufacturer's instructions.

11.9.4 Skirtings (Set-on cove):

(a) Firmly cement to wall. Press down so that bottom cove edge follows floor.

(b) Form internal corners by butting two pieces.

(c) Form external corners by heat-bending method.

(d) Scribe skirting accurately to abutting materials.

11.9.5 Floor Number Indicators: A floor number indicator shall be provided at locations indicated on drawings by means of cutting and filling vinyl asbestos tiles of the same quality as adjacent tiles to make figures as directed by the Engineer.

11.10 CLEANING AND WAXING

11.10.1 Upon completion of work under this section and on all adjacent work, clean floors and wash with cleaner specified.

11.10.2 When flooring is dry, apply two coats of wax. Thoroughly buff.

11.11 PROTECTION

11.11.1 Fiber-board, plywood or other suitable materials that will not mar the tile shall be placed over tile in areas used as passageways by workmen, in areas subject to floor damage because of subsequent building operations, and elsewhere as directed.

SECTION 12

MISCELLANEOUS METAL WORK

12.1 SCOPE OF WORK

12.1.1 Extent: The work required under this section consists of all miscellaneous metal work and related items necessary to complete the work indicated on drawings and described in specifications.

12.1.2 Work not Included: The following items of related metal work are specified and included in other sections of this specification:

(a) Access doors and panels, except floor access panels.

(b) Anchors, bolts, sleeves, and supports required for installation of items specified and included in other sections of the specification, except as specified otherwise herein.

(c) Lift doors, frames and thresholds.

(d) Hardware, except as specified herein.

(e) Hollow metal doors and frames.

(f) Metal suspension system for ceilings.

(g) Structural steel shapes inside of hollow metal, aluminum, or stainless steel frames.

12.2 SHOP DRAWINGS

12.2.1 Submit three (3) copies of shop drawings to the Engineer for approval. Obtain approval of drawings prior to proceeding with manufacturing. Shop drawings shall indicate the fabrication, assembly and erection details; sizes of all members; fastenings, supports and anchors; patterns; clearances; and all necessary connections to other work.

12.3 SAMPLES

12.3.1 Submit samples in duplicate of the following materials to the Engineer for approval. Approval must be obtained prior to delivery or fabrication.

(a) Safety tread nosings.

(b) Floor access panels.

(c) Metal framings for wall.

(d) Hanger rings.

(e) Roof drains.

(f) Manhole covers.

12.4 MATERIALS

Materials used for miscellaneous metal work shall be suitable to the construction and function of each item, conforming to the requirements of BS, ASTM, and/or JIS. The materials of each item must be approved by the Engineer prior to delivery or fabrication.

12.5 WORKMANSHIP

12.5.1 Metal surfaces shall be clean and free from mill scale, flake rust and rust pitting; well formed and finished to shape and size, with sharp lines and angles and smooth surfaces. Shearing and punching shall leave clean true lines and surfaces. Weld or rivet permanent connections. Welds and flush rivets shall be finished flush and smooth on surfaces that will be exposed after installation. Do not use screws or bolts where they can be avoided; where used, heads shall be countersunk, screwed up tight and treads nicked to prevent loosening.

12.5.2 Castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion or other defects.

12.5.3 Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water. Provide holes and connections for the other work.

12.5.4 At proper time, deliver and set in place items of metal work to be built into adjoining construction.

12.6 PAINTING AND PROTECTIVE COATING

12.6.1 All ferrous metal, except stainless steel, galvanized surfaces and castings to be left unpainted shall be properly cleaned and given two shop coats of red lead or zinc chromate primer. Anchors that are built into masonry shall be coated with asphalt paint unless

specified to be galvanized. Metal work to be encased in concrete shall be left unpainted unless specified or noted otherwise. Where hot-dip galvanized or zinc-coated metal is specified or shown, it shall not be shop primed unless specifically required. Castings that are to be left unpainted shall be cleaned and coated with a coal-tar-pitch varnish. Hot-dip galvanizing shall comply with JIS H 8641, or equal. Except for bolts and nuts, all galvanizing shall be done after fabrication.

12.6.3 Finish Painting: See "PAINTING".

12.7 BALUSTRADES

12.7.1 Balustrades for "STAIRCASE 1" shall be fabricated stainless steel pipe and steel pipe of sizes indicated on drawings. Baluster shall be anchored to reinforcing bar of concrete slab by welding and shall be provided for each two steps. Joint between handrail and balusters shall be stainless steel pipe which shall be welded to handrail and fixed on top of baluster by using two screws.

12.8 STEEL PIPE RAILING

12.8.1 Steel pipe railings shall be provided for decks in "STAIRCASE 2". They shall be set on both sides walls and shall be anchored to reinforcing bars.

12.9 BALCONY HANDRAILS

12.9.1 Balcony handrail shall be steel pipe of sizes indicated on drawings. They shall be removable type.

12.10 TRENCH COVERS AND FRAMES

12.10.1 Provide steel frames and steel covers for trenches in floors at locations indicated. Covers shall be not less than 4.5 mm thick and have a checkered pattern on exposed surface. Provide 30mm x 3mm x 150mm bent bar anchors, welded to frames and spaced not more than 60 cm on centers.

Frames shall be aligned and leveled accurately to finish flush with adjacent floors. Covers shall be in sections not more than 60 cm long; allow approximately 3 mm space between the ends of adjoining sections. Provide suitable lift holes near the ends of each section of cover.

12.11 FLOOR ACCESS PANELS

12.11.1 Floor access panel shall be fabricated of 450mm x 450mm aluminum plate with reinforcing ribs on under surfaces, similar to "New Hatch-A, NHA 450 AG" as manufactured by Naka Industry Co., Ltd. or equal. Panels and frames shall be aligned and levelled accurately to finish flush with adjacent floors.

12.12 SAFETY TREAD NOSINGS

12.12.1 Provide safety tread nosings of extruded stainless steel with vinyl non-slip ribs for concrete treads, platforms and landings of interior stairs. Similar to "Hi-step, STL-30" as manufactured by Naka Industry Co., Ltd. or equal.

12.12.2 For concrete stairs having a floor covering on treads, platforms or landings, the safety-treads shall extend full length of tread, platform and landing and be set at proper height to finish flush with floor covering.

12.12.3 Tread nosings shall have exposed surfaces covered at the factory, or at the site prior to setting, with an approved masking tape or heavy paper. Covering shall remain in place for protection until directed by the Engineer to be removed.

12.13 DIVIDER STRIPS

12.13.1 Provide brass divider strips in floors at locations as indicated on drawings. Divider strip shall be 5 mm thick, 15 mm wide and

long straight. They shall be stock type of manufacturer attaching anchor plates spaced 30 cm on centers and shall be aligned and levelled accurately to finish flush with both side floors: similar to "BRASS DIVIDING BEAD" as manufactured by Naka Industry Co., Ltd., or equal.

12.14 HOOK

12.14.1 Hook shall be fabricated of carbon steel forgings specified in ASTM A235 Class C, or JIS G3201 SF 40, or equal, and shall be of sizes indicated on drawings: similar to "2^{t} Hook" as manufactured by Nakanishi Sangyo Co., Ltd., or equal. Apply protective zinc coating by dipping in a bath of molten zinc on all surfaces except for surfaces to be encased in concrete. Allowable bearing capacity shall be written by vinyl resign type enamel on concrete surfaces of beams as directed by the Engineer.

12.15 METAL FRAMING FOR WALL

12.15.1 Metal framings for plastered hollow wall shall be a channel stud system similar to "NS-P" as manufactured by Okumura Jubei Shoten Co., Ltd., or equal. Studs and runners shall be of 65 mm wide and not less than 0.8 mm thick galvanized steel. Steel runners shall be aligned and securely fastened 80 cm or less on centre. Steel studs shall be positioned vertically in the runners spaced not more than 450 mm on centre.

12.16 HANGER RINGS

12.16.1 Provide hanger rings at locations indicated on drawings. They shall consist of 140 mm diameter steel ring, 280mm x 60mm x 12mm steel plate and 600 mm cross bar anchor. Protective zinc coating by dipping in a bath of molten zinc shall be applied to these materials. Prior to placing concrete, hanger rings shall be secured to forms with cross bar anchor welded to main reinforcements.

12.17 METAL FILLER PANELS

12.17.1 Provide metal filler panel between windows mullions and terminated ends of plastered partions or those of movable steel partitions.

Metal filler panel shall be of 1.2 mm thick steel sheet and manufactured in any shape to fit the contours of openings between windows and partitions. They shall be installed by screwing to vertical metal studs.

12.18 MOVABLE STEEL PARTITIONS

12.18.1 Provide movable steel partions as indicated and designed on drawings. They shall be of prefabricated knockdown system similar to "UNIPART" as manufactured by Nichi-Bei Partition Co., Ltd., or equal. Installation, erection, recessed base, recessed ceiling trim, end fillers, door's fitting, hardwares, colours and all other materials and fabrication methods shall comply with the manufacturer's specification.

12.19 ROOF-DRAINS

12.19.1 Provide roof-drains at locations indicated on drawings. They shall be of stock type of manufacturer: similar to "RATC-K-80" and "RATC-K-125" as manufactured by Daiichikizai Co., Ltd., or equal.

12.20 ROOF-FENCES

12.20.1 Provide roof fence where indicated on drawings. They shall be fabricated of steel pipes and plain bars by welding. Handrail, main support, sub-support and bottom rail shall be steel pipe and baluster shall be plain bar. They shall be hot-dipped galvanized. Concrete base shall be provided at 6 m intervals with sub-support. In addition, provide two small concrete bases at 60 cm apart from the center of span. Main supports shall be anchored to base plate enclosed these bases by welding. Sizes, finishes of each materials shall be as indicated on drawings.

12.21 CAST IRON MANHOLE COVER

12.21.1 Provide cast iron manhole cover for fresh water reservoir and hand hall as indicated on drawings.

Cast iron manhole cover shall be of stock type of manufacturer.

They shall be watertight type similar to "MWPS 600" as manufactured Daiichikizai Co., Ltd., or equal.

12.22 LADDERS

12.22.1 Vertical ladders not shown otherwise shall be 44 cm wide, fabricated of 75mm x 75mm x 9mm steel angle rails and 19 mm round steel rungs extending through the rails with connections welded. Space rungs 35 cm on centers. Anchor ladders at bottoms and tops and at beam, with brackets as indicated on drawings. Brackets shall be of 50mm x 6mm steel rails and of such length as to hold ladder 20 cm away from walls. Provide returns at top of ladders where indicated.

12.23 LADDER RUNGS

12.23.1 Rungs shall be of plain bars with minimum tensile strength of 3,900 kg per sq.cm, not less than 22 mm diameter, bent in the shape of a "U" to form steps not less than 40 cm wide, extending 18 cm from faces of walls and spaced 35 cm apart. Ends of rungs shall be hooked to provide anchorage of at least 15 cm in walls. Rungs shall be hot-dipped galvanized after fabrication.

12.24 EXPANDED METAL LATH

12.24.1 Expanded metal lath for use in reinforcing the roof gutter shall be ordinary non-rib type-2 conforming to JIS A5505, or equal.

12.25 U-SHAPE HANGER

12.25.1 Provide U-shape hanger at location indicated on drawings. Hanger shall be of plain bar not less than 22 mm diameter, bent in the shape of a "U" with a radius of 80 mm. Ends of hanger shall be hooked to provide anchorage of at least 55 cm in a beam. Hanger shall be hot-dipped galvanized after fabrication. Allowable bearing capacity shall be at least 2 ton.

12.26 CURTAIN BOX

12.26.1 Curtain box shall be of 1.6 mm thick galvanized steel sheet folded

into the shape shown on drawings, and shall be applied synthetic resin oil paint. Box shall be reinforced with 3.2 mm thick 25 mm wide steel bands provided at intervals of 120 cm.

12.26.2 In room where false ceiling is installed, the edge of curtain box shall be outwardly folded to receive ceiling units. Provide two curtain rails in parallel on bottom of box by screws to hang curtains doubly.

12.26.3 Curtain box shall be fastened to wall by L-shape steel brackets spaced at intervals of 60 cm.

SECTION 13

PAINTING

13.1 SCOPE OF WORK

13.1.1 Extent: The work required under this section consists of all painting and finishing work and related items necessary to complete the work indicated on drawings and described in the specifications.

13.2 SAMPLES AND COLOURS

13.2.1 The Contractor shall submit a set of colour cards showing all colour range of paints and shall make, under the direction of the Engineer, a schedule showing where the various colours shall be used. The Contractor shall then prepare 15cm x 30cm samples in duplicate of each colour and finish on hardboard and/or metal plate as required until the colours and textures are satisfactory. These samples must be approved by the Engineer prior to delivery of paints to the site.

13.2.2 The Contractor shall submit for approval a list of all materials proposed for use.

13.3 MATERIALS

13.3.1 All painting materials shall be as tabulated below:

Table of Materials

Materials	Applicable Standards	Products
Synthetic Resin Oil Paint	JIS K5516-1	Shinto SP Paint or equal
Synthetic Resin Emulsion Paint	JIS K5663-1	Shinto Envy Super #60 or equal
Vinyl Chloride Resin Enamel	JIS K5582-1	Shinto Envy #3000 or equal
Etching Primer	JIS K5633-1	Shinto Wash #20 or equal

Materials	Applicable Standards	Products
Putty, Emulsion	None	Shinto Emulsion Putty #300 or equal
Putty, Vinyl Resin	None	Shinto Envy #210 Hard Putty or equal
Sealar, Vinyl Resin	None	Shinto Envy #700 Sealar or equal
Sealer, Emulsion	JIS K5663-1	Shinto Latex Primer #1000 or equal
Varnish, Vinyl Resin	JIS K5581	Shinto Envy Clear #1000 or equal
Emulsion Clear	None	Shinto Envy Clear #60 or equal
Lead Suboxide Anticorrosive Paint	JIS K5623-1	Shinto Asanka Derust or equal
Lead Cyanamide Anticorrosive Paint	JIS K5625-1	Shinto Cyanamide Derust or equal
Epoxide Resin Enamel (2-part type)	None	Shinto Neogoze #2300 or equal
Epoxide Resin Primer	None	Shinto Neogoze #2300 Primer or equal

Note: "Shinto" means Shinto Paint Co., Ltd.

13.4 GENERAL REQUIREMENTS

13.4.1 Before starting any work, inspect all surfaces to be painted or finished.

(a) All spaces shall be broom clean before painting is started.

(b) All surfaces shall be dry.

(c) All surfaces shall be free of foreign matter before applying paint on finish.

13.4.2 No work shall be done under conditions which are unsuitable for the production of good results.

(a) Do not apply varnish or paint when temperature is below 10°C.

(b) Do not apply exterior paint in damp, rainy weather. Weather must be "drying".

(c) Do not apply paint on surfaces in direct sun so as to prevent proper application and drying.

(d) Do not apply finishes in spaces where dust is being generated which would speck the finish.

13.4.3 Remove and protect hardware, accessories, device plates, lighting fixtures, factory finished work, and similar items; or provide ample in-place protection. Upon completion of each space, carefully replace all removed items. Use only skilled mechanics for removal, replacement and protection.

13.4.4 Remove doors to paint tops and bottoms.

13.5 PREPARATION OF SURFACES

13.5.1 General:

(a) Surfaces shall be clean, dry, and adequately protected from dampness.

(b) Surfaces shall be smooth, even, and true to plane.

(c) Surfaces shall be free of any material which will adversely affect adhesion or appearance of applied coating.

13.5.2 Plywood:

(a) Sandpaper to smooth and even surface, then vacuum off.

(b) Apply shellac, to all knots, pitch, and resinous sapwood.

(c) Putty all nail holes, cracks, open joints.

13.5.3 Plaster:

(a) Rake cracks, scratches, and abrasions deeply. Soak with water. Fill with patching plaster or emalsion putty.

13.5.4 Concrete and Masonry:

(a) Fill all minor holes to produce uniform texture over surface.

13.5.5 Ferrous Surfaces:

(a) Remove dirt and grease with mineral spirits.

(b) Remove rust, mill scale, and defective paint down to sound surface or bare metal, using scraper, sandpaper, or wire brush as necessary. Grind if necessary to remove shoulders

at edge of sound paint.

(c) Touch up all spots and damaged shop coats with specified rust inhibitive primer.

13.6 COLOURS

13.6.1 Colours shall match control samples submitted by the Contractor for approval.

13.7 SCHEDULE OF PAINTING

(a) Synthetic Resin Oil Paint (Ferrous Metal) ..... SOP

Pretreatment	Etching Primer	0.08 kg/sq.m
Under Coat	Lead Suboxide Anticorrosive Paint	0.11 kg/sq.m
(2 coats)	or Lead Cyanamide Anticorrosive Paint	0.11 kg/sq.m
Middle Coat	Synthetic Resin Oil Paint	0.08 kg/sq.m
Top Coat	Ditto	Ditto

(b) Synthetic Resin Oil Paint (Plywood) ..... SOP

Under Coat		0.09 kg/sq.m
Putty	Emulsion Putty	
Middle Coat	Synthetic Resin Oil Paint	0.08 kg/sq.m
Top Coat	Ditto	Ditto

(c) Synthetic Resin Emulsion Paint-1st Class (Asbestos Cement Boards, F.F. Concrete) ..... AEP

Sealer		
Putty		
Under Coat	Synthetic Resin Emulsion Paint	0.10 kg/sq.m
Middle Coat	Ditto	Ditto
Top Coat	Ditto	Ditto

(d) Synthetic Resin Emulsion Paint-2nd Class ..... EP

Painting sequence shall be same as on "(3) AEP".

(e) Vinyl Chloride Resin Enamel ..... VE

Sealer		
Under Coat	Vinyl Chloride Resin Enamel	0.12 kg/sq.m
Putty	Vinyl Putty	

Middle Coat	Vinyl Chloride Resin Enamel	0.12 kg/sq.m
Top Coat	Ditto	Ditto

(f) Epoxide Resin Enamel

Under Coat	Epoxide Resin Primer	0.12 kg/sq.m
Middle coat	Epoxide Resin Enamel	0.25 kg/sq.m
Top Coat	Ditto	Ditto

13.8 APPLICATION

13.8.1 General:

(a) Brush paint all work except as specifically scheduled or except as approved by the Engineer.

(b) Each coat shall be brushed on well and worked out evenly to leave no brush marks.

(c) Each coat shall be flowed on smoothly and free from sags and runs.

(d) Rate of application shall not exceed average rate of coverage recommended by paint manufacturer for the type of surface.

(1) Minimum dry film thickness per coat shall not be less than thickness recommended by the paint manufacturer.

(2) Surface shall be free of skips in any coat, voids, pinholes, etc.

(e) Packaged paint may be thinned immediately prior to application in accordance with the manufacturer's directions.

(f) The Contractor shall apply additional coats of paint or finish as required to completely cover surfaces which are painted or finished to provide uniform colour and appearance.

(g) A whole wall shall be refinished rather than spot finishing where a portion of the finish has been damaged or is unsatisfactory.

(h) Minimum drying time shall comply with that recommended by paint manufacturer. Each coat shall be thoroughly dry before application of succeeding coats.

(i) Sand between coats with proper abrasive papers conforming to JIS R6252.

(j) Make edges of paint adjoining other materials or colours

sharp and clean, and without overlapping.

(k) Apply primer on all work before glazing.

13.9 PAINTED SIGNS

Provide painted signs on doors to the rooms and spaces as designated. Locate signs at height and location directed. The type and design of letters shall be selected by the Engineer.

13.10 PROTECTION

13.10.1 Protect other work against damage, injury, or soiling from materials, tools, or utensils used.

13.10.2 Furniture and other movable objects, equipment, fittings, and accessories shall be moved, protected, and replaced upon completion of a space or provided adequate covers in-place.

13.11 CLEANING UP

13.11.1 The Contractor shall, upon completion, remove all paint where it has been spilled, splashed, or spattered on surfaces, including fixtures, glass, furniture, fittings, hardware, etc. It shall be removed without marring the surface finish of the item being cleaned.

SECTION 14

FALSE CEILING

14.1 SCOPE OF WORK

14.1.1 Extent: The work required under this section consists of all false ceilings and related items necessary to complete the work indicated on drawings and described in specifications.

14.1.2 Work not Included: The following items of work are included in other sections of this specification:

(a) Electrical lighting.

(b) Air diffusers.

(c) Plastered ceilings.

14.2 SHOP DRAWINGS

14.2.1 Submit three (3) copies of shop drawings to the Engineer for approval. Obtain approval of drawings prior to proceeding with fabrication.

14.2.2 Shop drawings shall indicate type of material, layout and pattern of ceiling units, details of suspension system, details at change of level, details at ceiling penetrations, access doors, special edge treatment, and all necessary connections to other work.

14.3 SAMPLES

14.3.1 Prior to fabrication or delivery submit samples in duplicate of the following materials to the Engineer for approval.

(a) Mineral acoustical tile.

(b) Asbestos cement board.

(c) Gypsum plaster board.

(d) Wall moulding.

(e) Typical sections of suspension system.

14.4 MATERIALS

14.4.1 General Notes:

(a) Ceiling units shall be delivered to project site in manufacturer's original packages with seals unbroken, and with

manufacturer's name and contents legibly marked thereon.

(b) Texture of finished material shall match approved samples.

14.4.2 Ceiling Suspension System:

(a) All materials for ceiling suspension system shall be strictly in accordance with manufacturer's recommendation.

(b) Hanger Inserts: "Insert IC-9" as manufactured by Okumura Jubei Shoten Co., Ltd., hot-dipped galvanized or equivalent.

(c) System shall be "N-OM Ceiling" as manufactured by Okumura Jubei Shoten Co., Ltd., or equal.

(d) System consists of hanger bolts, adjustable hangers, main runner channels, cross furrings and other accessories required and designed.

14.4.3 Mineral Acoustical Tile: Similar to "Solartone" as manufactured by Nitto Boseki Co., Ltd., or equal.

(a) Thickness shall be 12 mm.

(b) Tiles shall be 300mm x 600mm.

(c) Edges shall be fabricated uniformly and true to fit suspension system. All finished edges and corners shall be unbroken and unmarred.

(d) Tile surfaces shall be fissured with white, washable factory applied finish.

14.4.4 Asbestos Cement Board (Flexible Type): Similar to "Flexible Sheet" as manufactured by Nozawa Co., Ltd., or equal.

(a) Thickness shall be 4 mm.

(b) Units shall be 90cm x 180cm.

14.4.5 Plaster Board: Similar to "Tiger Board" as manufactured by Yoshino Sekko Co., Ltd., or equal.

14.4.6 Wall Moulding: Wall mouldings shall be of 1.2 mm thick extruded aluminum sheets, similar to "Alumi Panel N-2" as manufactured by Okumura Jubei Shoten Co., Ltd., or equal.

14.4.7 Ceiling Access Panel: Similar to "Hi-Hatch" as manufactured by Naka Industry Co., Ltd., or equal.

(a) Panel shall be 450mm x 450mm or 600mm x 600mm.

14.5 INSTALLATION

14.5.1 General Notes:

(a) Space to receive ceiling units shall be satisfactorily closed and protected against the weather before beginning work.

(b) Maintain temperature of 10°C or above while system is being installed.

(c) Space to receive ceiling units shall be dry, and with no more dampening materials to be installed.

(d) Application of ceiling units shall be done by the manufacturer or his authorized applicator, and in strict accordance with the manufacturer's specifications except as modified herein.

(e) Install ceiling units in a true and even plane, in straight line courses laid out symmetrically about center lines of ceiling or panel.

(f) Reinforcement shall be provided around openings of electrical lighting, air diffusers and access panels as indicated and shown on drawings.

(g) Reinforcing bracing for hanger volts shall be provided where the height of space in ceiling is more than 1.5 m.

(h) Anti-corrosive paint shall be provided at welding points.

(i) Access panels shall be furnished and installed as shown on drawings in strict accordance with manufacturer's specifications.

14.5.2 Suspension System (Concealed):

(a) Install hanger bolts securely to the structure at 90 cm on centers in both ways.

(b) Install metal runner channel with adjustable hanger, to a leveling tolerance of 3 mm in 1 m each way.

(c) Install wall mouldings as recommended by manufacturer, to a true level.

(d) Space main runner channels at interval indicated on drawings.

(e) Space cross furrings at interval indicated on drawings.

14.5.3 Asbestos Cement Boards and Gypsum Plaster Boards:

(a) Attach directly to cross furrings by nailing at interval of 9 cm.

14.5.4 Mineral Acoustical Tiles:

(a) Attach with adhesive on gypsum plaster back boards which are nailed to cross furrings.

14.6 CLEANING

14.6.1 Following installation, clean soiled or discoloured surfaces of units.

14.6.2 Remove and replace units which are damaged or improperly installed.

SECTION 15

INTERIOR FURNISHING AND MISCELLANEOUS WORK

15.1 SCOPE OF WORK

15.1.1 Extent: The work required under this section consists of all interior furnishings, miscellaneous works not included in other sections and related items necessary to complete the work indicated on drawings and described in specifications.

15.2 SHOP DRAWINGS

15.2.1 Submit three (3) copies of shop drawings to the Engineer for approval of all items included in this section. Obtain approval of drawings prior to proceeding with fabrication.

15.3 SAMPLES

15.3.1 Submit samples in duplicate of the following materials or assemblies to the Engineer for approval. Approval must be obtained prior to delivery or fabrication.

(a) Carpets.
(b) Carpet underlay.
(c) Curtains and curtain rails.
(d) Room name plates.
(e) Hardware and accessories for toilet compartment.
(f) Downspouts and hangers.
(g) Vinyl cloth.

15.4 CARPETS

15.4.1 Unless otherwise specified, carpets shall be machine-crafted first class wool carpets made in Pakistan. The quality and colour of materials shall be determined by samples to be submitted. Carpets shall be manufactured in any shape to fit the contours of the places.

15.4.2 Carpet Underlay: Carpet underlay shall be of 10 mm thick, preservature treated wool felt.

15.5 CURTAINS

15.5.1 The quality, colour and accessories of the curtain materials shall be determined by samples to be submitted.

15.5.2 Hang windows with curtains doubly, one is an ordinary cloth curtain and the other is a lace one.

15.5.3 Blackout curtain shall be installed where indicated on drawings.

15.6 ROOM NAME PLATES

15.6.1 Provide and install room name plates as indicated on drawings and directed by the Engineer. The plates shall be of plastic plate of 10cm x 30cm x 3mm. Room names shall be painted on by enamel in English under the direction of the Engineer.

15.7 NOTICE BOARD

15.7.1 Provide and install notice board as indicated on drawings. Frames shall be of wood timbers finished with stainless steel sheet. Face board shall be 3 mm thick plywood with double cloth hanging on surface.

15.7.2 Install notice board with board hangers and wall clips.

15.8 LAVATORY COMPARTMENTS

15.8.1 Doors and panels shall be plywood flush type and consist of wood frames, plywood surfaces and honeycomb cores. Thickness shall be 40 mm. Doors and panels shall be pre-pierced for application of fittings and hardware.

15.8.2 Hardware such as hinges, slide latches, bumpers shall be fastened properly for each booth. Provide other accessories as indicated on drawings.

15.9 KITCHENETTE UNITS

15.9.1 Provide sink units, wall cabinet units and suspended racks where indicated on drawings. They shall be as follows:

(a) Sink: "B-55S-1700".

(b) Wall Cabinet: "B-55A-1200".

(c) Suspended Rack: "SR-B-1200"

(d) Sink (Tea room): "B-55S-1700"

(e) Wall Cabinet (Tea room): "65A-1500" "65A-1200"

(f) Kitchen Table: "B-55K-1050"

as manufactured by Sun Wave Industry Co., Ltd.

15.10 SERVICE COUNTER

15.10.1 Service counter shall consist of concrete body, marble counter top and preparation board. Counter top shall be 50 mm thick marble plate finished and placed level.
Use marble also for facing outside surface of counter. Preparation board shall be 40 mm thick plywood with hard wood edge and secured to inside surface of counter with supporting steel brackets provided at intervals of 60 cm.

15.11 PLASTIC ROOF DOME

15.11.1 Provide and install plastic roof domes as shown on drawings. Roof dome shall be stock type square dome with aluminum curb having ventilating louvers, similar to "Acrydome square #130 with ventilator" as manufactured by Mitsubishi Rayon Co., Ltd., or equal. Installation shall be in accordance with manufacturer's specification.

15.12 LOUVERED CEILING UNIT

15.12.1 Louvered ceiling unit shall be aluminum lattice louver having square cells of 45° interrupt angle, similar to "Aluminums Louver-S type" as manufactured by ABC Co., Ltd., or equal. Provide louvered ceiling units at locations indicated on drawings.

15.13 ANECHOIC ROOM

15.13.1 The foundation of anechoic room shall be isolated from rest of

the structure for prevention from shocks or vibrations.

15.13.2 Interior of anechoic room shall be lined with double layer flat type sound absorbing glass wool mats, similar to "Superfine" as manufactured by Nippon Mukiseni Co., Ltd., or equal. Glass wool mats shall be 20 cm thick in double layer and install on walls, ceiling and floor with 25 cm mesh stainless steel wire nets and wire nets shall be secured to wall with turn backles.

15.13.3 2.5 cm diameter steel rods with vertical supporting rods shall be placed on floor at intervals of 100 cm to support steel mesh footboards.

15.13.4 Install insert bolts in a staggered manner with a spacing 75 cm horizontally and vertically so as to fix testing materials.

15.14 DOWNSPOUTS

15.14.1 Downspouts shall be polyvinyl chloride pipes of sufficient pouring capacity, and installed at locations indicated on drawings with hot dipped galvanized iron downspout hangers provided at both ends and intermediate points not over 120 cm apart.

15.14.2 Joint pipes with joint sleeves overlapping not less than 30 mm.

15.15 ROOF INSULATION

15.15.1 Provide insulating polystylene foamboards for roof insulation as shown on drawings.
Boards shall be 2.5 cm thick, similar to "Styrofoam" manufactured by Asahi Dow Co., Ltd., or equal. Use the width and the maximum length recommended by the manufacturer.
Installation method, adheisve and other materials shall comply with the manufacturer's specification. After installation, protection concrete shall be placed over insulation foamboard, and then waterproof cement shall be applied.

15.15.2 Burnt clay brick tiles shall be layed for roof covering, making empty layer between brick layer and roof floor.

15.16 CABLE PIT COVER AND FRAME

15.16.1 Lauan plate cable pit covers and frames shall be provided in floor of cable room. Cable pit cover shall be in sections 1 m long, 32 cm wide and 3 cm thick. Frame shall be of same material timbers, 10 cm x 5 cm in section size. Each section of cover shall be screwed to the frame at six points. They shall be aligned and levelled to finish flush with adjacent floor.

15.17 VINYL CLOTH HANGING

15.17.1 Provide vinyl cloth hanging where indicated on drawings. Vinyl cloth shall be similar to "Unilon" as manufactured by Shinko Cloth Co., Ltd., or equal and applied carefully with adhesive. No slackenings, no creases and no contrarieties in pattern shall be permitted.

15.18 FACE COVER FOR RECESSED LIGHTING FIXTURE

15.18.1 Provide face cover for recessed type wall lighting. Face cover shall be polymethyl methacrylate panel not less than 3 mm thick, milk white colour. Face cover shall be fixed to steel frame with screws.

15.19 TRENCH COVERS AND FRAMES IN COMPUTER ROOM

15.19.1 Provide covers and frames for trenches in floors of the computer room. Cover shall be wood plate painted with synthetic resin oil paint. Frames shall be of 2.3 mm thick steel sheet folded into the shape shown on drawings. 20 mm wide brass strips shall be attached on the frames for finishing flush with adjoining floors.

15.20 RANGE HOOD

15.20.1 Provide range hood above kitchen table in tea room. Hood shall be be 1.0 mm thick galvanized steel sheet and be covered by plywood with suitable wood frames as shown on drawings. The space above wall cabinet shall be also covered by same materials.

15.21 COMPARTMENT

15.21.1 Provide compartment in STAIRCASE 2 on ground floor as indicated on drawings. It shall be 2.1 m high and 1.2 m wide and be composed of same materials as lavatory compartment.

SECTION 16

EXTERNAL WORK

16.1 SCOPE OF WORK

16.1.1 Extent: The work required under this section consists of all external work and related items necessary to complete the work indicated on drawings and described in specifications.

16.2 SHOP DRAWINGS

16.2.1 Submit three (3) copies of shop drawings for external work to the Engineer for approval. Obtain approval of drawings prior to fabricating any material or proceeding with the work.

16.3 SAMPLES

16.3.1 Submit samples of material as required to the Engineer for approval. Approval must be obtained prior to delivery.

16.4 MEASUREMENT

16.4.1 Prior to proceeding with the work, necessory measurement of building site shall be done. If any discrepancy between present condition and drawings is encountered, the Contractor shall immediately notify the Engineer in writing.

16.5 MATERIALS

16.5.1 Filling Material: Filling for use in making up levels under paved areas shall be suitable surplus material arising from the excavation.

16.5.2 Concrete Materials: All concrete materials such as portland cement, coarce and fine aggregates, water, reinforcing bars shall be as described in "CONCRETE WORK".

16.5.3 Bricks: 1st class burnt clay bricks. See "MASONRY".

16.5.4 Concrete Pipes: Socket type concrete pipes of 350 mm, 300 mm, 250 mm and 200 mm in diameter, conforming to JIS A5302 or JIS A5303 and/or BS No. 556. Concrete pipes will preferably obtained from the local manufacturers.

16.5.5 Materials for Hot Mix Asphalt Concrete:

(a) Bitumen: Bitumen shall be residual asphaltic with a penetration of 60 to 70 at 25°C, conforming to BS 1621.

(b) Mineral filler: See PPWD, Table 28-2 IV.

(c) Fine and coarse aggregate: See PPWD, Table 28-2.

(d) Mixing Composition: Mixing composition of hot mix asphalt concrete shall be as tabulated below:

Mixing Composition (5 cm finished thickness)

Materials	Percentage by weight
Bitumen	6%
Mineral filler	6%
Fine aggregate	28%
Coarse aggregate 10 mm	60%

16.6 ASPHALT CONCRETE PAVING

16.6.1 Subsurface:

(a) The existing ground shall be cut, filled and consolidated to the required formation levels.

(b) Where directed by the Engineer, all pot holes, soft pots or depressions below formation level shall be excavated and filled with crushed stone, well watered and consolidated in 15 cm thick layers.

(c) Where required, approved filling shall be deposited, spread, well watered and consolidated to the required formation level in 15 cm thick layers.

(d) The surface of the ground at formation level in cuttings shall be well watered and consolidated to the satisfaction of the Engineer.

16.6.2 Underlayers:

(a) Underlayers for asphalt concrete paving shall consist of 20 cm thick crushed stone base and 20 cm thick crushed stone sub-base extending to bottoms of gutter.

(b) The grading of crushed stone shall be as tabulated below:

Test Sieve (mm)	For Base	For Sub-base
50.8	-	100
38.1	95-100	95-100
19.1	60-100	50-80
5.0	-	15-40
2.5	20-50	5-25
0.074	2-10	-

(c) The base and the sub-base shall be laid to the cross-fall of 2% and the required gradients.

(d) Each layer shall be well watered to the satisfaction of the Engineer, and rolled with a roller to the proper compaction.

(e) After rolling, apply prime coat over finished surface.

16.6.3 Finishing Asphalt Concrete:

(a) Asphalt concrete shall be laid by means of machanical sprender. Laying of asphalt concrete shall be done at suitable temperature with the Engineer's approval.

(b) Asphalt concrete shall be laid in a coat and compacted to 5 cm thick by rolling with a 8 or 10 ton smooth wheeled roller. Rolling shall be done in a longitudinal direction from edge to center of the area, working up the cross-fall.

(c) Rolling shall be done in successive passes with each rear wheel overlapping the preceding wheel track by one half.

(d) Prior to laying asphalt concrete, surface shall be cleared of all loose and wind-blown sand.

16.7 BRICK PAVING

16.7.1 Subsurface: The existing ground shall be cut, filled and consolidated to the required formation levels.

16.7.2 Underlayers: Underlayers for brick paving shall be consist of 10 cm thick crushed stone sub-base and 10 cm thick concrete base laid on sub-base.

(a) Crushed stone for sub-base of brick paving shall be similar to that of "ASPHALT CONCRETE PAVING". Crushed stone shall be laid and compacted with tamping machine to the required levels.

(b) Concrete base shall be placed over well compacted sub-base to the required levels to receive topping finish.

(c) Brick shall be laid on hardened concrete base with mortar in "Running flat" pattern as indicated on drawings. Paving slabs shall be laid with 1 cm wide joints flush up solid in mortar.

16.8 ROAD GUTTER

16.8.1 Gutter shall be provided after placing sub-base of road paving and before placing base and top finish.

16.8.2 Gutter along both edges of road shall consist of cast-in-place concrete placed on crushed stone sub-base of road paving and burnt clay brick curbs laid with mortar along one edge of concrete with long edges upright.
Top surface of concrete shall be finished with metal float flush with adjoining road surface and have 10% fall.

16.8.3 Provide expansion joints at intervals of not more than 20 m and between gutter and catch basin.

16.9 MANHOLE AND CATCH BASIN

16.9.1 Manholes and catch basins shall be constructed in the positions and to the dimensions shown on drawings.

16.9.2 Manholes and catch basins shall be constructed of cast-in-place concrete. Thickness of walls, cover slabs and bottom slabs shall be 20 cm. Inside dimension of manhole shall be 90cm x 90m, and that of catch basin shall be 70cm x 70cm. Cover slab shall be reinforced with 9 mm diameter reinforcing bars at 15 cm intervals both ways.

16.9.3 Cast iron grating cover and frame shall be provided for each manhole and catch basin. Bent steel plate frames or steel angle frames shall be galvanized and firmly fixed to concrete with proper anchors.

(a) Cover for Manhole: Similar to "T-6 GR 50-55 type" as manufactured by Daiichi Kizai Co., Ltd., or equal.

(b) Cover for Catch Basin: Similar to "T-6 GR 50-45 type" as manufactured by Daiichi Kizai Co., Ltd., or equal.

16.9.4 Connection with concrete pipes entering manhole or catch basin shall be sufficiently filled with mortar and trowelled smooth.

16.10 HAND HOLE

16.10.1 Hand hole for electricity shall be constructed at locations and to the dimensions indicated on drawings.

16.10.2 Hand hole shall be of reinforced concrete and inside surface shall be finished with waterproof mortar. Hand hole cover shall be watertight type cast iron cover as specified in "MISCELLANEOUS METAL WORK".

16.10.3 Connection with concrete pipes shall be sufficiently filled with mortar.

16.11 LADDER RUNG

16.11.1 Ladder rungs shall be provided on interior walls of manholes, catch basins and hand holes. Rungs shall be of plain bars not less than 22 cm diameter, bent in the shape of a "U" to form steps not less than 40 cm wide, extending 10 cm from faces of walls and spaced 30 cm apart. Ends of rungs shall be hooked to provide anchorage of at least 15 cm in wall. Rungs shall be hot-dipped galvanized after fabrication.

16.12 PIPES

16.12.1 Each pipe shall be carefully examined on arrival. Any defective pipes shall not be used.

16.12.2 Concrete cradles shall be provided for all concrete pipes so as to support pipes at required positions.

16.12.3 Concrete pipes shall be accurately laid true to line and gradient from point to point as indicated on drawings.

16.12.4 Joint of Pipes: Wet well spigot and socket. Insert the spigot end of the pipe having rubber sealing ring into the socket. The remainder of the socket shall be filled with mortar and fillet formed around the joint from the edge of the socket to the barrel of the pipe at an angle of 45 degrees. No leakage of water shall be permitted.

16.12.5 When concrete pipes are connected with existing manholes, the work shall be done without interfereing with the function of the existing manholes, and damages caused by the work shall be immediately repaired.

16.12.6 Backfilling shall be done carefully without marring pipes.

16.13 CLEANING AND TEST

16.13.1 The Contractor shall on completion of the storm water system remove all silt and foreign matter from the drain runs and manholes and leave the whole in a clean and workable condition.

16.13.2 The storm water system shall be inspected and tested to the satisfaction of the Engineer in an approved manner and shall be retested, if necessary, until passed. Test, unless otherwise specified, shall be by water.

CENTRAL TELECOMMUNICATION RESEARCH LABORATORIES

ISLAMABAD

TECHNICAL SPECIFICATIONS

PART II

FOR

ELECTRICAL INSTALLATION

PLUMBING, GAS INSTALLATION

AIR CONDITIONING

AND

LIFT

NIPPON SŌGŌ ARCHITECTS' AND ENGINEERS' OFFICE CORP., LTD.

(NSK) TOKYO JAPAN

TECHNICAL SPECIFICATIONS

PART II

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ELECTRICAL INSTALLATION

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PLUMBING, GAS INSTALLATION

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PART II-(i)

PARTICULAR CONDITIONS

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PARTICULAR CONDITIONS

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1. GENERAL

The General Conditions and the Particular Conditions of Contract shall form a part of the Contract Document with the same force and effect as though repeated herein, and in case of discrepancy these Particular Conditions will be applied.

2. SCOPE OF WORK

The works shall include design, manufacture, inspecting and testing at manufacturer's premises, insurance, delivery to site, providing all the builder works, erection, installation, testing at site, setting to work, handing over in perfect operating and running conditions, as well as guaranteed maintenance of the whole works for a period of one year after Acceptance and Taking Over.

3. DEFINITION OF TERMS

The "Government" or "Purchaser" means The Telegraph and Telephone Department, Ministry of Communications, The Islamic Republic of Pakistan as represented by Director-General Telegraph and Telephone Department or representative thereof.

"Plant" shall mean and include all machinery, apparatus, materials, equipment, articles and things of all kinds to be provided under the Contract.

"The Works" shall mean and include all plants to be provided and all works to be done by the Contractor under the Contract. It shall also mean the site where the context so indicates.

"Contractor's equipment" shall mean tools, tackle and stores, etc., brought upon the site by the Contractor for incorporation in the Works.

"Inspector" shall mean any approved examining Authority appointed by the Engineer.

4. CLIMATIC CONDITION & DERATION

(a) The equipment is required to work in the following climatic condition without deterioration in its performance:

Ambient temperature of	3°C to 47.3°C
Relevant humidity of	20% to 95%
If exposed to direct sunlight	87.9°C as measured by black bulb thermometer.

(b) 20 percent shall be the minimum derating factor for all electrical equipment at 47.3°C.

5. DRAWINGS & SPECIFICATIONS

(a) The drawings and specifications and other Contract Documents are complementary and any material, equipment or work called for by either shall be furnished or performed as if called for by all. Should any conflict occur between the drawings and specifications or within either the Engineer shall interpret them and determine the manner or item with which work shall be installed.

(b) The contract drawings shall indicate the extent and general arrangement of the specified systems. If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted as soon as practicable to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer.

(c) Contractor shall take into consideration that the drawings are meant to show the general picture and layout with not much detail and shall not reflect the final execution of the works. The Contractor shall furnish all drawings required and all parts and material necessary to make the installation complete and ready to operate without any additional cost in price whether such items are specified or not.

(d) The Works covered by these specifications, in general, shall be sized, located and performed as indicated on the drawings and in the specifications. They shall be installed and adjusted in accordance with the manufacturer's instruction and these specifications to insure they fulfill the design conditions. However, the tenderer shall be responsible to check and make sure that the design, drawings and schedules of all equipment satisfy the design

requirements. The design, drawings and schedules included in this document shall not relieve the Contractor of his obligation towards proper selection and functioning of all specified equipment. If, after the systems are in operation, any equipment and any work should appear inconvenient, abnormal, or give unsatisfactory operation after adjustment, the Contractor shall replace them with a type selected by the Engineer and shall make any other changes that may be necessary without any additional charges to the Purchaser.

(e) Modification and alteration of the drawings and/or the specifications of any item of Works, materials, etc., necessary for or to the proper completion or operation of the Works outlined in these specifications shall not relieve the Contractor from furnishing same without any further cost to the Engineer or the Purchaser.

(f) Contractor shall also refer to all drawings of other sections for details, concerning to the Works and to the approved shop drawings of equipment furnished under other sections of the Works for exact locations of service, utility, etc., connections. The Contractor shall not install any roughing-in, piping or ductwork for said equipment until he has received approved copies of shop drawings from the Engineer for same.

(g) The Contractor shall install the Works as closely as possible to the layout shown but the layout shall be checked and exact locations shall be determined by the dimensions of the equipment approved. Contractors shall obtain the Engineer's approval for the revised layouts before apparatus is installed. Consult the architectural and structural drawings for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc. The Contractor shall make without additional costs any changes in routing of piping, ducting, grilles, diffusers, conduits, cables, switches, fittings, valves, equipment, etc., to meet the job conditions as required and/or as the Engineer may direct.

6. INFORMATION REQUIRED WHEN OFFERING

When offering, the tenderer shall submit the following information of the Works and Associated Services to enable the Purchaser to evaluate each offer. All of the information listed shall be submitted in one lot, and part submissions and/or delaying submission shall not be considered. The submission shall be required in three sets suitably bound and duly signed.

(a) Schedules of detailed technical data of equipment and material as attached in the specifications. The information shall be clearly typed and handwriting shall not be accepted.

(b) Sample calculations showing in details the basis for selection of each mechanical and electrical equipment. For electrical motors include basis for selection of size and rating of motors.

(c) Manufacturer's engineering catalogues for the offered equipment showing the complete details of the selected equipment and its performance.

(d) Any samples, or any other information that will help in evaluating the offer.

7. BUILDER'S WORKS

All builder's work necessary and required for the works shall be provided by the Contractor whether such works are mentioned or shown on drawings or not, and the Contractor shall be deemed to allow in his tender price for all such works. All builder's work shall be made to match the design of the buildings.

8. CUTTING, DRILLING, PATCHING & SLEEVES

Cutting or drilling of the work of other sections finished or otherwise must be avoided wherever possible, however, if due to ill timed work or errors in laying out of a contractor's work, cutting or drilling can in no way be avoided, the Contractor shall do such cutting or drilling necessary for the proper installation and entry of his work and the cutting and drilling must be held to a bare minimum. No cutting or drilling of any building structural members will be permitted

without the approval of the Engineer. Contractor shall do his own patching of all area where cutting is done by him.
Unless otherwise specified, Contractor shall furnished and install sleeves for all pipes or ductwork he installs which pass through foundations, walls, partitions, floors, ceilings or roofs. Reinforcing and framing for openings for ducts, grilles, registers, etc., in walls, partitions, floors, roofs, etc., will be provided as specified in other sections of the work. Contractor shall submit the detail drawings of such openings to the Engineer and shall be responsible for locating and providing the proper dimensions for all required openings.

9. WORKING DRAWINGS & INSTRUCTIONS

The Contractor shall submit to the Engineer for approval, as early as possible, after the Contract is signed, all the working drawings, patterns, models, samples, required for the erection of the various plants and equipment and all of the Works. All the working drawings required shall be submitted in one lot, part submissions will not be considered.
Copies of working drawings for which approval is required shall be submitted in four sets. Three sets of the approved copies shall be retained by the Engineer, and one shall be returned to the Contractor.

Drawings Required:

(a) General arrangement and layout drawings of all installation including mechanical and electrical items:
Scale 1/100

(b) Detailed constructional working drawings of all plants and plant rooms:
Scale 1/20 include all plants components and connections, details of pipework, ductwork and all other accessories wherever applicable.

Instructions:

Within three months after the completion of the installation the Contractor shall:

(a) Prepare complete operating and maintenance instructions covering

all items of plant and equipment. Maintenance and operating instructions are to be the manufacturer's standard instructions amplified where necessary. When these instructions have been approved in detail by the Engineer, the Contractor shall submit six copies suitably bound.

(b) Prepare and supply the Engineer with six sets of all the working drawings as installed, and with schedules of all plant and equipment.
The above sets of drawings and schedules shall be specially prepared for record purposes and shall be stamped "record drawing".

(c) Prepare and supply the Engineer with six sets of manufacturer's detail drawings and catalogues of all fans, pumps, self-contained air conditioners, switchgears, electrical diagrams, etc., suitably bound. These need not be prepared specially as record drawings, but may be copies of the manufacturer's working drawings with suitable title and reference number added.

10. PROTECTION

The Contractor shall protect all pipework, valves, fittings, ductwork, plant and equipment where any part or parts of the installation are liable to damage from other trades or any cause whatsoever.

11. SPARE PARTS

When offering, the Contractor shall submit the schedule of spare parts recommended by him to be supplied. The spare parts shall be sufficient for one (1) year operation.
Any spare parts ordered must be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant. They shall comply with the specification and tests and must be suitably marked and numbered for identification and prepared for storage by greasing or painting to prevent deterioration during delivery and storage by the Purchaser.

12. INSPECTION & TESTING DURING MANUFACTURE

The Engineer or Inspector appointed by him shall be entitled at all

reasonable times during manufacture to inspect, examine, and test on the Contractor's premises the materials and workmanship of all plant to be supplied, and if part of the said plant is being manufactured on other premises the Contractor shall obtain for the Engineer or inspector permission to inspect, examine, and test as if the said plant were being manufactured on the Contractor's premises. Such inspection, examination, or testing, if made, shall not release the Contractor from any obligation under the Contract.

Where the Contract provides for tests on the premises of the Contractor, the Contractor shall provide such assistance, labour, materials, electricity, water, fuel, stores, apparatus, and instruments as may be requisite and as may be reasonably demanded to carry out such tests efficiently. As and when any Plant shall have passed the tests referred to in this Clause the Contractor shall submit to the Engineer in the writing performance test data.

13. DETAILS OF TESTS & ADJUSTMENTS ON COMPLETION

The Contractor shall notify the Engineer in accordance with Clause when he wants to proceed with tests on completion. All equipment, instruments, facilities, labour, etc., required to properly conduct the tests and adjustments shall be furnished by the Contractor at no additional cost to the Purchaser. All test must be made to the satisfaction of the Engineer, and approved by him.

The following tests shall take place:

(a) Initial Trial Tests: After the completion of the works, the Contractor shall, and as directed by the Engineer, demonstrate to the Engineer that the installation is adjusted and regulated correctly to fulfill the function for which it has been designed. Contractor shall test, adjust, balance and regulate the section concerned as necessary until the required conditions are obtained.

(b) Reliability Tests: After finishing the initial trial tests to the satisfaction of the Engineer, the Contractor will be responsible for running Reliability Tests for all plants and equipment.

The reliability Tests shall be made under the full responsibility

of the Contractor, and he shall provide full time skilled operators for running the plants during one (1) week the test period. The whole reliability Tests of the cooling and heating plants shall take place during the period between 1st of May and 30th of July and for the heating plants during the period between 1st December and 15th February.

(c) Any other test required in the specifications.

TECHNICAL SPECIFICATIONS

PART II

FOR

ELECTRICAL INSTALLATION

PLUMBING, GAS INSTALLATION

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PART II-(ii)

ELECTRICAL INSTALLATION

NIPPON SŌGŌ ARCHITECTS' AND ENGINEERS' OFFICE CORP., LTD.

(NSK) TOKYO JAPAN

TECHNICAL SPECIFICATION FOR ELECTRICAL INSTALLATION

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1. GENERAL

1.1 General Description: The Contractor responsibilities shall include the supply, delivery to site, erection and commissioning of all materials and equipment required in accordance with this Specification.

1.2 Extent of Work: The electrical installation shall comprise complete installation and the supply, erection and connection of:

(a) Sub-station equipment.
(b) Feeder installation.
(c) Lighting and socket outlet installation.
(d) Fire alarm system.
(e) Telephone conduit system.
(f) Earthing.
(g) Lightning protection system.

1.3 Material: All materials used shall comply in every respect with this Specification and the relevant British Standard Specifications including dimensional standards where such exist. Material shall be to the entire satisfaction of the Engineer.
Other international standard specifications, such as Japanese Industrial Standard, IEC Specifications, etc., are acceptable, if they comply with the following conditions:

(a) Material used is equivalent in Technical Characteristics and quality to those in BSS.
(b) Material used shall pass all tests prescribed in BSS.

1.4 Regulation: The work shall be carried out to the satisfaction of, and in strict accordance with the "REGULATIONS FOR THE ELECTRICAL EQUIPMENT OF BUILDINGS" issued by 'INSTITUTION OF ELECTRICAL ENGINEERS 1974'.

1.5 Spare Parts, Tools and Instructions: The Contractor shall furnish the spare parts sufficient one year service and the tools necessary for maintenance of the electrical installation.
The spare parts shall be comprised of fluorescent lamp, incandescent lamp, motor drive type molded case circuit breaker and normal molded case circuit breaker, etc.

Upon completion of the work, and at a time designate by the Engineer, the Contractor shall provide the services of a competent engineer at the site for the necessary period to instruct authorized representative of the Government in the operation and maintenance of the system and equipment.

2. SUB-STATION EQUIPMENT

2.1 General: The equipment to be supplied under this contract has to be designed for use in the climate and conditions of Islamabad. 11 KV switchgear, WAPDA metering out fit, medium voltage switchgear, power transformer, automatic voltage regulator, transformer for experimental use, static condenser for power factor correction, bus-duct, cables, circuit breakers, etc., specified herein have been adequately derated as follows:

Twenty percent shall be the minimum derating factor for transformer, automatic voltage regulator, static condenser, all busbars, circuit breakers, and cables, etc.

Electrical distribution system of utility electric power and consumer shall be as follows:

(a) Utility electric power shall be supplied through one 3 phase, 3 wire, 50 Hz, 11 KV (nominal) incoming line.
The ratings of the supplied electrical power will be always maintained as follows:
(1) Voltage: 11KV ± 10%
(2) Frequency: 50Hz
(3) Rupturing capacity (Symmetrical): 250 MVA at 11 KV incoming points.

(b) Secondary of the transformer shall be 400/230 volts, 3 phase, 4 wire system solidly earthed, and/or by 400 volts, 3 phase, 3 wire system.

(c) The voltage of control and operational equipment for electrical distribution system shall be D.C. 100 volts.

2.2 Electrical Equipment

2.2.1 11 KV Switchgear

(a) The switchgear shall be of the indoor metalclad type with horizontal draw out vacuum circuit breaker.
The bus bars shall be of hard drawn high conductivity copper rated at 600 amps. continuously and air-insulated.

(b) The materials of switch cubicles shall be 2.3 mm thick in good quality of steel plate, rolled flat and straighten.

(c) The ratings of the equipment mounted in 11 KV switchgears shall be as follows:

(1) The circuit breaker shall be of the vacuum type having a continuous tropical rating mentioned in Article 2.1 and indicated on the drawing.
The vacuum breaker shall have rated voltage 13.8 KV, rated current 600A, guaranteed rapturing capacity not less than 250 MVA symmetrical at 11 KV, rated interrupting time 5 cycle (0.1 second) and solenoid mechanism for closing, spring mechanism for tripping.

(2) The current transformer for functioning to operate A.C. ammeter, wattmeter, etc., shall have rated voltage 11.5 KV, rated secondary current 5A, rated over current strength 150 times for 1 second, and rated burden 40 VA.
The current transformer shall be indoor use, resin molded dry type.

(3) The potential transformer shall have rated primary voltage 11.5 KV, rated secondary voltage 110 V, and rated burden 200 VA.
The potential transformer shall be indoor use, resin molded dry type.

(4) The indicating meters such as ammeter, voltmeter, watt-meter, power factor meter, and frequency meter shall be rectangular, flush mounting, circular scale type.

(5) The protective relay shall be rectangular, flush mounting, drawout pattern case, induction type relay having the inverse time limited characteristics on operation.

(6) The instrument transformer secondary such as current transformer and potential transformer shall be earthed in the switchgear cubicles.

2.2.2 WAPDA Metering Out Fit: The incoming WAPDA 11,000 volt utility electric power will be metered at metering out fit (MOF) installed in the sub-station.
The Contractor shall supply and install a cubicle type metering out fit for reception of WAPDA metering equipment.
Metering potential transformer and current transformer which are installed in the Metering Out Fit will be provided by WAPDA.

2.2.3 Medium Voltage Switchgear:

(a) The switchgear shall be of the indoor metalclad type with motor operated molded case circuit breaker (M.C.C.B.) and/or manual operated M.C.C.B.
The rating of each M.C.C.B. indicated on the drawings.
The bus bars shall be of hard drawn high conductivity copper required capacity continuously and air-insulated.

(b) The materials of switch cubicles shall be 2.3 mm thick in good quality of steel plate, rolled flat and straighten.

(c) The ratings of the equipment mounted in medium voltage switch-gears shall be as follows:

(1) The circuit breaker shall be of the M.C.C.B. The M.C.C.B. shall be 500 volts rated.
They shall be of the non-adjustable type and plug-in or bolt-on type.
The M.C.C.B. shall have shunt trip coil and trip-free operating mechanism of the quick-make, quick-break type.
The M.C.C.B. shall have a thermal or magnetic overload trip designed to operate on a continuous steady current of 150% of normal full load current and instantaneous magnetic trips which operate at currents exceeding 500% of normal full load currents. Dollies of the breakers shall be of the trip free pattern to prevent closing the breaker onto a faulty circuit and shall be engraved ON/OFF.
The circuit breaker shall having a continuous tropical rating mentioned in Article 2.1, and indicated on the drawings.

(2) The indicating meters such as ammeter and voltmeter shall be rectangular, flush mounting circular scale type.

2.2.4 Power Transformer: The service condition of power transformers conforming to this Specification shall be suitable for operation in the derated condition as herein before.
The ambient temperature does not exceed 47.3°C and the average cooling air temperature for any 24-hour period does not exceed 40°C.
Power transformer shall comply fully with the requirements of B.S.S. 171 and be rated as follows:

(a) The transformer shall be oil-immersed, self-cooled nitrogen gas sealed, indoor use.

(b) Rated output, primary and secondary rated voltage, and winding connection of transformer, etc., indicated on the drawings.

(c) The core shall be formed from re-annealed, cold rolled, oriented steel conforming to B.S. 601 Part 2.

(d) The yoke and core legs shall have uniform flux distribution. Transformers shall have oil ways arranged for maximum circulation of the cooling oil through the windings to keep 'hot spot' temperatures within acceptable limits.

(e) Only annealed copper strip and round wires complying with relevant British Standard Specifications for Copper for Electrical Purposes shall be used in the construction.

(f) All phase and tapping leads brought out from the transformer coils shall be suitably insulated and braced to maintain clearances under all conditions.

(g) The transformer tank shall be formed from steel. The cooling tubes shall be of steel with liberal radiating surfaces.

Power transformer shall be complete with the following fittings:

(a) Skids under base.
(b) Oil conservator with integral sight oil gauge and level at 47.3°C.
(c) Thermometer pocket.
(d) Dial temperature gauge.
(e) Locked oil drain valve with flanged connection.
(f) Medium voltage neutral point terminal on insulated bushing.
(g) Tank earthing terminal.
(h) Lift lug.

2.2.5 Automatic Voltage Regulator: The service condition of an automatic voltage regulator shall be as same mentioned in Paragraph 2.2.4.

Automatic voltage regulator shall be rated as follows:

(a) Automatic voltage regulator shall be oil-immersed, self-cooled, indoor use.
(b) The automatic voltage regulator shall be to maintain the steady state of voltage regulation within plus or minus 2 percent of 400 volts under the voltage variation of supply undertaking.

The maximum voltage variation of supply undertaking will be plus 10 percent or minus 10 percent at incoming point.

(c) Manual voltage regulation facilities via a suitably positioned off/manual/auto switch shall be incorporated into the automatic voltage regulator circuit.
(d) Rated out put, primary and secondary rated voltage, and winding connection of automatic voltage regulator, etc., are indicated on the drawings.

Automatic voltage regulator shall be completed with the following fittings:

(a) Skid under base.
(b) Oil conservator with integral sight oil gauge and level at 47.3°C.
(c) Thermometer pocket.
(d) Locked oil drain valve with flanged connection.

(e) Medium voltage neutral point terminal on insulated bushing.

(f) Tank earthing terminal.

(g) Lift lug.

2.2.6 Transformer for Experimental Use: The service condition of the transformer shall be as same mentioned in Paragraph 2.2.4.
The transformer shall be rated as follows:

(a) The transformer shall be dry type, self-cooled, indoor use.

(b) Rated out put, primary and secondary rated voltage, and winding connection of the transformer, etc., indicated on the drawings.

2.2.7 Static Condenser for Power Factor Correction: The service condition of a static condenser shall be as same mentioned in Article 2.2.4.
The static condenser shall be rated as follows:

(a) The static condenser shall be oil-immersed, self-cooled indoor use.

(b) Rated capacity, rated voltage, and ancillaries such as choke coil, etc., are indicated on the drawings.

2.2.8 Direct Current Power Source: The service condition of the direct current power source shall be as same mentioned in Paragraph 2.2.4.
The direct current power source shall be rated as follows:

(a) The direct current power source shall be cubicle type contained lead battery, rectifier and auxiliary equipment.

(b) The lead battery shall be rated 100 volts, 100 ampere-hour, 54 cells and high sealed.

(c) The rectifier shall be suitable for charging the lead battery, above-mentioned, and shall be controlled by a Thyristor element.

(d) The connection and constitution of molded case circuit breaker indicated on the drawings.

2.3 Test & Inspection:

(a) All tests shall be carried out in accordance with the latest applicable British Standard Specifications.

(b) Following tests shall be carried out at the manufacturer's plant:

(1) Routine test: Each equipment shall be subject to the routine tests such as construction and dimension check, insulation resistance test, dielectric strength tests, operation test, etc.

(2) Type test: One equipment of each type and rating shall be subject to the type tests.

Instead of type test, the manufacturer may submit two certified copies of test reports certifying that the tests have been carried out.

(c) The site tests shall be carried out after erection on site in the presence of the Engineer and at the expense of the Contractor. All the equipment and apparatus for site tests shall be furnished and shall be included in the tender price. The site tests shall be as follows:

(1) Insulation resistance and earth continuity.

(2) Overall operation tests.

(3) Any other test found necessary by the Engineer.

3. FEEDER INSTALLATION

3.1 General: All works included in this Specification shall operate at a electrical systems indicated on the schematic drawing.
All works shall be included cables, cable-trays, accessories, conduits, conduit fittings and boxes, central operation panels, control panels for air conditioning, etc., relay panels, and experimental distribution boards, and installation of control wiring for air conditioning and plumbing.

3.2 Cables: All cables shall comply in all respects with the current British Standard Specifications covering Poly Vinyl Chloride Insulated cables, and sheathed PVC Insulated cables, as a minimum. All cables shall have multi-stranded copper conductors. All cables shall be new and shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer covering at regular intervals and shall be delivered in complete coils or reels with identifying size and insulation tags. Cables shall be suitably protected from

weather and damage during storage and handling. Sizes shall be as specified in this specification and/or indicated on the drawings. Conductors shall be annealed copper with insulation and outer covering as noted. No cable with a conductor smaller than 2.5 mm^2 shall be used in any circuit except flexible cord and cable. Cable shall be factory colour-coded, with a separate colour for each phase and neutral used consistently through the system.

PVC Insulated Cables shall be insulated and/or sheathed with Poly Vinyl Chloride in single, twin or multi-core type as specified and shall conform with BS 6004, including latest amendments. The insulation of each line conductor shall be to the standard of the 660 volt grade of the Cable Makers Association. Sizes of cables shall be such that the currents carried by them do not exceed those derated by the appropriate rating factors given in an ambient temperature where installed.

3.3 Cable Tray: The cable trays shall be made in 3.0 meter length, 300 mm, 600 mm, 700 mm width, stove enamel finished steel. The section design imparts great strength and shall be provided with straight sections, necessary fittings such as horizontal bends, horizontal tees, horizontal crosses, reducer plate, vertical bends, splice plate, and rod clamps.

The construction of cable tray shall be rigid enough to prevent distortion of trays during cable installation.

(a) Where cable trays are necessary for changes of direction, horizontal bends, tees and vertical bends, etc., shall be employed.

(b) Cable trays shall be run parallel to or at right angle to the lines of the building horizontally or vertically.

(c) Horizontal cable tray runs, except where cable tray run on the structure of the building, shall be supported by means of approved suspension rods and rod clamps.

Suspension rod shall be either 13 mm in diameter or larger galvanized steel rods, and shall be as approved by the Engineer. The Contractor shall submit for approval all applicable loads and rating data.

All suspension rods of cable tray shall be spaced not more than

1.5 meters aparts, and parts of each cable tray conjunction, tee, elbow and other fitting shall be suspended or secured completely.

3.4 400 Volts Switchgear/Control Panel: The 400 volts switchgear shall comprise one factory built wall mounted type control panel. The constitution of control panel is as indicated on the drawings.

The control panel shall house:

(a) Molded case circuit breakers.

(b) Magnetic contactor and timer for the motor.

(c) Indication lamps for the motor and heater to show whether it is in operation or not.

(d) Moving iron, dial type, square patterns ammeter for each motor as shown on the drawings.

(e) Moving iron, dial type, square patterns voltmeter scaled 0 - 600 volts as shown on the drawings.

The control panel shall be totally enclosed dust and vermin proof. Locks, each with two keys, for each control panel shall be provided in this contract.

The molded case circuit breaker shall be equipped with cable boxes suitable size, as well as the proper cable fixing clamps, terminal lugs and the earth bonding connection.

The control panels except self contained air conditioner shall be equipped with power factor correction condensers.

The capacity of condensers shall be such as to bring the overall power factor of plumbing motor up to 0.85 or better under all normal operating conditions.

3.5 Relay Panel: The relay panel shall comprise one factory built wall mounted type. The constitution of relay panel is as indicated on the drawings.

The relay panel shall house:

(a) Molded case circuit breakers.

(b) Magnetic contactor, auxiliary contactor and timer for motor control.

The relay panel shall be manufactured in the same way specified in the paragraph 3.4 400 Volts Switchgear/Control Panel.

3.6 Central Operation Panel: The central operation panel shall comprise one factory built wall mounted type. The constitution of central operation panel is as indicated on the drawings.

The central operation panel shall house:

(a) Push buttons, "ON", and "OFF" for compressor, heater and fan of every self contained air conditioner and/or ventilator.

(b) Indicating lamps for the compressor, heater and fan to show whether it is in operation or not.

(c) Water level alarm buzzer with lamps indicated water level conditions, i.e. "HIGH" or "LOW" of underground water storage tank and water storage tank.

3.7 Experimental Distribution Board: The experimental distribution boards shall be 3 phase, 4 wire (solid neutral) 400/230 volts, and 3 phase, 4 wire 173/100 volts for experimental use. Constitution of experimental distribution boards is as indicated on the drawings and this board shall be floor mounted type.

The experimental distribution board shall house:

(a) Molded case circuit breaker.

(b) Earth terminal for experimental use.

This board shall be totally enclosed dust and vermin proof. The molded case circuit breaker shall be equipped with cable boxes suitable size, as well as the proper cable fixing clamps, terminal lugs and the earth bonding connection.

3.8 Molded Case Circuit Breaker: The main molded case circuit breaker installed on the feeder of the medium voltage switchgear shall be operated by motor drive.

The connection and constitution of molded case circuit breaker is shown on the drawing and power source of motor drive shall be used direct current 100 volts from direct current power source.

The other molded case circuit breaker installed on the feeder shall be used motor drive type prepare to future motor operation at the time of emergency generator will be installed.

3.9 Test and Inspection: Test and inspection shall be performed in the manner specified in the paragraph 2.3 "Test and Inspection".

4. LIGHTING AND SOCKET OUTLET INSTALLATION

4.1 General: All works included in this Specification shall operate at a system voltage not exceeding 400/230 volts, 3 phase, 4 wire 50 hertz and the entire works shall be carried out in strict accordance with this Specification, the various electrical scheme Drawings, and "Regulations for the Electrical Equipment of Building" issued by "Institution of Electrical Engineers 1974". This work shall be included all earthings, cables, conduits, conduit fittings and boxes, cable trunkings, accessories, final distribution boards and lighting fittings, etc., required in Central Telecommunications Research Laboratory.

4.2 Cables: All cables shall be comply with the manner specified in the paragraph 3.2 "Cables".

4.3 Cable Installation: No cables shall be installed in conduits, trunkings, and asbestos cement pipes buried in the ground until these system have been completed, except when the cables installed inside of false ceiling. Cable lubricants may be used if previously approved by the Engineers, when necessary.

4.3.1 Final Branch Circuit System within the Buildings: Final branch circuit cables for lighting fittings, socket outlets and other electrical apparatus shall be installed in the conduits specified in this specifications, from the final distribution boards to lighting, socket outlet points and other accessories, between points as indicated on the drawings. The contractor's attention is further drawn to the following items which shall be strictly adhered to:

(a) The LOOP-IN system of wiring shall be employed throughout electrical installation.

(b) In any one room or otherwise well defined area not exceeding 100 square meters in area, all single phase consuming devices shall be connected to the same phase of supply unless otherwise specifically required by the Engineer.

(c) In a large hall, office, laboratory and other situations where the load is required to be divided between two or three phases, whether for load balancing purposes or otherwise, lights,

switches, socket outlets, other electrical equipment or accessories connected to different phases shall be so constructed or so marked and maintained that it is impossible for any person to expose live metal therein without first being aware that danger of shock between phase exists therein. Identification of phase cables shall be Red, White, and Blue.

(d) In the lighting circuits, the ring system of wiring shall not be employed, but in the socket outlet circuit, the ring system shall be employed, except in special cases.

(e) The wiring of each final branch circuit shall be electrically insulated from that of every other final branch circuit.

4.3.2 Lighting circuits: No cable smaller than 2.5 mm^2 shall be used for any lighting final branch circuit. The lighting circuit shall be protected by a molded case circuit breaker (MCCB) of 15 amperes current carrying capacity. A molded case circuit breaker exhibiting an inverse-time characteristics is regarded as a fuse. Not more than five lighting circuits shall be bunched in the same conduit.

(a) In every final branch circuit the sum of the total load shall not exceed 3,000 VA.

(b) The cable sizes shall be the following:

15 A. MCCB	Phase and Neutral	2.5 mm^2. PVC Insulated Cable, Single Core.

4.3.3 Socket Outlet Circuits: No cable smaller than 4.0 mm^2 shall be used in any socket outlets final branch circuit. The socket outlet circuit in the ring system shall be protected by a molded case circuit breaker of no more than 30 amperes current carrying capacity. Not more than three socket outlet circuits shall be bunched in the same conduit.

(a) The socket outlets having 15A, 5A rating shall be connected to a ring circuit in which the current-carrying conductors connected in the form of loops, both ends of which are connected to an associated molded case circuit breaker. When spurs supplying outlying socket outlets are connected to a ring circuit,

not more than two socket outlets or one fixed appliance shall be fed from each. A spur of a ring circuit shall be a branch cable having conductors of cross-sectional area not smaller than that of the conductors forming the ring. Except in case of socket outlets connected on a spur, no more than two conductors shall be connected into one terminal of any socket outlet. Spurs shall be connected to a ring circuit in socket outlets, in a manner approved by the Engineer. The earth conductor lead to a steel conduit shall be effectively connected to the earth contacts of each socket and the phase and neutral conductors shall be connected to the correct socket identifications.

(b) Ring circuits shall not be used where there is any likelihood of the total load connected to the circuit exceeding 6 KVA.

(c) The cable size shall be the following:

30 A. MCCB Ring Circuit	Phase and Neutral	4.0 mm^2. PVC Insulated Cable Single Core

(d) Two socket outlets having 15 A rating shall be connected to a circuit wire with 4.0 mm^2 cable protected by a molded case circuit breaker of not greater than 30 A carrying capacity.

4.4 Conduits, Conduit Fittings and Boxes

4.4.1 General: All conduits, conduit fittings and boxes shall comply in all respect with the current British Standard Specifications covering Steel Conduit, Flexible Metallic Conduit, Conduit Boxes and Switch Boxes as a minimum, except where specified in this specification.

Conduits, conduit fittings and boxes shall be suitable protected from weather and damage during storage and handling. Sizes shall be as indicated on the drawings and the schematic diagram and/or in this specification. No conduit smaller than 19 mm shall be used in any circuit connected to the medium voltage.

4.4.2 Conduits, Conduit Fittings and Boxes

(a) Conduits shall be heavy gauge and/or light gauge steel with welded seams or solid drawn and seamless, except flexible metallic conduit or rigid PVC conduit. All steel conduits shall be zinc-coated on the outside and inside by galvanizing or sheradizing processes and shall conform with BS 31, including latest amendments.

(b) Flexible metallic conduits shall be PVC covered and shall conform with BS 731, including latest amendments. This conduit shall terminate in two part brass adaptors.

(c) Rigid PVC conduits shall not be used in any location, except where earth conductor have to be embeded underground. Rigid PVC conduit shall conform with BS 4607, including latest amendments.

(d) Conduit fittings shall conform with BS 31, including latest amendments. Boxes used ordinarily shall be single type box to conform with BS 31. Boxes with holes in the back but without spouts called "loop-in" boxes and switch boxes shall conform with BS 3676, including latest amendments. When the prior approval of the Engineer is obtained, zinc-coated or cadmium-plated sheet-steel boxes may be used, and square cornered, straight side gang boxes 10 cm octagon concrete rings and 10 cm octagon ceiling hung boxes with bars may be of the folded type. All other boxes shall be of the one-piece deep-drawn type.

4.4.3 Conduit Installation

(a) The outside diameter of any conduit embedded in concrete shall not exceed one third of the thickness of the structural slab and wall in which it is placed.

(b) Junction boxes and draw-in boxes shall not be placed in inaccessible positions, i.e. voids between ceiling slab and false ceiling. The location of drawn in and junction boxes shall be so installed that suitable access box plates shall be provided at these locations on the false ceiling. Where cables run underground, they shall be drawn through heavy gauge steel conduit. This conduit shall be embedded into the wall so as to allow a minimum plaster cover of 12 mm.

Where conduits are run buried in the wall of the building, all branch switches, socket outlets, etc., shall be housed in galvanized boxes.

All switch plates, socket outlet plates and accessories shall be installed flush with the plaster. The Contractor shall obtain for himself all necessary information regarding plaster thickness and finished floor levels before commencement of work.

(c) Exposed conduits shall be run parallel to or at right angles to the lines of the building. For large conduit sizes exceeding 31 mm, Made Bends shall be employed. The ends of Made Bends shall be threaded internally so that the conduit can be screwed into them. Each run of exposed conduit shall be carried out after plaster is finished and dry, and before cables are installed. Exposed horizontal runs shall installed close to the surface of the structural beams and above water, or other piping, wherever possible.

(d) Conduits connected to wall boxes shall be run in such a manner that they shall not cross water, waste pipes, wherever possible. Conduits shall be kept at least 50 cm from parallel run of water, waste pipes.

(e) Expansion fittings or other devices shall be used to provide for expansion and contraction where conduit crosses expansion joints. Expansion fitting shall be approved by the Engineer, or shall be PVC covered flexible metallic conduit connected between boxes installed at both sides of the expansion joint. The PVC covered flexible metallic conduits shall be sagged suitably.

(f) Where exposed to water, rain or weather, all conduit, conduit fittings and accessories shall be protected by the galvanizing process and shall be painted with black bituminous paint. Where indicated on the drawings and exposed to water, rain or weather and corrosive atmospheres, PVC covered flexible metallic conduit shall be employed. Covers shall be so arranged or fitted with machined joints and/or gasket that water cannot get inside.

(g) The number and sizes of the cables installed in the conduit shall be such that a space factor of 40% is not exceeded. The conduit sizes in the final branch circuits shall be as follows, except where specifically indicated on the drawings.

		Conduit Size
Lighting Circuits		
15 A circuit	2.5 mm^2 between 2 and 5 PVC single core cable	19 mm
	2.5 mm^2 between 6 and 10	25 mm
Socket Outlet Circuits		
30 A circuit (Ring)	4.0 mm^2 between 2 and 3 PVC single core cable	19 mm
	4.0 mm^2 between 4 and 7	25 mm
15 A circuit (Special case)	4.0 mm^2 between 2 and 3	19 mm
Other Electric Apparatus Circuits		
15 A circuit	4.0 mm^2 between 2 and 3 PVC single core cable	19 mm
20 A circuit	4.0 mm^2 between 2 and 3	19 mm
30 A circuit	10 mm^2 between 2 and 3	25 mm
Emergency Lighting Circuit		
15 A circuit	4.0 mm^2 between 2 and 3 PVC single core cable	19 mm

4.5 Trunkings: Trunkings shall be employed cable trunkings and lighting trunkings.

The cable trunkings shall be used for bunched wires of final sub-circuit.

The lighting trunkings shall be used for luminous lighting fittings installed in the laboratory and work shop.

4.5.1 Cable Trunkings: The cable trunkings shall be made in 3.6 meter lengths of not less than 1.2 mm galvanized steel. The section design imparts great strength and shall be provided with all tees, elbows and similar fittings. The cable trunking shall consist of metal trough made from the above metal with detachable lids. The

internal surfaces of all erected cable trunkings and fittings shall be smooth and free from defects.

(a) Where trunking are necessary for changes of direction, intersection and so on, tees, elbow and similar fittings shall be employed. Cable trunkings consist of a metal trough with detachable lids, and conduits may be connected to trunkings. Cable trunking covers in 1.8 meter lengths of not less than 0.55 mm steel are secured by strong spring action or other approved manner, but are easily opened.

(b) Cable trunkings shall be run parallel to or at right angles to the lines of the building horizontally or vertically. Supports shall be rigid enough to prevent distortion of trunkings during cable pulling. Horizontal trunking runs, except where trunkings run on the structure of the building, shall be supported by means of approved straps or hangers, etc. Hanger rods shall be either 9 mm in diameter or larger galvanized steel rods. No wire shall be used for the support of any trunking. Sizes of straps or hangers, etc., and hanger rods for all suspended loads shall be as approved by the Engineer. The Contractor shall submit for approval all applicable loads and rating data. Vertical trunking runs shall be fastened directly on the structure of the building. In this case trunkings shall be secured to the structure of the building in an approved manner using bolts. All supports of trunking shall be spaced not more than 2.4 meters apart, and parts of each trunking conjunction, each tee, elbow and other fitting shall be suspended or secured completely.

(c) The number of cables to be installed in cable trunking shall in no circumstances be such that a space factor of 45% is exceeded.

4.5.2 Lighting Trunkings: The lighting trunkings shall provide an economical, adaptable and easily erected system of fluorescent lighting fittings.

The lighting trunkings shall be supplied with self-centering or other approved couplings designed to provide strong joints, additional fastenings and ensuring complete earth continuity.

(a) The adaptor which support of lighting fittings, shall be capable to be fitted at any point along the channel length, thus facilitating the re-arrangement of lighting at any time.
The lighting trunking shall serve as a conduit for electrical wiring and the adaptor, being hollow, also shall serve as same for the wiring between channel and fitting.

(b) Suspension of the system can be made from steel or concrete structure by means of rods or beam clamps.
The lighting trunkings shall be made in 3.0 meter or 3.6 meter lengths of not less than 1.2 mm galvanized steel.

4.6 Accessories: All socket outlets and tumbler switches shall comply in all respects with the current British Standard Specifications covering socket outlet and tumbler switches, as a minimum.

4.6.1 Socket Outlets: All socket outlets shall be flush, completely insulated except where indicated on the drawings and when the prior approval of the Engineer is obtained, and shall be of the single 5A, 15 A switched 3 pin flat pin type, complete with approved colour insulated plate.
Single 15A, 5A switched 3 pin socket outlets shall conform with BS 1363, including the latest amendments. The earth contacts of each socket shall be effectively connected to the earth continuity conductor and the phase and neutral conductors shall be connected to the correct sockets.
Where socket outlets are installed in an exposed manner as indicated on the drawings and when the prior approval of the Engineer is obtained, socket outlets may be 15 A surface mounting metal-clad, switched.
Where 15 A or 30 A socket outlets are necessary, they shall be shuttered and switched to conform with BS 546, including latest amendments. They shall be of approved design.
The Contractor shall provide all plug taps for use with socket outlets, and shall be fitted with 2 A fuses unless the apparatus connected to the plug normally takes a larger current, when a 5 A or

15 A, fuse may be fitted. Fuses with a 15 A rating shall be fitted only with the approval of the Engineer or his authorized representative to determine conformance with the requirement of this specification.

4.6.2 Tumbler Switches: All switches shall be flush, completely insulated except where indicated on the drawings and when the prior approval of the Engineer is obtained. They shall be approved colour plastic switches of full 5 A capacity having insulated dollies and plates, for plaster depth mounting. Switches shall conform with BS 3676, including latest amendments.

Where more than one switch is grouped together, multi-gang switch boxes and insulated plates finished in approved colour shall be employed.

Where switches are installed in an exposed manner as indicated on the drawings and when the prior approval of the Engineer is obtained, switches may be 5 A surface mounting metal clad.

4.6.3 Socket Outlet and Switch Installation: Socket outlets and switches shall be securely fixed by screws to boxes that are installed flush with the finished plaster or wall. The Contractor shall obtain for himself all necessary information regarding plaster thickness and finished floor levels before commencement of work.

Socket outlets shall be mounted with bottoms 30 cm above the finished floor level, except where otherwise specified.

In places such as garages, etc., every fixed socket outlet shall be fixed at a height of at least 1.40 meter above the finished floor level.

No socket outlets shall be mounted within 2 meter of any tap, sink, basin, metal draining board, pipework, etc., in any kettle, etc., without the special approval of the Engineer in each case.

The earth pin and the metal cases of all socket outlets should be firmly connected to an earth continuity conductor which is not liable to be accidentally broken throughout the life of the installation.

Unless otherwise indicated on the drawing, all switches shall be mounted with the dollies 1.40 meter above the finished floor level. Where several switches are mounted in two horizontal rows, the lowest row shall have dollies 1.40 meter above the finished floor level.

Unless otherwise indicated on the drawings, all switches shall be mounted inside the room. Where not prevented by the swing of the door, switches shall be mounted on the same side of the door as the catch or lock, the nearest switch being approximately 15 cm from the door frame.

4.7 Final Distribution Board: Final distribution board shall comply in all respect with the current British Standard Specification, as a minimum. All molded case circuit breakers in final distribution boards shall be approved by the Engineer specifically, and conform with British Standard Specification or the international standard specifications covering them.

Final distribution boards shall be 3 phase, 4 wire (solid neutral) 400/230 volts for lighting and socket outlets, etc., as indicated on the drawings. All final distribution boards shall be totally enclosed, dust protected and vermin-proof, factory fabricated board complete with internal wiring in copper PVC insulated cable coloured for phase identification, busbars, flush mounting sheet steel cabinets.

Molded case circuit breaker, busbars and cabinet shall be as follows:

(a) Molded case circuit breaker shall be 500 volts single, twin and/or triple pole circuit breakers with a molded case. They shall be of the non-adjustable type and Plug-in or bolt-on type.
The molded case circuit breakers shall have shunt trip coil and trip-free operating mechanism of the quick-make, quick-break type.
The molded case circuit breakers shall have a thermal or magnetic overload trip designed to operate on a continuous steady current of 150% of normal full load current and instantaneous magnetic trips which operate at currents exceeding 500% of normal full load currents. Dollies of the breakers shall be of the trip free pattern to prevent closing the breaker onto a faulty circuit and shall be engraved ON/OFF.

Single pole molded case circuit breakers shall have 50-ampere frames and trip ratings of 15, 20 or 30 A with interrupting capacities of not less than 5,000 A.

(b) Busbars for final distribution boards shall be of the sequence phased type connection arranged for 3 phase, 4 wire, 400/230 volts. Busbars shall be of hard drawn copper with a current density not exceeding 1,000 A in any case.

The molded case circuit breaker shall control the phase side of each branch circuit and shall connect the phase side busbar by plug-in or bolt-in means. The neutral connector block shall be insulated from the cabinet and shall have numbered terminals.

In addition to the phase busbar and the neutral connector, a bare uninsulated earth bar shall be suitably bolted to the cabinet.

(c) Cabinets for final distribution boards shall be flush mounting sheet steel enclosure, wall mounted or floor mounted type in an approved manner. The arrangement of the enclosure shall be such that the molded case circuit breakers could not be operated without opening the hinged door, but to obtain access to the interior of the board, it should be necessary to remove a second cover.

Cabinets for final distribution boards shall provide proper space for all cables and connections. Cabinets shall have proper means for securing, supporting and adjusting the final distribution boards and fronts. Cabinets without through feeder wiring shall be arranged to provide a wiring gutter not less than 10 cm wide for the final distribution boards.

4.8 Lighting Fittings: The Contractor responsibilities shall include manufacture, testing, supply, delivery to site, erection, cabling, wiring and commissioning of all lighting fittings, associated with them, etc.

(a) All lighting equipment shall be installed complete with suspension accessories, hickeys, casing, sockets, lampholders, reflectors, fluorescent and/or mercury vapor control gears, capacitors, diffusing materials, louvers, acrylic panels, plaster frames,

recessing boxes, poles and concrete basements for outside lightings, etc., wired and assembled. The Contractor shall furnish and install all lamps and accessory, wiring, and also spare lamps, lampholders, acrylic panels, control gears, capacitors, etc.

(b) All lighting fittings and accessories, including outside lighting fittings, etc., shall comply in all respect with current British Standard Specifications, as a minimum. All lighting fittings and accessories including outside lighting fittings, etc. shall be factory fabricated, the best of their respective kinds and approved by the Engineer.

(c) The dimensions of lighting fittings shall refer to approved manufacturer's products so that lighting fittings having necessary lamp wattage and number of lamps shall be fabricated in accordance with the type indicated on the Figure of Lighting Fittings. Their exact dimensions shall be approved by the Engineer.

(d) The position of all lighting fittings on the drawings are intended to indicate the general position installed.
The Contractor shall submit drawings showing final position of all lighting fittings to make reference to the reflected ceiling plan drawings of the building, for the approval by the Engineer before commencing installation.

4.8.1 Components of Lighting Fittings: Lighting fittings shall be complete, including lights, to comply with latest BS 3820, including latest amendments, as a minimum. Components of lighting fittings shall be the following:

(a) Fluorescent fittings shall be equipped with "WARM WHITE" colour tubes. All fluorescent tubes shall comply with BS 1270 and 1853, including latest amendments, as a minimum. For simplicity and clarity, fluorescent fittings shall be designed in accordance with the following tube sizes of each wattage.

Wattage	Length	Diameter
40 W	1,198 mm	38 mm
20 W	580 mm	38 mm

All incandescent lights shall comply with BS 161, including latest amendments, as a minimum.

(b) Control gears and capacitors: The control gear for all fluorescent fittings shall be suitable for operation on a 230 volts, single phase, 50 hertz supply.
Autotransformers, chokes, capacitors and other accessories shall be rated for service on such a system. The control gear of all fluorescent fittings shall be of the instant start type. All control gear shall give trouble free service when operated for prolonged periods at ambient temperatures up to 47.3°C except where the fittings are exposed to direct sunlight. All fluorescent fittings shall be equipped with capacitors of adequate capacity for improving the power factor.
The control gear and capacitor shall comply with BS 2818, including latest amendments.

(c) Internal wiring: All internal wiring shall be in high temperature PVC flexible cable or high temperature PVC solid copper conductor of adequate current carrying capacity. All internal wiring shall be neatly clipped into position.

(d) Materials and finishes: Materials and finishes of lighting fittings shall be in accordance with specifications of lighting fittings.

(e) All lighting fittings shall in all cases be fixed or suspended directly to the structure and not to the false ceiling.
All fluorescent fittings fixed directly shall be attached to the ceiling, wall, or column with supports in addition to the fixture studs. All fluorescent fittings fixed to the false ceiling shall be suspended to the ceiling with either 9 mm diameter or larger galvanized steel rods. The numbers of supports shall be:
Square flush type
Flush type, surface type not less than two.

(f) All fluorescent fittings, incandescent fittings and H.F. mercury vapor fittings exposed to direct sunlight shall have appropriate finishes. Materials and internal wiring shall to resist an ambient temperature of 87.9°C.
They shall be water-proof and dust-proof.

All glass used in them shall be heat-resistant glass and shall resist an ambient temperature of 87.9°C.

4.8.2 Lighting Fittings: Each type of lighting fittings shall be in accordance with the following specifications:

(a) Type. Recessed (FL): The Recessed type fluorescent fitting comprise of stove enamelled sheet steel ceiling plate of ample dimensions for housing control gears.
The control gear shall be of the instant start type and shall be suitable for operative condition as required.
The fitting shall be suitable for accommodating two or three 40 watt tubes or two 20 watt fluorescent lamps and associated control gears.
All fittings shall be equipped with suitable capacitors to improve the power factor to at least 0.9.

Type of Fitting	
A	FL 40W x 3
B	FL 40W x 2
C	FL 20W x 2

(b) Type. Reflector (FL): The reflector type fluorescent fitting shall be suitable fixing on a lighting trunking, comprised of stove enamelled sheet steel channel section base with a cover of ample dimensions.

Type of Fitting	
D	FL 40W x 2

(c) Type. Square Recessed with Diffuser (FL): The square recessed with diffuser fluorescent fitting shall be suitable for mounting into false ceilings, comprised of sheet steel housing finished in white stove enamel with white plastic panel at bottom and frame for concealing gap between false ceiling and fitting.
The plastic panel assembly shall be a removable unit firmly supported from the channel and hinged from either side for simple and easy maintenance.

Type of Fitting

E	FL 20W x 6

(d) Type. H-shape Batten: The H-shape Batten suspended type fluorescent fitting shall be comprised of stove enamelled sheet steel channel section base with a cover of ample dimensions to house control gears.
Fitting shall be suitable for mounting suspended from the ceiling by means of two 15 mm diameter conduits, and shall be provided with stove enamelled sheet steel reflector white coloured.

Type of Fitting

M	FL 40W x 2
N	FL 40W x 1

(e) Type. V-shape Batten (FL): The fitting shall be comprised of white stove enamelled sheet steel "V" section base with ample dimensions to house control gears.
Fitting shall be suitable for mounting directly to the ceiling, and shall be provided with stove enamelled sheet steel reflector white coloured.

Type of Fitting

O	FL 40W x 2
P	FL 40W x 1
Q	FL 20W x 2

(f) Type. Simple Batten: The simple batten type fluorescent fitting shall be comprised of white stove enamelled heavy gauge sheet steel channel section base with cover of ample dimensions to house control gears.
The fitting shall be suitable for mounting directly to the ceiling.

Type of Fitting

R	FL 20W x 1

(g) Type. Waterproof Bracket (FL): The waterproof bracket type fluorescent fitting shall be comprised of a body in pressed

brass sheet, stove enamel finished in approved colour and complete with hinged white acrylic plastic cover of superior quality. The fitting shall be equipped with necessary control gear on a removable cover and with provision for each access to the control gear. The fitting shall complete with a moisture resistant special gasket. The construction shall prevent moisture and dust getting to the lamps and shall protect against falling lamps and resultant lamp breakage, and contamination to products. Ferrous metal parts shall have a corrosion-resistant finish. The acrylic plastic cover shall be shaped with rounded corners for case in cleaning and shall be held securely by knurled thumb nuts.

Type of Fitting

T FL 20W x 2

(h) Type. Exit Signs (IL): The single sided flush type exit sign light fittings shall be comprised of sheet steel enclosure white inside and black outside. In front of the enclosure a processed glass panel with the inscription "EXIT" shall be provided. The inscription shall be in red or green lettering on white background.
The fittings, also, shall be equipped with D.C. 100 volts emergency incandescent lamp light on at breakdown of supply undertaking power.

Type of Fitting

L FL 10W x 2 (A.C 230V)
IL 5W x 1 (D.C 100V)

(i) Type. Bracket (FL+IL): The bracket type fluorescent fitting shall be comprised of white stove enamelled sheet steel channel section base and complete with hinged white acrylic plastic cover. The fitting shall be equipped with necessary control gear on a removable cover and with provision for easy access to the control gear. The fitting, also, shall be equipped with D.C. 100 volts emergency incandescent lamp light on at breakdown of supply undertaking power.

Type of Fitting

K	FL 20W x 2 (A.C 230V)
	IL 40W (D.C 100V)

(j) Type. Suspended (IL): The suspended incandescent fitting shall be comprised of lamp holder and suspension pipe. The fitting shall be suitable for suspended from the ceiling by means of one 19 mm diameter conduits.

Type of Fitting

F	IL 150W x 1 (A.C 230V, swan base)

(k) Type. Recessed (IL): The recessed type incandescent fittings shall be comprised of sheet steel construction finished in white stove enamel inside with a rust inhibition coating outside. The fitting, also, shall be provided with suitable holes to give off heat.

Type of Fitting

G	IL 100W x 1 (A.C 230V, swan base)
H	IL 60W x 1 (A.C 230V, swan base)

(l) Type. Lamp Holder (IL): The lamp holder type incandescent fitting shall be comprised of sheet steel reflector and/or receptacle in white stove enamel finished.

Type of Fitting

T	IL 40W x 1 (A.C 230V, with guard, swan base)
I_1	IL 40W x 1 (A.C 230V, swan base)
J	IL 40W x 1 (D.C 100V, screw base, white ball lamp)

(m) Type Revolving Three Sides Bracket: The revolving three sides bracket type darkroom work-light shall be comprised of a body in pressed brass sheet, stove enamel finished in approved colour and complete with hinged yellow cover, orange and green mixed cover and dark green cover.
The each side of coloured shall be able to revolute and fix by an operation handle in required condition.

The fitting shall complete with a moisture resistant special gasket.

(n) Type. Bracket with red glass glove: The bracket with red glass glove type incandescent fitting shall be comprised of sheet steel construction finished in white stove enamel.
The lighting fitting shall be complete with 20 cm red glass glove.

Type of Fitting	
U	IL 40W x 1

4.9 Test and Inspection: Test and inspection shall be performed in the manner specified in the paragraph 2.3 "Test and Inspection".

5. FIRE ALARM SYSTEM

5.1 General: The fire alarm system shall be installed circuit alarm push-button in order to make it possible for personels to manually operate the fire alarm.

5.2 Alarm Push Buttons: The alarm push-buttons shall be of round recessed type having cover plate, recess box, and indicating red lamp. Lamp shall be of rated voltage 140 volts and rated wattage 5 watts.

5.3 Alarm Bells: The alarm bells shall be approved for the purpose intended, not less than 150 mm in diameter and operate on medium voltage A.C. 100 volts.

5.4 Power Supply: The power shall supply A.C. 100 volts for operation of the fire alarm system.
The final distribution board shall be installed of independent final sub-circuit, A.C. 100 volts, for fire alarm system.

5.5 Wiring: Wiring between the alarm push buttons and alarm bells, final-distribution board shall be installed the approved way as used for lighting and socket outlet installation, and shall be as indicated on the drawings.

5.6 Tests: Every component of the system shall be tested at the factory to demonstrate its capacity and general operating characteristics. After the wiring and installation is completed, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for approval. All wiring shall be tested after completion with a megger insulation tester at a pressure of not less than 500 volts.

6. TELEPHONE CONDUIT SYSTEM

6.1 General: The installation work for telephone cabinets, telephone outlets, and laying of conduits shall be carried out as specified in the drawing. Laying of conduits shall be performed in the manner specified in the paragraph 4.4 Conduits, etc.

6.2 Telephone Conduits, etc.: Each item specified for the conduit installation shall be observed, taking into consideration the following:
Radius of curvature of a conduit bend in which a cable is to be accommodated shall be not smaller than 6 times the inner diameter of the bend.
Number of bends in a single section in which a cable is to be accommodated shall be three or less, and its total bending angle shall be 180° or less providing a single bending angle within 90°.
Length of a vertical conduit in which a cable is to be accommodated shall be 8 meters or less.
In case of a conduit whose length is 10 meters or more for one section or by reason of necessity for installation work, a pull box shall be installed in the proper location. But, when the prior approval of Engineer is obtained, conduits may be run not exceeding 30 meters.
Cable tray shall comply with specified in the paragraph 3.3 "Cable Tray".

6.3 Telephone Outlets: The mounting location for a telephone outlet and junction shall be in conformity with the drawing, and the outlet's plate shall be provided with a hole 9 mm in diameter on its center.

6.4 Telephone Cabinet: Telephone cabinet shall be semi-flush or flush mounting sheet steel enclosure, recessed into the walls in an approved manner. All telephone cabinets shall be totally enclosed

dust-protected and vermin-proof. The cabinet shall accommodate the number of pairs prescribed in the drawings. Telephone cabinets shall provide a wooden board fixed in the cabinets, and the wooden board shall be a lauan board not less than 20 mm in thickness. Each cabinet box shall be constructed with ample interior dimensions permitting easy maintenance, approved by the Engineer.

Fronts for semi-flush or flush cabinets shall consist of a one-piece sheet steel frame and a hinged door which provide maximum-size opening to the box interiors, with locking device. Frame shall be about 20 mm larger than the cabinet on all sides and shall be set with its back flush with the finished wall. The door or doors where required may be equipped with half-round molding on the front face to form a rabbet and cover the joint between the door and frame, or the door shall close against a rabbet placed all around the inside edge of the frame, with a close fitting joint between door and frame, and shall be provided with a card holder inside.

Telephone cabinets and telephone outlet shall be installed with bottom 30 centimeters above the finished floor level.

7. EARTHING

7.1 General: This work shall include the provision of complete earthing systems for electrical installation, air conditioning plant, plumbing plant, telephone conduit system, and research laboratory apparatus. The earthing for their plant and/or research laboratory, etc., shall be installed in their room for protective use of power, for neutral use of transformer and for research laboratory apparatus.

This system shall comprise electrodes, manholes, main earth continuity conductors and branch earth continuity conductors.

Power protective use earthing, neutral use earthing, research laboratory apparatus use earthing shall be separated.

The following requirement shall be applied to earth in accordance with the WAPDA Regulations and/or the latest issued IEE Regulations.

(a) All metal work associated with wiring system (other than current carrying parts), including conduits, cable tray, trunking and boxes, etc., at a voltage exceeding extra-low voltage.

(b) Exposed metal of all electrical equipment, fittings and apparatus operating at a voltage exceeding extra-low voltage.
(c) Earth terminal of socket outlet.
(d) On the neutral point of the secondary low voltage winding and metal work (other than current carrying parts) of any transformer.
(e) Earthings for research laboratory apparatus.
(f) Earthings for telephone conduit system.

7.2 Electrodes: One main earth electrode shall be comprised 14 mm diameter copper coated iron core rodes shall be driven to a depth of not less than 2.0 meters immediately outside the building, connecting the necessary numbers of rodes, where possible into undisturbed soil.
The copper coated iron core rods shall be of the extensional type and shall have a spike at one end and driving head at the other.
If soil conditions do not permit obtaining an earth resistance of required, the earth electrodes shall be driven to a great depth, and the Contractor shall perform the earthing to obtain the specified earth resistance, in any conditions.
Distance between the earth electrodes shall not less than 2 meters.
Distance between the earth electrodes of one earthing system and another earthing system shall be not less than 5 meters.
The earth electrode shall be enclosed in a manhole covered on the top so that it is easily accessible, and the earth electrodes and manholes shall be installed to avert possibly installation conflicts to the service and manholes of the other Section.
Each earth electrodes shall be provided complete with approved non-ferrous plugs or clamps for connection to main earth continuity conductors.

7.3 Testing Bars: Earth continuity conductor's connection point shall be used testing bars approved design.
Testing bar shall be mounted in the earth terminal box for easy maintenance and testing.
The manhole shall be located in accessible position and in the proximity of a electrode.
Each testing bar shall be comprised of testing bar, studs,

nuts and washers to take a bolted copper lug for the earth continuity conductor connection.

7.4 Earth Continuity Conductors: Earth continuity conductor shall be PVC insulated cable, and shall conform with BS 2004, including latest amendments.

Earth continuity conductor shall have a corss section as indicated on the drawings.

Earth continuity conductor embedded in concrete shall be protected with a rigid PVC conduit continuously.

The end of a earth continuity conductor extended into the building shall be connected to a testing bar mounted in a terminal box.

7.5 Value of Earth Resistance: The following value of earth resistance shall be required in each earthing system.

The earthing for electrical installation, research laboratory apparatus, air conditioning plant and plumbing plant shall be as follows:

(a) For protective: not more than 2 ohm.

(b) For neutral of transformer: Ditto.

The earthing for telephone conduit system shall be as follows:

(a) For M.D.F.: not more than 10 ohm.

(b) For frame or cabinet of main distribution board: not more than 100 ohm.

The earthing for research laboratory apparatus shall be as follows:

(a) For research laboratory apparatus: not more than 10 ohm.

(b) For D.C. power source: not more than 10 ohm.

(c) For rectifier and battery: each not more than 3 ohm.

7.6 Tests: The tests of earth resistance shall be in accordance with regulation Section E of the IEE Regulations, and shall be obtained the specified value, measured by means of that the resistance areas of the electrodes should not overlap.

The tests of earth continuity conductor resistance shall be in accordance with regulation Section E of the IEE Regulations, and shall be carried out with an alternating current.

All parts of the installation and associated equipment shall also be adjusted to work properly and be left in good operating condition.

Tests shall be repeated after any defects disclosed thereby have

been made good or the work replaced if, in the judgment of the Engineer, it is deemed necessary.
All defects disclosed in the work tests and otherwise shall be made good in very limited case or work replaced without additional compensation to the Contractor.

7.7 Installation and Wiring: All wiring shall be of the approved type as used for electrical installation and shall be as indicated on the drawings.
The Contractor shall install earth electrodes and manholes to avert possibly installation conflicts to the service and manhole of the other section.
The installation of earth electrodes shall be taken place at the same time as the excavation work for the building is done.

7.8 Inspection: Each earthing shall be inspected by the Engineer or his authorized representative to determine conformance with the requirements of this specification. No part of the earthing shall be concealed until it has been inspected and approved by the Engineer.

8. LIGHTNING PROTECTION SYSTEM

8.1 General: The installation work for installing the lightning protection air termination on the roof of buildings and for burying the earth termination shall be performed so as to conform to the specified drawings.
Total resistance between this air termination and burried electrode shall be not more than 10 ohms.
This earthing shall be tested after the electrodes are burried and after the work has been completed.

8.2 Materials:

(a) Air termination: The air termination shall be phosphor bronze rod, medium hard drawn, 13 mm diameter, and should project at least 30 cm above the object to which it is fixed.
Fasteners shall be substantial in construction, not subject to breakage, and shall be of the same materials as the conductor

or of such nature that there will be no serious tendency toward electrolytic corrosion in the presence of moisture because of contact between the different parts.

(b) Down conductors: Down conductors shall be of copper strip, soft annealed, 25 mm by 3 mm and shall follow the most direct path between the air termination and the earth termination. If there have to be bends, these should be of as large a radius as possible.

(c) Joints and bonds: Where joints are necessary, they shall be mechanically and electrically effective and shall be so made as to exclude moisture completely.

Joints for strip shall be tinned, soldered and at least double riveted.

Materials for bonds shall be copper strip, soft annealed, 19 mm by 3 mm and shall be of recommended designs shown in clause 802, BS CP 326. 101.

(d) Testing points: Each down conductor shall be provided with a testing joint mounted in a manhole in such a position that, while not inviting unauthorised interference, it is convenient for use when testing. No connection, other than one direct to an earth electrode, shall be made below a testing joint. Testing points shall be copper.

(e) Earth terminations: Earth terminations shall be copper coated, iron rod, 14 mm diameter, driven into the ground to a depth of at least 2.0 meters. The distance between any two driven rods shall be not less than 2 meters. In any case, this earthing system shall be completely separated to another earthing system, and the distance between the driven rods of this system and another earthing system shall be 5 meters at least. Where the nature of the sub-strata makes burying into undisturbed soil impossible, the Contractor shall arrange for holes to be bored and install the rods, and fill with soil. The Contractor shall perform the earthing to obtain the specified earth resistance, in any soil conditions.

8.3 Tests: The tests of earth resistance shall be in accordance with regulation Section E of the IEE Regulations, and shall be obtained

the specified value, measured by means of that the resistance areas of the electrodes should not overlap.
The tests of earth continuity conductors resistance shall be in accordance with regulation Section E of the IEE Regulations, and shall be carried out with a alternating current.

8.4 Inspection: The lightning protection system shall be inspected by the Engineer to determine conform with the requirements of this specification. No part of the system shall be concealed until it has been inspected and approved by the Engineer.

Addition of Article 4.4.3 Conduit Installation

(h) In a laboratory, junction boxes and draw out apparatuses shall be water-proof and manner of installation shall be approved by the Engineer.

Addition of Article 4.8.2 Lighting Fittings

(w) Type. Obstruction lighting fitting: The obstruction lighting fitting shall be complete with the lamp, lamp holder, cast iron base, heat-resistant red glass diffusing globe, weather-proof gascket and other accessories. The fitting shall be totally enclosed by means of the heat-resistant red glass diffusing globe and shall be so constructed that no water can penetrate to the interior.

The obstruction light shall be designed for a 100 watt lamp and a fixed light of an intensity of not less than 32 candles of red light. And time switch cooperate with obstruction light shall be as follows:

The time switch shall be driven by a self-starting synchronous motor and shall have a spring driven reserve of power sufficient for 36 hours operation.

The switch mechanism shall be equipped with a manual push button or other suitable means of operating "ON" and "OFF" for maintenance purposes without interference with the Solar Dial mechanism. The complete switch shall be enclosed in a dust and vermin proof cabinet.

The time switch is to be operated on 100 volts, 50 Hz, single phase supply and shall be of the size specified below:

15 Ampere, single pole.

9. ELECTRIC CLOCK AND HOUSEHOLD APPARATUS.

9.1 General: The contractor shall supply and install of electric clock and household apparatus, such as juicer-mixer, toaster and refrigerator.

9.2 Electric Clock: The electric clock shall be of the wall mounting, rectangular and/or circular type.
The electric clock shall be designed for operate by crystal quarz oscillator driven D.C. 3 volts of drycells in series.
Rectangular type shall be sized 311 mm by 366 mm resin frame and circular type shall be sized 250 mm in diameter metal frame.

9.3 Household Apparatus: Household apparatuses supplied shall be marketing goods and capacity, etc., shall be as follows:

(a) Juicer-mixer

Juicer	Mixer
A.C 100 volts, 50 Hz	A.C 100 volts, 50 Hz
Power consumption: 220W	Power consumption: 220W
R.P.M.: 11,000	R.P.M.: 7,000 - 10,000
Weight (kg): 3.7	Weight (kg): 4.0

(b) Toaster

A.C 100 volts, 50 Hz
Power consumption: 620W

(c) Refrigerator

A.C 100 volts, 50 Hz
Power consumption: 180W
Effective inner volume:
Freezing part: 52 litres.
Refrigeration part: 149 litres.

TECHNICAL SPECIFICATIONS

PART - II

FOR

ELECTRICAL INSTALLATION

PLUMBING, GAS INSTALLATION

AIR CONDITIONING

AND

LIFT

PART II-(iii)

PLUMBING, GAS INSTALLATION

NIPPON SŌGŌ ARCHITECTS' AND ENGINEERS' OFFICE CORP., LTD.

(NSK) TOKYO JAPAN

TECHNICAL SPECIFICATION FOR PLUMBING, GAS INSTALLATION

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1. GENERAL

1.1 General Description: The Contractor responsibilities shall include the supply, delivery to site, erection and commissioning of all materials and equipment required in accordance with the specification.

1.2 Scope of Work: All the work covered by this specification shall include External Drainage Works, Plumbing Works and Gas Installation Works for Central Telecommunication Research Laboratories in Isramabad.

1.3 Materials & Equipment:

(a) All materials and equipment shall comply in all respects with the relevant Japanese Standard Specifications (JIS), as a minimum, including dimensional standards, where these exist, exception so far as this specification is at variance therewith notably in respect to ambient temperatures and raised temperature. Other international standard specifications are acceptable, if they comply with the following conditions:

(1) Material and equipment used shall be equivalent in Technical Characteristics and thickness to those in JIS.

(2) Material and equipment used shall pass all tests prescribed in JIS.

(b) All materials and equipment shall be the best of their respective kinds and shall be approved by the Engineer before use. All samples requested by the Engineer shall be properly tagged and submitted to him for approval.

2. EXTERNAL DRAINAGE WORK

2.1 General: All external drainage work for sewage drains shall comply fully with all by-laws which may be in force, including those issued by the Government of Pakistan.
Except as otherwise specified, the work under this contract shall consist of furnishing all labour, materials, equipment and appliances for the complete execution of all external drainage and related work as required by the contract.

The work shall comprise all sewage drains and manholes, etc., shown on the drawings, required by the schedules or directed by the Engineer. All external drainage piping covered in this section of the specification is from one meter outside the building walls to the site boundary.

2.2 Pipes and Fittings: Pipes and fittings for conducting soil and waste water shall be concrete pipes and fittings to comply with JIS A5303. The concrete pipes and fitting will preferably obtained from the local manufacturers.

2.3 Accessories: The manhole covers and frames shall, unless otherwise stated, be steel iron coated flat covers and frames approved by the Engineer.

The covers and frames in areas subject to motor traffic shall be Grade A, those in footways and remainder shall be Grade B.

Manhole covers and frames shall be bedded and pointed with cement and sand mortar (1:4) mix.

Step irons for manholes shall be galvanized malleable cast iron step irons approved by the Engineer.

The Contractor shall provide lifting keys for each type of manhole cover.

The Contractor shall protect these frames and covers from injury or misalignment by suitable timber or other protection until completion of his contract.

2.4 Sundry Materials: The cement, sand, aggregates and reinforcement shall be as specified in "Concrete Work" and blocks shall be as specified in "Masonry".

The concrete and mortar shall be in accordance with the Mixing Table in "Concrete Work".

The grading of sand for jointing, pointing and bedding mortars shall be as for fine aggregate.

The mortar for jointing drains shall be composed of 1,450 kg of cement to each cubic meter of sand (1:1 mix), with sufficient water

for a good workability, and thoroughly mixed to the satisfaction of the Engineer.

The mortar for rendering, pointing and bedding manhole covers, gratings, etc., shall be composed of 350 kg of cement to each cubic meter of sand (1:4 nominal mix), mixed as above.

2.5 Jointings: Joints between pipes, fittings and drains shall be executed as below:

Concrete to Concrete: Wet well the spigot and socket, wrap one turn of approved tarred yarn gaskin round the spigot end of the pipe and lightly caulk into the socket so as to occupy not more than one quarter of the socket depth. The remainder of the socket shall be filled with cement and sand (1:1 mix) mortar and fillet formed round the joint from the edge of the socket to the barrel of the pipe at an angle of 45 degrees.

2.6 Excavation and Backfill: The work of this Contract shall include, without being limited to, all excavation and backfill for underground piping and manholes, etc., as required to complete the work of this Contract.

Excavations for drainage trenches shall be to straight lines and to the correct depths and gradients required for the pipes as specified hereafter. The trench bottom shall be of sufficient width to allow adequate working space for the pipe jointers.

Excavated material shall not be deposited within 50 cm of the edge of the trench. The sides of the excavations shall be supported by planking and strutting if necessary to ensure proper and speedy execution of the work.

In the event of excavations being made deeper than necessary they shall be filled to the proper level with gravel at the Contractor's expense. The excavations shall be kept free from water by pumping, or by other methods.

All pipes, ducts, cables, mains and other facilities serviced by the excavations shall be effectively supported and protected by timbers or by other means.

No backfilling shall be done until so authorized by the Engineer.

Earth filling to the bottom of trenches and a to height of 30 cm

above the tops of the pipes shall be of selected material, hand packed, watered, if necessary, and well rammed on either side of the pipe. Special care shall be exercised where pipes are laid direct on to the earth or on beds without benching or covers. The remainder of the earth filling shall be in 30 cm layers, each layer wetted if necessary and well rammed with mechanical rammers or other efficient means of effecting consolidation. Surplus earth shall be transported to a location specified by the Engineer.

2.7 Pipe Laying: Each pipe shall be carefully examined on arrival, any defective pipes shall not be used and shall be segregated and marked in a conspicuous manner.

All drains shall be accurately laid, true to line and gradient from point to point. Manholes shall be provided at changes of direction or gradient and at points of connection. Drain pipe runs between manholes should be absolutely straight. Lines and falls shall be accurately set out as shown on the drawings or as directed on Site. Unless otehrwise directed by the Engineer or shown on the drawings all drains shall be laid to the gradients stated below:

Gradients

Pipe size (mm)	Ratio	Percentage (%)
80 and less	1:50	2
100	1:100	1
125 to 200	1:200	1/2

All drains shall be kept free from earth, debris, superflous cement and other obstructions during laying and until the completion of the contract when they shall be handed over in a clean condition.
The Contractor shall conduct his work so that he will not interfere with the function of the existing sewers. Extreme care shall be taken to prevent debris or other materials from entering the existing sewers.

2.8 Manholes: Manholes shall be constructed in the positions and to the dimensions shown on the drawings and/or the schedules or as directed on site. Excavate, return fill and ram, dispose of surplus earth, prepare bottoms and support sides, etc., all as previously described.

Manholes shall be constructed of cement blocks. Thickness of the wall shall be in accordance with the following Table:

Wall Thickness of Manholes

Height of Wall up to (cm)	Thickness of Walls (cm)
60 and less	20
61 to 150	20
151 to 300	30
301 and more	40

Manholes not exceeding 1.00 m deep internally shall be constructed to the sizes stated below unless specifically shown otherwise on the drawings or ordered by the Engineer.

Straight channel not more than one branch	60cm x 60cm
Change of direction not more othan one branch	60cm x 60cm
Straight channel not more than three branches on one side	60cm x 90cm
Straight channel not more than five branches on one side	60cm x 120cm

Manholes exceeding 1.00 m deep internally shall have a minimum internal size of 75 cm by 75 cm.

Bottoms shall be of concret (1:3:6) projecting 10 cm beyond the wall of the manhole; walls of blockwork in cement and sand (1:4) mortar; and cover slab of vibrated reinforced concrete (1:2:4), reinforced with the including 12 mm diameter bars at 15 cm intervals both ways.

The benching, main channels and branch channels shall be formed in concrete (1:2:4) and screed with waterproof cement and sand (1:3) trowelled smooth. The walls shall be rendered internally with waterproof cement and sand (1:3) plainface. Pipes entering the manholes shall not project beyond the face of the internal plainface rendering. The reinforced cover slab shall be trowelled smooth where exposed.

Each manhole shall provide a steel iron manhole cover and frame to the type shown on the schedule and as specified in Clause 2.3, Accessories.

2.9 Clean Drains: The Contractor shall on completion of the drainage systems remove all silt and foreign matter from the drain runs and manholes and leave the whole in a clean and workable condition.

2.10 Test: The drainage work shall be inspected and tested to the satisfaction of the Engineer at the following times and in an approved manner and shall be retested, if necessary, until passed. Test, unless otherwise directed, shall be by water.

(a) With the pipes laid and jointed in the trench bottom and before haunching or surrounding is executed.
They shall be tested for line, level, gradient and water tightness.

(b) After haunching or surrounding the pipes and backfilling the trench, the drain shall be tested for line, level, gradient, water tightness and rate of flow.

(c) At completion of the work and before handing over to the Government of Pakistan, the entire system shall be tested to the complete satisfaction of the Engineer.

3. PLUMBING WORK

3.1 General: All plumbing work shall comply fully with all by-laws which may be in force.
Except as otherwise specified, the work under this contact shall consist of furnishing all labour, materials, equipment and appliances for the complete execution of all plumbing and related work as required by the contract.
All plumbing work covered by this specification shall include the following items:

(a) The soil and waste drainage system, including ventilation, except piping covered in External Drainage Work.

(b) Water supply system, including tanks and storage water heaters.

(c) Plumbing fixtures and toilet accessories.

(d) All pumps including motors.

(e) Fire fighting equipment.

3.2 Pipes and Fittings

3.2.1 Pipes and fittings for various services specified in this section shall be as per the following items, except where otherwise indicated or specified.

3.2.2 Water pipes shall be of galvanized screwed and socketed steel tubes to comply with JIS G 3452. They shall be with pipe threads in accordance with JIS B 0203. Pipe fittings shall be of galvanized malleable cast iron fittings to comply with JIS B 2301.

3.2.3 Overflow pipes shall be of galvanized screwed and socketed steel tubes to comply with JIS G 3452. They shall be with pipe threads in accordance with JIS B 0203. Pipe fittings shall be of galvanized malleable cast iron fittings to comply with JIS B 2301.

3.2.4 Lead pipes for flushing pipes from flushing cisterns to water closet, they shall be comply with JIS H 4311.

3.2.5 Waste pipes and vent pipes shall be galvanized screwed and socketed steel tubes to comply with JIS G 3452. They shall be with pipe threads in accordance with JIS B 0203. Waste pipes fitting shall be of galvanized cast iron fittings to comply with JIS B 2303. Vent pipe fittings shall be of galvanized malleable cast iron fittings to comply with JIS B 2301.

3.2.6 Soil pipes and fittings shall be of cast iron pipes and fittings to comply with JIS G 5525.
Where piping and caulking for cast iron pipes in narrow spaces are difficult, the Contractor may use other metal pipes by his proposal with approval of the Engineer.
Lead pipes for final drainage connection to water closet, wash basin and such fixtures shall be comply with JIS H 4311.

3.2.7 All cast iron pipes and fittings shall be completely coated internally and externally by painting with coal tar or equivalent materials.

3.2.8 Waste pipes for laboratories shall be unplasticized polyvinyl chloride (PVC) pipes to comply with JIS K 6741, class VP. Pipe fittings shall be of unplasticized polyvinyl chloride (PVC) fittings to comply with JIS K 6739.

3.2.9 Hydrant pipes shall be of galivanized screwed and socketed steel tubes to comply with JIS G 3452. They shall be with pipe threads in accordance with JIS B 0203. Pipe fittings shall be of galivanized malleable cast iron fittings to comply with JIS B 2301.

3.3 Miscellaneous Requirements: Nipples on all piping shall be made from new pipes.

All unions on 50 mm and smaller steel pipes shall be ground joint, ring pattern unions. The body of the union shall be galvanized malleable cast iron.

All unions on 65 mm and larger steel pipes shall be flanged type. The body of the union shall be galvanized malleable cast iron.

Brass ferrules shall be cast brass, machine finished, not less than 3 mm in thickness.

3.4 Valves

3.4.1 All valves shall be furnished and installed at point as on the drawings and as necessary for the proper control of piping and equipment.

3.4.2 Gate, globe and check valves 50 mm and smaller in size shall be bronze in accordance with the following:

JIS B 2013 (5 kg/cm^2 Bronze Screwed Gate Valves)
JIS B 2011 (5 kg/cm^2 Bronze Screwed Globe Valves)
JIS B 2025 (10 kg/cm^2 Bronze Screwed Swing Check Valves)

The valves shall have rough bodies and finished trimmings.

3.4.3 Gate, globe and check valves 65 mm and larger in size shall be in accordance with the following:

JIS B 2031 (5 kg/cm^2 Cast Iron Flanged Gate Valves, outside screw and york)
JIS B 2041 (10 kg/cm^2 Cast Iron Flanged Globe Valves)

JIS B 2045 (10 kg/cm^2 Cast Iron Flanged Swing Check Valves)
The valves shall have cast iron bodies and bronze mounted seats.

3.4.4 Non-slamming check valves for water and fire pump discharge connections shall be of the fully guided, spring closed type, with flanged ends. Bodies shall be bronze, or cast iron. Seats, discs, and springs shall be bronze or stainless steel. Valves shall be designed for a working water pressure of not less than 10 kg/cm^2.

3.4.5 Each valve body shall be marked with cast-on or stamped lattering giving the following information:

(a) The manufacturer's name or trade mark.
(b) The size of valve.
(c) The guaranteed working pressure.

3.5 Taps: Bib or pillar taps shall be provided and fixed to sinks, lavatory basins, and cisterns as shown on the drawings and/or specified under the 'Sanitary Fixtures' section.
All taps shall be in accordance with JIS B 2061.
The bodies and heads of the taps shall be cast bronze, and shall be chromium plated in accordance with JIS H 8617.
Spindles, glands, crutches, washer plates and nuts shall be of brass or cast bronze. The taps shall have crutch or capstan heads made of metal or plastic, with tail having threads in accordance with JIS B 2061. They shall be marked with manufacturer's name or trade mark.
Hose taps for car washing shall be exactly as the above but with a screw or union on the outlet for the attachment of a hose.
Silll cocks shall be 20 mm rough brass with "Y" outlet threaded for 20 mm hose coupling and loose key handle. Shut-off valves and drain valves shall be provided in each sill cock line. The sill cocks shall be installed in tar-coated cast iron box with hinged lids, square in pattern with bottom flanged plate.
All taps shall be designed for a working water pressure of not less than 7.5 kg/cm^2.

3.6 Valve Boxes: Valve boxes shall be installed on valves fitted underground water main and branch pipes at a point as shown on the drawings.

Valve boxes for small size valves shall be tar-coated cast iron with hinged lids, square or round in pattern with bottom flanged plate. Valve boxes for large size valves shall be constructed of blocks to the suitable internal dimension for easy operating. The top covers of valve boxes shall be cast iron cover plate with frames having a required thickness to support motor lorry vehicle traffic load. All valve boxes shall be so installed as to prevent any damage the underground piping. The top cover plate shall be formed so that it may be readily fixed flush with foot path.

3.7 Pressure Gauges: Pressure gauges shall be Bourdon tube type pressure gauge which shall have a dial not less than 100 mm in diameter. The dials shall be graduated in kilograms per square centimeter gauge. The graduation shall be from zero to not less than one and half times and not more than three times the working water pressure. All pressure gauges shall be fitted with a siphon pipe and a cock or valve integral.

The pressure gauges shall be installed on the piping at easy access points and connected to the water pipes listed below:

Water pipes	Graduation of Gauges
Each delivery pipe side of pumps	From zero to not less than one and half times and not more than three times the discharge water pressure
Each suction pipe side of pumps	From minus 10 m water column to one time or not more than one and half times the working water pressure

3.8 Pipe Supports

3.8.1 All piping shall be supported by means of approved supports. Piping shall be supported to maintain required grading and pitching of lines, to prevent vibration, and to secure piping in place. It shall be so arranged as to provide for expansion and contraction.

3.8.2 Horizontal overhead pipes shall be supported with single or multiple type hangers consisting of inserts, clevis, clevise rods, turnbuckles with locknuts and clamps or other methods of suspension suitable for the type of building construction and for the purposes of pipe supporting. Horizontal pipes which are close to the floor shall be supported with stout pipe rests. Horizontal pipes running near the wall will may be supported with hangers suspended from wall brackets. Inserts for concrete floor construction shall be made of cast iron or wrought iron of approved type to receive a machine bolt head or nut, after installation, of the required size. They shall permit adjustment of the bolt in one horizontal direction and shall, when installed in properly cured concrete, develop the full strength of the bolt. The rod size for pipe 50 mm or less in diameter shall be of not less than 10 mm and for larger sized pipes shall be not less than 15 mm. All hanger rods, clevis, turnbuckles, nut, clamps and other hanger devices shall be painted or hot-dipped galvanized in an approved manner. All hangers must be of a design which will permit removal and replacement of band or clamps and hanger without taking down pipe. It must also permit vertical adjustment of pipes.

Hanger spacing on straight runs of piping shall be not greater than the following:

Pipe size (mm)	Space (meter)
Galvanized steel pipe	
20 and less	1.8
25 to 80	3.0
100 and more	4.0
PVC pipe	
20 and less	1.0
25 to 40	1.5
50	2.0
65 to 100	2.5
Cast iron pipe	
Pipe	1 (one) per one unit
Fitting	1 (one) per half unit

3.8.3 Vertical pipes shall be supported with steel pipe clamps, special cast iron pipe rests, base fittings, or by other approved methods suitable for the type of building construction.
Where several vertical pipes are installed parallel in the pipe space, the vertical pipes shall be supported on at least 100 mm by 50 mm by 5 mm steel channels resting at even interval between pipe surfaces and bolted tightly around the pipes with not less than 12 mm diameter steel "U" clamps or a least 25 mm by 3 mm steel plate. The channels shall be secured and welded on the building structure at every floor.

3.8.4 Spacing of clamps for support of vertical piping shall be close enough to keep the pipe in alignment, prevent rattle and vibration and to support the weight of the piping and contents.
In no case shall they be more than the following:

Pipe size (mm)	Interval for Vertical Runs (m)
15	2.40
20 and 25	3.00
32 and more	3.60

The interval for vertical PVC piping intermediate clamps shall be in no case less than one at each floor.

3.8.5 Vertical piping shall be adequately supported at their bases either by a suitable hanger placed in the horizontal line near the riser or by a base fitting set on a pedestal or foundation and at the middle of every floor with a riser clamp.
All risers shall be erected plumb and true, shall be parallel with walls and other pipes and neatly spaced.

3.8.6 Where pipes are located in concrete trenches, support pipes in concrete trenches on brackets or concrete piers, or hang from cross rods and hangers, as approved.
Where a concrete pier extends the full width of the trench provide weep holes in the floor a minimum of one inch in size.

3.8.7 Pipe anchors shall consist of steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise shown. Anchor braces shall be installed in the most effective manner to obtain the desired results. No supports, anchors, or stays shall be attached in locations where their installation or the weight or expansion of the pipe line will result in damage to the building construction.

3.8.8 Detailed drawings or samples of all pipe supports, hangers and anchors shall be submitted to the Engineer for approval before installation.

3.9 Pipe Sleeves, Escutcheons and Flashings

3.9.1 Furnish and install sleeves in connection with all piping passing through slabs, partitions or other building construction. The sleeves shall be set in new concrete construction before pouring. The sleeves in underground water storage tank's walls shall be furnished and installed in openings and lead poured and caulked joint between the sleeves and piping to make a watertight installation shall be made under this contract. Furnish any additional sleeves required for this work together with the cutting of walls and the proper grouting-in of the sleeve in the cut openings.

3.9.2 Sleeves through walls, floors and partitions shall be not less than 0.47 millimeter thick galvanized iron sheet or made of galvanized iron pipe.

3.9.3 Sleeves through outside walls above the foundation shall be galvanized steel pipe sleeves and properly caulked to insure watertight joints.

3.9.4 Where uninsulated exposed pipes pass through floors, finished walls or finished ceilings, they shall be fitted with neat, heavy, spun, cast or chromium plated stamped brass sheet escutcheons, firmly secured to the pipes. The escutcheons shall be of sufficient outside diameter to amply cover up the sleeved openings for the pipes. Where the escutcheons are not furnished with plumbing fixtures, they shall be supplied under this contract.

3.9.5 Pipes extending through the roof shall be flashed with sheet lead, copper or some other durable material to make the roof watertight.

3.9.6 Complete shop drawings showing method of dressing as may be required by the Engineer shall be submitted for his approval prior to the installation.

3.10 Floor Drains: Floor drains shall have cast iron bodies and bottom outlets designed for inside thread connection.
Floor drains shall be to comply with JIS A 4002.
Type C floor drains shall be installed in floor areas that are regularly flushed and not membrane waterproofed such as toilet rooms.

3.11 Cleanouts and Traps

3.11.1 Cleanouts shall be fitted on drainage lines in the positions shown on the drawings, and unless otherwise shown on the drawings the location of cleanouts shall be specified as follows:

(a) Cleanout shall be not more than 15 meter apart in horizontal drainage lines of 100 (mm) diameter or less and not more than 30 meter apart for larger pipes.

(b) Cleanout shall be installed at each change of direction of the drains greater than 45 degrees.

(c) A cleanout shall be provided at or near the foot of each vertical drainage stack.

3.11.2 Each vertical soil, waste and vent pipe which connects to horizontal drain piping below ground shall be fitted with a test tee installed above the ground or floor. Where accessible space is available, the test tee may be installed in the horizontal pipe at the base of the vertical pipe.

3.11.3 Where cleanouts or test tees occur on concealed pipes in finished rooms they shall each be provided with a 3 mm thick, machine finished, brass over plate of sufficient diameter to cover the

opening in the finished wall or partition. The cleanout plug must have a solid head which shall be tapped for a 6 mm brass machine screw to secure the cover plate. Where cleanout plugs extend beyond the wall finish the cover plates shall be of machine finished brass and plated or polished and shall be only sufficient depth to fit against the wall and to cover the plug.
Cleanout cover plates may be painted to match adjacent wall finish in lieu of being plated or polished.

3.11.4 Where cleanouts are shown on exposed pipes, cast brass plugs shall be installed.

3.11.5 Cleanout plugs on screw-jointed pipes up to and including 100 mm shall be the same size as the pipe. On pipes 125 mm and larger the cleanout plugs shall be at least 100 mm. A bushing to reduce to the plug size will be permitted.
Cleanout plugs on hub and spigot pipe shall be screwed into ferrules calked in the hub of pipe or fitting. In lieu of cleanout plugs, cast iron pipe fittings with access covers may be used.

3.11.6 Running traps or "P" traps shall be placed on connections from area and floor drains, where the same connect to a sewer carrying sanitary drainage and at other points indicated on the drawings. The traps shall be cast iron and shall have inlets and outlets designed for calking to cast iron pipe or threaded for connection to threaded pipe as required. Running traps, except the trap on the main sewer, shall have a cleanout on each side. When below ground floor or grade, cleanouts shall be extended up to floor level or grade and shall be provided with calking ferrules and brass cleanout plugs with countersunk heads.
"P" and "S" traps above ground floor, that are accessible after completion of the building, shall have brass screw cleanout plugs in bottoms of same.

3.12 Jointings

3.12.1 All joints shall be made watertight under pressures required for various services. The ends of all pipes shall be reamed free from

burrs and threads shall be clean cut and tapered. Piping shall be kept free from scale and dirt. Pipe shall not be split, bent, flattened nor otherwise injured either before or during the installation.

3.12.2 No bend or curve shall be made in any pipe which will diminish the waterway or alter the internal diameter of the pipe in any part.

3.12.3 All cutting shall be square to the pipe axis by approved means and all burrs removed. The use of pipe cutting machines which diminish the bore of the pipe shall not be permitted.

3.12.4 All pipes shall be free from cuts, dents or other surface damage, and damaged pipe shall be removed and replaced with new pipe.

3.12.5 Joints between pipes, fittings and drains shall be properly made and executed as below.

(a) All joints in threaded pipe shall be made up with red lead or approved pipe-joint compound and, if the Contractor wishes, he may use gaskin in conjunction with compound.

(b) Joint in PVC pipe shall be bell and spigot joints fittings, outer surface of pipe ends and inner surfaces of fitting shall be cleaned and polished. Solvent cement approved manufacturer shall be applied as recommended without binding. Solvent cement shall be penetrate fully and shall fill the joint completely.

(c) Joints in lead pipe shall be nearly executed wiped solder joints.

(d) Joints for drainage, ventilation shall be executed by either of the following methods:

(1) Lightly caulked with approved hemp yarn or lead strip, then molten pig lead tightly caulked to fill the socket.

(2) Lightly caulked with approved hemp yarn or lead strip, then lead wool tightly caulked home skein by skein to fill the socket.

(e) Joints between cast iron pipe and lead pipe shall be made with cast brass ferrules, wiped to lead pipe and caulked into the hub of the iron pipe.

(f) Joints between cast iron pipe and galvanized iron pipe shall be made with approved caulking fittings and jointed in threaded pipe.

(g) Joints between the waste pipe and traps of sinks, lavatory basins, shall be made with suitably screwed unions for steel, caulked run lead joints for cast iron, and wiped soldered joints for lead.

(h) Connections to urinals shall be made with adjustable flanged nipples.

(i) Connections between the pipes and floor-outlet type European waterclosets and slop sinks shall be made with lead pipes and cast brass floor flanges.

The lower end of lead pipe shall be jointed to cast iron pipe as specified in (e), a solder upper end shall be connected to the floor flange. Connection between floor flange and china fixture shall be made a tight connection by means of approved molded asbestos gasket or setting compound and bolting.

(j) Cement or other non-flexible material shall not be used for connection of water closet to soil pipe.

3.13 Piping Installations

3.13.1 General piping requirement shall be in accordance with the following:

(a) Where practicable pipe work shall be carried out as the building proceeds so as to minimize the amount of cutting away and repairing.

(b) The Contractor is responsible for the correct marking out of the positions of all necessary holes in walls, floors, ceilings, etc., for pipes and pipe supports. No pipe or other apparatus shall be installed in such a way as to interfere in any way with the full swing of the doors.

(c) The run and arrangements of all pipes shall be approximately as shown on the drawings and as directed during installation.

They shall be as straight and direct as possible, forming right angles or parallel lines with building walls and other pipes and be neatly spaced.

(d) Clearance between exposed pipes and the finished surface of wall, partition or ceiling shall be not less than 50 mm.

(e) Swing joints, offsets, expansion joints, etc., shall be provided wherever necessary to accommodate expansion of piping.

(f) Where pipe sizes shown or specified differ from the connection sizes of meters, pumps, fixtures, outlets, etc., reducing fittings shall be installed to the meters, pumps, etc. Bushings will not be allowed unless specifically approved.

(g) Unions or flanges shall be provided at tanks, storage water heaters, pumps, and elsewhere as may be required. They will not be allowed for drainage pipe joints, unless specifically approved.

(h) All horizontal runs of piping, except where concealed in partitions, shall be kept as high up as possible and close to walls. Consult with other trades so that grouped lines will not interfere with each other.

(i) The imbedding of valves, stop-cocks, unions or other movable fittings into concrete, plaster or other material so that they cannot be repaired or replaced without cutting the surrounding material shall be for bidden.

(j) Keep all ends of pipes plugged to prevent dirt accumulation or stoppage of the pipes of fixtures.

(k) Where openings are left on foundation walls for admission of plumbing pipes, spaces between the openings around these pipes shall be closed with brick or concrete as approved by the Engineer and made watertight as part of the work of this contract.

3.13.2 Water supply piping shall, without restricting the general piping requirement of the foregoing, be installed as follows:

(a) Water supply piping shall be complete from service connection to all fixtures, equipment, outlets, cooling towers, etc. Sizes of pipes shall be as shown and/or specified. No pipe

size allowing over two (2) meters per second flow velocity in the water supply piping will be permitted.

(b) Schedule of pipe sizes for water supply connections at fixtures shall be as following:

Fixtures	Pipe size (mm)
Water closet (flush tanks)	13
Water closet (flush valves)	25
Urinal (flush tanks)	13
Urinal (flush valves)	13
Lavatory basin	13
Sink	13
Slop sink	20

No water branch from riser or headers shall be less than 15 mm.

(c) The piping installation shall be arranged so that the entire system can be drained through accessible valves at low points.

(d) On each water service pipe shall be furnished and installed a stop-tap enclosed in a covered box or pit of such size as may be reasonable.

(e) No service pipe or distributing pipe shall be so laid so as to pass into or through any sewer, drain, or through any manhole.

3.13.3 Internal drainage piping covered soil and waste system shall be of the sizes noted and run as shown on the drawings. In addition to general piping requirement, the internal drainage piping shall be installed as follows:

(a) Pipes must be run in straight lines and have a uniform gradient per the following table, except that where such gradient on overhead pipes would reduce the headroom materially, the gradient may be reduce, if so directed by the Engineer.

Gradients

Pipe size (mm)	Ratio	Percentage (%)
80 and less	1:50	2
100 and more	1:100	1

No branch drain shall have a lesser grade than that given for the main drain to which it is connected.

(b) Outlet flanges and ends of soil and waste pipes shall be set the correct distance from the face of the floor or wall to make a first class joint with the gasket and fixture.

(c) Storm water shall not be drained into sewers intended for sanitary sewage only.

The soil drainage piping line for water closets and urinals, and the waste piping line for lavotory basins, sinks, etc., shall be combined from each other, as shown on the drawings.

3.13.4 The soil and waste sanitary system shall be provided with a system of vent piping which will permit the admission of air so that under normal and intended use the seal of any fixture trap shall not be subjected to a pressure differential of more than 25 mm of water column. The vent piping shall, without excluding general piping requirement described before, be installed as shown on the drawings and specified in the following:

(a) Top of ventilating pipes shall project through wall or roof to vent into the air at the point shown on the drawings. The ventilating pipes shall be fitted with a galvanized gooseneck and wallgrate at the top.

(b) No vent terminal from a drainage system shall be directly beneath any door, window, or other ventilating opening of the building or of an adjacent building, nor shall any such vent terminal be within 3 m horizontally of such an opening unless it is at least 60 cm above the top of such opening.

(c) All vent and branch-vent pipes shall be so graded and connected as to drip back to the soil or waste pipe by gravity.

(d) Where vent pipes connect to a horizontal soil or waste pipe, the vent shall be taken off above the center line of the soil

pipe. The vent pipe shall rise vertically, or at an angle not more than 45 degrees from the vertical, to a point at least 150 mm above the flood-level rim of the fixture it is venting before offsetting horizontally or before connecting to the branch vent.

(e) A connection between a vent pipe and a vent stack or stack vent shall be made at least 150 mm above the flood-level rim of the highest fixtures served by the vent. Horizontal vent pipes forming branch vents, relief vents, or loop vents shall be at least 150 mm above the flood-level rim of the highest fixture served.

3.14 Water Storage Tank

3.14.1 Water storage tank shall be provided in the sizes and in the positions shown on the drawings complete with all connections.

3.14.2 The tank and cover shall be free from any defects which would adversely affect the efficient functioning of the vessel. The water tank and cover shall be made from FRP (Fibergrass Reinforced Plastic). FRP called Fibergrass Reinforced Plastic is made of combination to fibergrass and unsaturated polyester. FRP panel shall be used sandwiched panel. The tank and cover shall be used field application type.
The tank shall be soundly constructed and assembled. The tank shall have adequate internal bracing and shall be fitted with an access opening 50 cm by 45 cm in size with angle framing assembled all round. The access cover with frame shall be of the same material as the tank cover. The access cover shall have rubber packing suitable for making the tank air tight and shall be secured with wing nuts to the tank cover. The tanks shall be thoroughly dust-proof.

3.14.3 Test the tank for water tightness, plug openings and fill with water to top.

3.14.4 Following connections shall be provided to the water storage tank.

(a) Filling inlet pipes from the pumps shall be located not less than 10 cm above overflow to provide an air gap.

(b) Overflow pipes shall be extended and the open end screened against entry of insects.

(c) Drain pipes from the bottom of the tanks shall be connected to the overflow with a gate valve and located where it can be reached conveniently.

(d) Filling inlet pipes from the pumps and distributing shall be connected to flexible conduit shown in the drawings.

(e) Fire lines shall be connected at the tank side as low as possible.

(f) Distributing pipes shall be connected at tank heights shown in the drawings.

3.15 Plumbing Fixtures

3.15.1 All fixtures specified as hereinafter, shown on the plans and noted on the schedules shall be furnished and set by the Contractor in a neat and finished manner, making connections with all supply, waste, soil and vent pipes, as hereinbefore specified, or as may be directed.

All fixtures shall be to comply with JIS A 5207.

General requirements for fixtures shall be the following:

(a) Where required by the Engineer and at any time, a fixture sample of each type designated on the drawing shall be submitted for approval. The samples shall be completely fitted and set up at the building or in some other convenient approved place.

The approved fixture samples shall be kept free from removal and protected at all times for comparison purposes. All fixtures of poorer quality than the samples will be rejected.

(b) Plumbing fixtures shall be of the best quality as fabricated by a manufacturer of established reputation.

(c) All ceramic fixtures shall be best quality regular selection, white vitreous china thoroughly fused, producting a white material which, when fractured, shall show a homogeneous mass

with close grain and freedom from pores. All surfaces coming in contact with walls, floors, or surfaces of other fixtures shall be reasonably flat.

(d) Enameled cast iron shall be the best quality and thickness necessary to form fixtures of the best commercial grade manufactured. Porcelain enamel coat on the surfaces required to be enameled shall be applied so that the enamel shall be smooth, of even thickness, white and free from craze, discoloration and chips. Exterior exposed surfaces not required to be enameled shall be treated with one coat of filler at the factories. The Contractor shall be responsible for any revisions of connection required to adapt the roughing sleeves and openings to the particular fixture he proposes to use.

(e) All fixtures shall have the manufacturer's guaranty label or trade mark indicating first quality.

(f) All fixtures shall be of the same manufacture unless otherwise directed by the Engineer.

3.15.2 Eastern Water Closets: Eastern water closets shall be of approximately 50 cm by 60 cm in overall size, "wash down type" unless otherwise specified.

It shall have a 100 mm "S" or "P" trap with an effective seal. The flush valves for the water closets shall be 25 mm flush valve, rubber inlet joint and pipe holder, and have expansion bolt and cover. The cistern for the water closets shall be 15 liter capacity high level vitreous china flushing cistern fixed to the wall with white acrylic resin baked iron bracket. It shall have a stop valve 13 mm, siphon with lever and chain pull, bend flush pipe 32 mm and pipe holder. All visible metal parts shall be chromium plated. Each water closets shall have a bibtap.

3.15.3 European Water Closets:

(a) European water closets shall be siphon-jet water closet with elongated rim, having integral trap with 75 mm or more

bore outlet, and be type VC-1110 of JIS No.
It shall have a inlet spud 32 mm, closed front solid plastic seat with cover, floor flange with gasket for 75 mm lead pipe connection and screws with cap.
The flush valve for the water closets shall be 25 mm flush valve with straight flush pipe 32 mm, and have a inlet spud 32 mm and seat bumber. All visible metal parts shall be chromium plated.

(b) European water closets shall be siphon-jet water closet with elongated rim, having integral trap with 75 mm or more bore outlet, and be type VC-1410 of JIS No.
It shall have a inlet spud 32 mm, closed front solid plastic seat with cover, floor flange for gasket for 75 mm lead pipe connection and screws with cap.
The cistern for the water closets shall be 15 liter capacity low level close-coupled cistern.
It shall have tank trim with wall supply with stop 13 mm.
All visible metal parts shall be chromium plated.

3.15.4 Urinals: Urinals shall be wall hung urinals with extended shields and have integral trap.
It shall be type VU-410 of JIS No. It shall have a inlet spud 10 mm, wall flange with gasket for 50 mm lead pipe connection and bolts.

(a) The flush valve for the urinals shall be flush valve 13 mm with offset supply 16 mm.

(b) The cisterns for the urinals 2 (two) units shall be 11 liter capacity high level vitreous china flushing cistern fixed to the wall with expansion bolts and type VT-240 of JIS No.
It shall be fitted with one 13 mm supply bib tap with silencing chain, stop valve with loose key 13 mm, bend pipe 25 mm, automatic siphon and outlet fittings 25 mm.
Each urinals shall have a supply pipe. Flushing cisterns shall be connected through flush pipes of galvanized screwed and socketed steel tubes.

(c) The cisterns for the urinals 3 (three) units shall be 15

liter capacity high level vitreous china flushing cistern fixed to the wall with expansion bolts and type VT-230 of JIS No. It shall be fitted with one 13 mm supply bib tap with silencing chain, stop valve with loose key 13 mm, bend pipe 32 mm, automatics siphon and outlet fitting 32 mm. Each urinals shall have a supply pipe. Flushing cisterns shall be connected through flush pipes of galvanized screwed and socketed steel tubes.

(d) All exposed flush pipes shall be chromium plated brass or copper tubes.

3.15.5 Lavatory Basins: Lavatory basins shall be approximately 50 cm by 40 cm overall size, fitted with one 13 mm diameter pillar taps, wall supply with stop 13 mm, plug and chain waste with P-trap 32 mm and back hangers with screws. It shall be type VL-520 of JIS No. All visible metal part shall be chromium plated.

3.15.6 Slop sinks: Slop sinks shall be approximately 55 cm by 45 cm overall size with high back, fitted with one 20 mm diameter bib tap with adjustable flange, waste & silver painted cast iron P-trap with flange for 65 mm lead pipe connection, rim cover and back hanger with expansion bolts. It shall be type VS-210 of JIS No. All visible metal part shall be chromium plated.

3.15.7 Stainless Steel Sinks: Stainless steel sinks shall be constructed of highest quality 18-8 stainless steel sheets. Dimensions and forms of sinks shall be in accordance with the drawings and the schedules. All draining boards and surrounds shall be polished to a mirror finish and bowls shall be polished to a satin finish. Stainless steel sinks shall be single bowl sink unit tops with draining boards. Each sink unit top shall be fitted with one 13 mm chromium plated pillar taps with single swivel supply nozzle, and each bowl fitted with 40 mm chromium plated waste fitting, vulcanite plug and chain. The stainless steel sinks shall be mounted on anticorrosive coated steel or wooden adjustable legs or skirt and fitted with drawers and/or open storage compartments. Each sink shall be fitted a trap having not less than 40 mm

diameter connections and type of "P".

Stainless steel sinks shall be made to the dimensions and installed in the positions in accordance with the following:

Dimensions	Locations
170cm x 55cm x 80cm high overall, single bowl with single draining boards	Tea room and kettle room

3.15.8 Unless otherwise specified, each plumbing fixture shall have a integral china trap or shall be fitted with a chromium plated brass or bronze, enameled cast iron water seal "P" trap or approved type trap wherein the extent of the water seal is not more than 100 mm and not less than 50 mm.

3.15.9 All plumbing fixtures installation shall be in accordance with manufacturer's printed instructions for conditions indicated and as required to obtain a rigid installation. The location of each fixture and the fixing method of ceramic fixtures shall be as shown on the drawings or as directed by the Engineer.

3.15.10 The height of fixtures above the finished floor shall be as follows:

European water closet	36 cm to top of basin
Urinal	53 cm to top surface of lowest front lip
Lavatory basin	72 cm to top of rim
Slop sink	68 cm to top of rim

3.15.11 The Contractor shall be responsible for protecting against injury from building materials, acids, tools and equipment all plumbing fixtures included in these specifications.

3.15.12 After all fixtures have been mounted and are ready for use and before leaving the job, thoroughly clean all fixtures furnished and mounted under this contract, removing all plaster, stickers, rust stains and other foreign matter or discolorations on fixtures, leaving every part in perfect condition and ready for use.

3.16 Toilet Accessories: All water closets shall be provided with chromium plated toilet paper holders. The paper holders shall be recessed or flush, fixed in position by means of chromium plated screw and wooden cleat embedded in the wall.

Mirrors shall be highly polished mirror, quality plate glass, 45 cm by 45 cm by 5 mm thick and fixed in position by means of 4 chromium plated brass screws and washers over rubber washers driven into lead or approved type plugs firmly embedded in the wall.

Glass shelves shall be of best quality glass with edges rounded off. The size of the shelf shall be 350 mm by 125 mm unless otherwise specified. The shelves shall have a chromium plated brass guard rail with rubber washers in position resting on glass plate and chromium plated brass brackets which shall be fixed with chromium plated brass screws to lead or approved plugs firmly embedded in the wall.

3.17 Storage Water Heaters

Provide where indicated the following storage water heaters as specified herein. Each storage water heater shall be provided in the capacity specified on the schedules and in the position shown on the drawing. The heater shall be cylindrical type on the sink, and operated by gas, automatic and exhausted.

The heater shall be robustly constructed with stainless steel sheet. The heater shall be of attractive styling and have two taps for hot water outlet 15 mm, a gas connection, water inlet 15 mm, glass water gauge, thermostat, automatic fuel control valve, gas control valve, gas pressure regulator, piezo-electric ignition, overflow, baffler and ball tap.

3.18 Pumps

3.18.1 Pumps shall be of centrifugal type, horizontally split, single suction with casings designed for suitable working pressure. Pressure classification of flange connection shall correspond to

casing working pressure. Sleeves (if any), eye rings, wearing rings, bolts and nuts in contact with water shall be of suitable stainless steel material. High points of pump casings shall be provided with air vent cocks.

3.18.2 Pump speed shall not be higher than 1,500 rpm. The pumps shall be quiet and free from vibration when in operation and the pumps shall be suitable for continuous operation.
Impellers shall be of good quality bronze, shall be fully enclosed and shall be dynamically and hydraulically balanced. Shafts shall be stainless steel. Bearings for pumps shall be either ball or roller bearings or ring oiled, babbitted, sleeve bearings with ample oil reservoirs. Thrust bearings shall be of the ball. All bearings shall be effectively sealed to prevent loss of oil and entrance of dirt or water. Each pump shall be provided with mechanical seals of an approved type and one extra replacement kit shall be provided for each pump.

3.18.3 Each pump shall have a cast iron or fabricated steel bed plate. The bed plate shall have a raised lip and drain tapping or bearing brackets shall have integral drip pockets with drain tappings. Bed plate shall be extended under the motor and both pump and motor shall be in accurate alignment when running at normal temperatures. Couplings shall be of the flexible type and shall impose no restriction on normal end play or expansion. Bed plate shall be carefully leveled, grouted and bolted in place on concrete fundations. Bed plate drain piping shall be connected to adjacent drain mains as shown on the drawings.

3.18.4 All pumps shall be factory engineered and assembled by the equipment manufacturer whose name-plate data is attached to the equipment. The pump shall be tested at the factory in accordance with specified conditions and the certified test results, by serial number of the pumps, shall be submitted to the Engineer. The pumps shall not be shipped until the factory unit tests have been formally approved.

3.18.5 Pump motors shall be of the totally enclosed type and insulated with class E materials of JIS C 4003. The motor shall be suitable for operation on a 400 volts, 3 phase, 4 wire, 50 hertzs supply and shall be designed for intermittent duty. 20 percent shall be the minimum derating factor for motors. Ball or roller bearing motors shall be used with ball or roller bearing pumps and sleeve bearing motors shall be used with sleeve bearing pumps.

3.18.6 The discharge pipe from each pump shall be provided with a check valve and a gate valve. The check valve for the water supply pump and the fire pump shall be of non-slamming type specified before. On the bottom of suction pipe, for othe water pump and the fire pump shall be furnished with a swing type screw foot valve with strainer.

3.18.7 In case the suction water level is lower than the suction flange, the pumps shall be provided with an automatic priming system complete with a make-up water tank and piping, etc., as indicated on the drawing.

3.18.8 The water supply pump shall be operated by the water level sensers. The water level sensers and installation work shall be included in this specification.

3.18.9 The water level senser for underground water storage tank shall be actuated by the high and low alarm relays, the low water cut-off relay and the relays for against the prevention of chattering.

3.18.10 The water level senser for water storage tank shall be actuated by the high and low alarm relays, the low water put-on relay and the high water cut-off relay.

3.18.11 The water level sensers shall be the electrode type and shall have each water levels. The electrodes shall be of stainless steel rod.

3.18.12 In lieu of electrodes, the Contractor may, with the Engineer's approval, offer a different type switch for actuating the pump motor starter, the high and low alarm relays and the low water cut-off relay.

3.19 Foundations: All foundations for apparatus and machineries, including all motors, pumps, etc., shall be the size specified or shown on the drawings.

All concrete foundations shall be constructed as specified under "Concrete Work".

All parts exposed above the floor shall be finished with cement mortar troweled smooth, with beveled edges.

All necessary anchor bolts, washers, templates, etc., shall be furnished complete and bolts shall be built into foundations with proper size sleeves.

3.20 Fire Fighting Equipment

3.20.1 All fire fighting equipment shall comply fully with all laws which may be in force.

3.20.2 The fire fighting equipment covered in this section of the specification shall include portable fire extinguishers, the fire hydrant system.

The Contractor shall complete the attached Schedule of Spare Parts recommended by him to be supplied, including handing in to Stores. The Contractor shall provide the spare parts and complete sets sufficient for 1 (one) years service for all fire fighting equipment.

3.20.3 After completion of the work, all fire fighting equipment installed shall be inspected to entire satisfaction in the presence of the Engineer.

3.20.4 Portable Fire Extinguishers

(a) Portable fire extinguishers shall be provided where specified and where so indicated on the drawings.

(b) The suitability of the various kinds of extinguisher as a means of extinction varies according to the materials involved.

The following is a guide in the selection of appropriate types.

(1) Fires in ordinary combustible materials (e.g. wood, textiles and paper) Fires in flammable liquids (e.g. spirits, oil or varnishes)	Dry powder type (A chemical powder of phoshoric acid bihydrogenate ammonium)
(2) Fires where there is an electrical risk	Carbon dioxide type

(c) The portable fire extinguishers shall be approved by the Engineer.
The extinguishers shall be completely equipped with valve, nozzle and necessary accessories.
The extinguishers shall be selected from the following tables and shall comply to the requirement as specified.

Dry Powder Extinguishers

	Type 10
Range of Discharge	3.0 - 4.5 m
Duration of Discharge	14 second
Weight Empty	2.9 kg
Weight Full	5.9 kg

Carbon Dioxide Fire Extinguishers

Liquefied Co_2 Gas Container	Type 7
Weight Full	12 kg
Weight of Gas Produced	3.2 kg (20°C)

(d) The portable fire extinguishers to be directly mounted on the walls shall be provided with approved type hooks for such attachment.

3.20.5 Hydrant System: The specification for water piping, water storage tanks, fire pumps and valves for the hydrant system shall comply with the preceding Section concerned. The requirement of each component shall be as follows:

(a) The fire indoor hydrant system shall consist of mains, branches, hose outlets, hose racks, cabinets, hoses, nozzles and all other necessary equipments to meet in full the requirements of the system as shown or specified.

(b) A cabinet shall contain a hose outlet with angle valve, hose rack, 30 m of hose and nozzle, etc. The cabinets shall be of 1.2 mm minimum thickness steel sheet,and rust-proofed with baked enamel finished surfaces.
The cabinets shall be of the recessed type except where specifically noted to be surface mounted. Surface of the cabinet cover shall be provided with suitable markings to indicate "FIRE".

(c) Each hose outlet shall have a 40 mm cast bronze angle valve as glove valve type with 40 mm brass nipple to the support rack.

(d) Hoses shall be installed on an chromium plated bronze or brass rack with sliding pins, checks and top cover.

(e) Hose for use with standard hydrants shall be 40 mm highest quality linen hose coupled and lined rubber in 30 m lengths with rough brass coupling.

(f) Nozzles shall be spray type, 40 mm instantaneous coupling made of brass or other sufficiently robust and corrosion resisting metal.

(g) Provide on the outside building wall bronze polished Siamese connections threaded to fit Fire Brigade coupling, wall type with two 65 mm inlets and 100 mm outlets, check valve clappers,

brass plugs, chains and brass escutcheon with the wors required cast on it.

(h) The fire siamese hydrant system shall consist of mains, branches, Siamese connections, hose outlets and all other necessary equipments to meet in full the requirements of the system as shown or specified.

(i) The hose outlets of siamese hydrants shall have an instantaneous outlet so that the public fire brigade can radily couple its hose to them.

3.21 Painting

3.21.1 All pumps and other machinery, all portions of pipes which are not concealed in duct or chase in concrete or block walls and all pipe supports, hangers, etc., shall be thoroughly painted as specified hereinafter and all underground pipes shall be provided with protection coating for corrosion.

3.21.2 Paint materials shall be of an approved type obtained from manufactures approved by the Engineer and shall be supplied to site in the manufacturer's sealed and branded containers.

3.21.3 Painting and finishing work shall be carried out careful and good workmanship. Exterior or exposed painting shall not be provided under adverse weather conditions such as rain, extreme humidity, dust storms, etc. Every possible precaution shall be taken by the Contractor to keep down dust during the painting process or preparation therefore. All surfaces shall be freed of loose matter, efflorescence, dust, etc., before the application of each coat and all paint shall not be applied to damp or wet surfaces.

3.21.4 All pumps, motors and other machinery shall have a priming coat or red lead, a suitable filler or under coat, and two finish coats of machinery enamel. If a priming coat has been applied in the shop, it may be omitted from the field painting. If two or more coats have been applied in the shop, only one finish coat of enamel will be required, unless additional coats are needed in the opinion of the Engineer to cover properly a contrasting shop colour.

3.21.5 All exposed piping and metal work, installed under Plumbing Work, shall be painted as follows:

(a) All exposed ferrous metal piping and iron work exposed to view, such as pipe hangers, etc., shall be thoroughly cleaned to remove grease and dirt and wire brushed and scraped to remove scale and rust. A minimum of two coats of primer shall then be applied by brushing well into the surface. Each coat shall be allowed to dry and harden thoroughly before the next coat is applied. Then, one or more coats of undercoat paint shall be applied and a minimum two coats of finishing coloured paint shall be given until sufficient cover is obtained to the satisfaction of the Engineer.

(b) All exposed galvanized piping and fittings shall be cleaned thoroughly by swabbing with thinners or solvents and any rust removed as for ferrous metal above. Two coats of primer which provide a bond for the paint shall then be brushed on. Under-coating and finishing shall be as for ferrous metal above.

(c) All cast iron pipes and fittings exposed to view, shall be thoroughly cleaned of all dirt, rust and grease and given a composition of coal tar or black paint finish over factory-applied coat.

3.21.6 Steel cabinets and boxes which are not factory primed or finished nor galvanized, shall be treated for rust inhibition by bonderizing shall have primer applied to all surfaces and one finish coat given to interior and to exterior surfaces which will be concealed after installation. Exterior surfaces which will be exposed after installation shall have two finish coats applied. Galvanized surfaces shall be applied a primer which provide a bond for the paint and finished the same as non-galvanized surface.

3.21.7 All underground steel or iron pipes, unless otherwise galvanized, except that cast iron pipes are factory coated, shall be applied and wrapped with enamel (Tar Epoxy Resin Base or other approved Base) for protection against corrosion as specified below:

(a) The pipe coating shall be carried out before pipe laying.

(b) The pipe shall be thoroughly cleaned of all oil, grease, rust, loose mill and other foreign substances. The pipe shall be cleaned by means of stiff wire brushes, scrapers or other hand tools.

(c) Immediately after cleaning, priming shall take place. The coating shall be uniform in thickness and the prime pipe shall not come into contact with the ground and shall not be handed until the primer is thoroughly dry. In any event primer shall be thoroughly dry before enamel is applied. If the primer has dried to the extent that it will not slide or rub off under moderately hard pressure of the hand it is usually dry enough for enameling.

(d) Enamel of the type and base similar to the primer employed shall be applied with method recommended by the manufacturer after the application of the primer. When the first coat has hardened a second coat of enamel shall be applied. The completed coating shall not be not less than 3 mm in thickness. The pipe shall be elevated so that the coating shall not come in contact with the earth. Coating work shall be done by experienced crews in skillful workman-like manner to the satisfaction of the Engineer. All coating where the pipe has rested on skids or at wrinkle bends and areas adjoining slackloops, shall be repaired or recoated as directed by the Engineer. Repairs shall be made by pouring a quantity of enamel over the damaged areas.

(e) All coating shall be inspected for the satisfaction of the Engineer prior to pipe installing.

3.21.8 All painting surfaces of piping, equipment, etc., except underground piping, shall be of the approved colour finish. All colours shall be submitted for approval by the Engineer before the application of the paint.

3.21.9 All pipes, whether exposed or concealed in accessible pipe spaces, shall be provided with colour bands and legends for identifying

contents of pipes by approved colour and legend scheme. Horizontal piping shall be marked at intervals of 15 meters, and vertical piping shall be marked on each floor. Marking shall be placed adjacent to valves and fittings.

3.22 Test

3.22.1 This section includes all tests required under laws, rules and regulations.
All the tests shall be done by and under the responsibility of the Contractor.

3.22.2 All tests, except the factory test, shall be conducted to entire satisfaction in the presence of the Engineer.

3.22.3 Instruments, facilities, labour, fuel, water, electricity, etc., required to properly conduct the test shall be provided by the Contractor at no additional cost to the Government.

3.22.4 All defects disclosed in the work by tests and otherwise shall be made good or the work replaces without additional cost.

3.22.5 Before any fixtures are connected, the water test shall be applied to the drainage system either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 3 m head of water. In testing successive sections, at least the upper 3 m of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 3 m of the system) shall have been submitted to a test of less than a 3 m head of water. The water shall be kept in the system, or in the portion under test, for at least 15 minutes before inspection starts, the system shall then be tight at all points.
If tests are authorized to be made with air, a pressure of not

less than 250 mm of mercury, shall be applied with a force pump, and said pressure maintained without leakage for not less than 15 minutes. If leaks appear, pipes shall be made tight and tests repeated till all joints are tight and approved.

3.22.6 After all fixtures have been permanently connected, the sanitary system shall be tested for tightness to the satisfaction for the Engineer. No piping or equipment shall show evidence of stoppage.

3.22.7 Water piping run in chases, in walls, above suspended ceiling or in any way concealed by structural work shall be subjected to a hydrostatic test and proved tight before being concealed. All other water piping shall be subjected to a hydrostatic test at the completion of the work and proved tight. The test pressure shall be 7.5 kg/cm^2 at the lowest point in the system and held for a period of not less than 30 minutes. The piping system shall be considered tight if the drop in pressure does not exceed 0.5 kg/cm^2 during the test period. If the pressure drop exceeds 0.5 kg/cm^2, all repairs and alterations in the piping system necessary to meet the test shall be made.

3.22.8 Hydrant system shall be subjected to hydrostatic test in the same manner as the water piping. After hydrant system work has been completed, the complete system shall be subjected to an operating test under fire pump normal operating conditions and each hydrant shall discharge the water through hose and nozzle.

3.22.9 All repairs to the piping system shall be made with new material. No caulking on screwed joints, cracks or holes will be acceptable. Where it becomes necessary to replace pieces of pipe, such replacements will be of the same length as the defective pieces.

3.22.10 Each water outlet shall be checked for the rate of flow and correct operation.

3.22.11 Every pump and other equipment shall be tested at the factory to demonstrate its capacity and general operating characteristics. A certificate of factory test shall be forwarded to the Engineer

for approval before the machine is shipped.

3.22.12 After the completion of the work to the satisfaction of the Engineer, the Contractor shall be responsible for running reliability test, under normal automatic operating conditions, for all pumps, storage water heaters and other mechanical equipment to the satisfaction of the Engineer before the acceptance and taking over of the works.
If any defect appears during the reliability tests, the Contractor shall take away the defect and shall apply repeatedly above-mentioned tests. The Contractor shall provide full time skilled operators during the reliability tests.
Performance tests to prove the speeds, power consumption capacities and other details as required for all pumps, and other mechanical equipment shall be made, and readings taken, during the above period.
Items to be measured for each equipment shall be as shown below.

Equipment	Items to be measured
Each pump	Total water head Delivering capacity Speed
Each pump motor	Voltage Starting current Loading current Operating horse power Speed

3.22.13 All fixtures shall be tested for soundness, stability of support and perfectness of operation.

3.22.14 All parts of the plumbing system and associated equipment shall be otherwise tested and adjusted to work properly and be left in good operating condition.

3.22.15 Tests shall be repeated after any defects disclosed thereby have been made good or the work replaced if, in the judgment of the Engineer, it is deemed necessary.

3.22.16 The Contractor shall be responsible in the last routine check preceding the end of the maintenance period to demonstrate that the operation of the complete systems including automatic operating device, interlocks and safety devices for the various equipment and auxiliaries are in satisfactory working order. The Contractor shall prepare and fill the routine maintenance schedules stating the date, frequency, type of the maintenance service carried out, and name of the Maintenance Engineer present, and shall submit same in duplicate to the Engineer after every check.

3.23 Disinfection

3.23.1 After completion of all tests, replacements and repairs, all water supply systems shall be thoroughly flushed with water to remove sediment. Disinfection shall be applied to all drinking water piping, pumps and tanks.

3.23.2 The disinfectant shall be chlorine, either in the form of a hypochlorite solution or in the form of compressed gas applied through an approved chlorinator. During chlorination, all valves and equipment shall be operated, to insure that chlorine reaches all parts of the system. Water and chlorination agent shall be fed into the system at rates that will provide a residual chlorine content of not less than 10 ppm after a retention period of 1 hours. (An initial application of 25 ppm or more will generally be required.)

4. GAS INSTALLATION WORK

4.1 General

4.1.1 Gas installation works including all gas piping and their accessories as described elsewhere in these specifications and drawings shall be included in this contract.

4.1.2 All gas installation works shall be provided by the Contractor whether such works are mentioned or shown on drawings or not, and the Contractor shall be deemed to allow in this tender price for all such works.

4.1.3 All gas installation works required in these specifications shall be carried out only by SUI NORTHERN GAS PIPELINES LIMITED in ISRAMABAD, and shall be entrusted to install as shown drawing to him.

4.1.4 The cost of gas installation works shall be included by the estimate of plumbing work.

4.1.5 The Contractor shall allow in this tender for prepairing detailed working drawings of all parts of the works and shall submit all such drawings to the Engineer for approval.

TECHNICAL SPECIFICATIONS

PART II

FOR

ELECTRICAL INSTALLATION

PLUMBING, GAS INSTALLATION

AIR CONDITIONING

AND

LIFT

PART II-(iv)

AIR CONDITIONING

NIPPON SŌGŌ ARCHITECTS' AND ENGINEERS' OFFICE CORP., LTD.

(NSK) TOKYO JAPAN

TECHNICAL SPECIFICATION FOR AIR CONDITIONING

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1. GENERAL

1.1 General Description: The Contractor responsibilities shall include the supply, delivery to site, erection and commissioning of all materials and equipment required in accordance with this specification.

1.2 Extent of Work: The works covered under these specifications shall include not only the Mechanical Services for Heating, Ventilating and Air Conditioning but also all necessary Associated Other Services.

1.3 Materials: The plant and materials shall be new and of the best of their respective kinds suitably tropicalized and adequately protected against the prevailing weather conditions of Pakistan.

1.4 Design Conditions: The scheme is based on the following design conditions:

(a) External Design Conditions:
Summer: 42.0°C D.B. and 27.0°C W.B.
Winter: 3.0°C D.B. and 1.0°C W.B.

(b) Internal Design Conditions:
Summer: 27.0°C D.B. and 50% R.H.
Winter: 20.0°C D.B. and 50% R.H.

2. SELF-CONTAINED AIR CONDITIONERS

2.1 General: Self-contained air conditioners shall be floor mounted type and shall be a factory-made encased assembly designed as a unit for water cooling type and shall be designed for delivery of conditioned air to an enclosed space without ducts or with ducts. Water cooled type unit shall consist of enclosed casing, plenum chamber and air distributing grills (if any), fan, fan motor, electric heater, cooling coil, air filter, hermetic condensing unit with compressor motor or semi-hermetic compressor with motor and condenser, humidifier, refrigerant piping and necessary accessories, safety devices, control panel, starter switches, base and frames, etc.
Every self-contained air conditioners shall have sufficient capacity indicated on the drawings.

The refrigerant employed shall be dichlorodifluoromethane (R-12) or monochlorodifluoromethane (R-22). Each conditioner shall be designed to operate on 50-hertz, 3-phase, 400 volts.

2.2 Water Cooled Condensers: Water cooled condensers shall be of double tube type or shell and tube type, and assembled by manufacturers.

2.3 Cooling Coils: Cooling coils shall have sufficient capacity indicated on the drawings, and shall be assembled by manufacturers.

2.4 Safety Devices: Unless otherwise specified, safety devices shall consist of pressure switch and fuse metal for refrigerant and over load cutout switches for motors. The pressure switch shall operate by refrigerant pressure both in the high pressure side and low, pressure side. Fuse metal shall protect against an emergency caused by an abnormal rise of refrigerant temperature and pressure. The melting point of the fuse metal shall be approved by the Engineer.

2.5 Humidifiers (Water Spray Type): The water spray type humidifier shall be of black steel pipe with atomizing nozzles mounted across the air stream in the casing of self-contained air conditioner. Each atomizing nozzle shall be of brass construction and shall be provided with an easily removable strainer constructed of fine mesh copper or brass wire screen. The nozzle construction shall be such as to produce an efficient and appropriate atomizing effect. The nozzle bodies shall be securely screwed in sockets welded on the pipe respectively and shall be removable to permit cleaning of the nozzles. Capacity and spacing of atomizing nozzles shall be such as will insure uniform distribution of the specified humidifying quantities at each pressure of water lines on which the nozzles are mounted. The Contractor shall submit samples, catalogues and performance data on each atomizing nozzle for the Engineer's approval.

2.6 Air Filters: Air filters shall be of the sectional, replaceable, dry media type and shall be supported in a tight fitting slide-out frame. Filters shall be easily removable. The type of filter shall be specified on the drawings.

2.7 Electric Heaters: Electric heaters shall be installed on the self-contained air conditioners indicated on the drawings. The electric heaters shall be of the functional insulation blast coil type and so designed that risk of fire, mechanical damage, electrical shocks is obviated as far as possible, controlled by an energy regulator of the contactor type. Electric heating units shall consist of a frame, casings, or other supporting means containing one or more heating elements, electric terminal connections, and electrical wiring and insulation all assembled into a unit.

Each electric heater shall be suitable for electricity supply of three phase, 400 volts, 50 hertz and shall satisfy the required capacity. The wattage output of the heater shall not exceed 105% of the nameplate rating.

Electric resisters shall be composed of metal-alloy wire and shall be safely enclosed within a protective metal sheath. The metallic resistors shall be firmly held in position by a refractory insulation material so it will not become grounded to the sheath when subjected to vibration, shock or moist air.

Each electric heating unit shall have a thermal limit control switch to limit the discharge air temperature to 80 degree C. Limit control switch for 400 volts heater shall be factory connected on all heaters rated at three-phase which are within the capacity of the switch. Where automatic temperature control is required, the heaters shall be divided into a number of sections dependent upon the degree of control to be effected. Control equipment shall include thermostats, device for overload and for short circuit protection and disconnecting equipment. Each stage shall be automatically controlled so that they will be cut-in or cut-off in sequence upon temperature drop or rise by controlled correspondingly with one or two thermostats.

2.8 Casing: Casing shall be substantially constructed of heavy rust-proofed sheet steel and shall be braced and stiffened to hold all working parts in line and prevent any change in shape when in operation. Casing panels shall be removable for access to interior parts. Casings shall be internally lined on all surfaces for thermal insulation and sound absorption. Lining shall be secured to the casing

with adhesive applied over the entire back. Compressor unit, fans and fan motors shall be provided with vibration isolating devices.

2.9 Foundation: Each self-contained air conditioner shall be mounted on a 15 centimeter high concrete foundation.

2.10 Miscellaneous: Every self-contained air conditioners shall be tested at the factory to demonstrate its capacity and general operating characteristics. The certificate of factory test shall be forwarded to the Engineer for approval before the machine is shipped.

3. COOLING TOWERS

3.1 General: Cooling towers shall be of the mechanical draft, counter-flow type and may be of wetted surface type. The cooling tower shall have sufficient capacity to handle the condenser water requirements for the refrigeration system indicated on the drawings. The cooling tower shall be designed to operate at the ambient temperature of 28 degree C wet-bulb.

The cooling towers shall be complete with open type distribution system, FRP (Fiberglass Reinforced Plastics) constructed basins, outlet strainers, float-type water make-up assemblies, inlet louvers and eliminators (if any), fans, motors, drive assemblies, structural framework, tower housing anchor bolts, and all necessary appurtenances and accessories.

Basins shall be FRP, of ample depth to cover the outlet and insure against entrainment of air.

Each basin shall be provided with a float controlled make-up connection, with air gap, and outlet connections with strainer consisting of a removable screen. Casings shall be constructed of FRP. Casings may be bolted.

The air intake to each tower shall be provided with louvers of PVC (Polyvinyl Chloride). Louvers shall be provide access to the basin. Tower filling shall be made of PVC and shall be of a type which will present the maximum wetted surface with the least resistance to air flow. Filling shall be removable or otherwise made accessible for cleaning.

The water distribution system shall give uniform coverage of water over the tower areas.

Fans shall be of the propeller type, quiet in operation and shall be driven by means of a V-belt drive with belt-guard, or direct connected drive. The fans shall be constructed of aluminum. Bearings shall be of ball or sleeve type which are provided with the means for lubrication for bearings extended outside the casing.

Each fan shall be driven by a totally enclosed electric motor that shall be quiet in operation. Fans may be belt driven or mounted directly on the extended motor shaft. Belt drives shall be weatherproof and shall have adequate means for adjusting belt tension.

Cooling towers shall be installed on suitable concrete foundations where indicated.

3.2 Cooling Tower Make-up Water Pump: Cooling tower make-up water pump having the capacity indicated shall be installed on suitable concrete foundation where indicated.

The pump shall be of the non-overloading, single-suction, enclosed-impeller, centrifugal type. The pump shall be arranged for continuous operation and shall be of heavy duty construction with screwed connections.

The pump casings shall be of cast-iron designed for a working pressure of 150 percent of the actual operating pressure.

Impellers shall be of suitable stainless steel or good quality bronze and shall be dynamically balanced. Shafts shall be steel.

Bearings shall be antifriction, permanently grease lubricated ball bearing type or oil lubricated sleeve type or roller type with an oil reservoir. Bearings shall be effectively sealed to prevent loss of oil and entrance of dirt or water. Shafts seals shall be of the mechanical type guaranteed by the pump manufacturer for the particular service involved.

The pump shall be directly connected by means of a flexible coupling to a drip proof electric motor of adequate capacity.

Cooling tower make-up water pump shall be provided with pressure tank and automatic operations accessories. Pressure switch installed for starting and stopping the make-up water pump automatically.

Pressure tank shall be made of black steel.
The pump shall be factory engineered, assembled and tested at the factory whose name-plate data is attached to the equipment.
The pump shall be tested at the factory in accordance with specified conditions and the certified test results shall be submitted to the Engineer.

4. CONDENSER WATER PUMPS

4.1 Pumps: All condensing water pumps shall be of centrifugal type, horizontally single suction with casings designed for suitable working pressure. Pressure classification of flange connection shall correspond to casing working pressure. High points of pump casings shall be provided with air vent cooks. Pump speed shall not be higher than 1,500 r.p.m. The pumps shall be quiet and free from vibration when in operation and the pumps shall be suitable for continuous operation.
Impellers shall be of suitable stainless steel or good quality bronze, shall be fully enclosed and shall be dynamically and hydraulically balanced. Shafts shall be stainless steel. Bearings for pumps shall be either ball or roller bearings or ring oiled, babbitted, sleeve bearings with ample oil reservoirs. All bearings shall be effectively sealed to prevent loss of oil and entrance of dirt or water. Each pump shall be provided with mechanical seals of an approved type.

4.2 Pump Motors: Pump motors shall be the drip proof type. Ball or roller bearing motors shall be used with ball or roller bearing pumps and sleeve bearing motors shall be used with sleeve bearing pumps.

4.3 Bed Plate: Each pump shall have a cast iron or fabricated steel bed plate. The bed plate shall have a raised lip and drain tapping or bearing brackets shall have integral drip pockets with drain tappings. Bed plate shall be extended under the motor and both pump and motor shall be in accurate alignment when running at normal temperatures. Couplings shall be of the flexible type and shall impose no restriction

on normal end play or expansion. Bed plate shall be carefully leveled, grouted and bolted in place on concrete fundations.

4.4 Name Plate and Tests: All pumps shall be factory engineered and assembled by the equipment manufacturer whose name-plate data is attached to the equipment. The pump shall be tested at the factory in accordance with specified conditions and the certified test results, by serial number of the pumps, shall be submitted to the Engineer. The pumps shall not be shipped from the factory unit tests have been formally approved.

5. FANS

5.1 General: In general, the following requirements shall apply to all fans which are not integral parts of cooling towers, and self-contained air conditioners. All fans shall be guaranteed to deliver the specified air quantities at the specified static pressures when tested in accordance with the authorized test code approved by the Engineer. All fans shall be accurately balanced both statically and dynamically and shall be free from objectionable vibration or noise in operation.

The Contractor shall submit to the Engineer for approval a dimensioned drawing of each fan, as prepared by the fan manufacturers. The fan, motor, drives, vibration isolating base and performance data shall show indispensable mounting dimensions, sheave diameters, motor type and size, drive center to center distances, number and type of belts, complete fan performance data including decibel ratings, and any other information requested by the Engineer.

All fan wheels and housing interiors and exteriors shall be well protected against corrosion and finished with a factory coating. Where specified on the drawings, all fans shall be given acid-proof treatments to minimise the harmful effects of sulphuric acid fumes possibly generated in the battery room or other similar rooms.

5.2 Centrifugal Fans: Unless otherwise specified, centrifugal fans shall be of the full housed, single inlet type with forward curved, multi-blade type wheels. Performance curves shall be submitted for each

centrifugal type fan to be installed. Fan curves shall show brake horsepower, static pressure and static efficiency plotted against air volume. All fans shall be selected for their maximum efficiency. Housing for fans having wheels smaller than 30 centimeters in diameter shall be made of cast iron or steel and housings for fans having wheels 30 centimeters or more in diameter shall be made of steel. Flat portions of housings shall be heavily braced so as to prevent vibration and provide adequate support for the bearings. Inlet rings shall form smooth curves to reduce turbulence. Large fan housings shall be made in sections small enough to permit installation or removal through openings available in the building. Field joints shall be flanged and bolted.

In general, fans shall be connected to the driving motor by means of an approved multiple V-belt drive. Belts shall be matched type and a removable painted black sheet steel belt guard shall be furnished for each unit. Fan motor sheaves shall be adjustable to permit regulation of the fan speed when necessary. Vibration isolating bases shall insure permanent alignment between the motor and fan by means of structural steel members and isolating elements shall be suited to the loads and type of installation involved.

Fan wheel and housing installed in plating room in annex shall be made of Polyvinyl chloride.

Motors except installed in plating room shall be drip proof type and shall be equipped with adjustable bases or with rails. The motor installed in plating room shall be totally enclosed type and acid-proof treatment. The motors shall be designed to suit the characteristics of the available electric service. Where air-filters are used in a fan system, fan horsepower shall be selected in sufficient strength so as to assure the design air quantities at the end of useful filter life when the pressure drop across the air filters is maximum. Fan motor starters shall be fitted with indicating lights in order to indicate running and off conditions.

5.3 Propeller Fans: Unless otherwise specified, propeller fans may be of either the direct connected, motor driven type or belt connected. Wheels shall have steel or aluminum blades with heavy hubs. Fans shall be quiet in operation and shall be dynamically balanced. Fans and motors shall be supported on heavy metal frames designed for the

required mounting, and shall be mounted on resilient supports.
Shafts for fans not mounted directly on motor shafts shall be of steel and shall be accurately finished on all working surfaces. Fan bearings shall be of the self-aligning ball or sleeve type with continuous oiling arrangements requiring fillings at infrequent interval and have effective seals to retain lubricant and exclude dirt, except where the fan wheels are mounted on extended motor shafts. A wire mesh guard shall be provided and installed on fans when they are mounted so that any part of the wheel is less than 2 meters above the floor.
Propeller fan for battery room shall be acid-proof treatment.
Motors shall be designed to suit the characteristics of the available electric service. Generally, the motors shall be the totally enclosed type.
Air stream operated dampers and discharge grills of approved type shall be installed on each exhaust fan as indicated on the drawings.
The casing shall be provided with an inspection door for access to lubricator and terminal box.

6. AIR FILTERS

6.1 General: Filters shall be suitable for the space available and shall be installed without damage to the building, building equipment or the filter.
Filters shall be fabricated and installed so as to prevent the passage of unfiltered air. Felt, rubber, or neoprence gaskets shall be provided between filter frames and unit casings, etc. All steel filter parts shall be protected against corrosion by a baked enamel, epoxy resin, zinc-coating, cadmium plating, two coats of oil paints, or two coats of lacquer.
Filter elements and media shall be adequately protected against dirt during construction and shall not be operated until ductwork is thoroughly cleaned. Filters must be put in regular operating condition before the fans to which they connect are operated for any purpose, such as temporary ventilation or adjusting. After all adjustments, etc., are completed and before the filters are accepted for

regular operation, they shall be cleaned and provided with additional new media to put them in NEW condition.
Unless otherwise specified, air filter shall be tested before installation to demonstrate its resistance to air flow, dust holding capacity and dust removing efficiency when operating at its specified capacity. The entire cost of all tests shall be borne by the Contractor.

6.2 Type A Air Filters: Type A air filters shall be of the sectional, replaceable, dry media type.
The filtering media shall be a polyamid fiber material. The media shall be supported by wire mesh or expanded metal screens arranged so that air is distributed evenly to all surfaces. Supporting screens shall be secured to heavy frames so constructed that they can be separated and reassembled easily to permit removal and renewal of the filtering media. Each filter section shall be provided with felt gaskets and latches to secure it in the frame.
The filtering media shall be 18 millimeters thick and have a 50 x 50 centimeter face.
Filter shall be provided with a factory made sectional supporting frame of aluminum constructed not less than 1.0 millimeter thick.
Joints in the frame section shall be welded or riveted, and individual frames shall be bolted together to form the whole frame assembly.
Type A air filters shall be of Model VB-W with Art. No. PS/600N, manufactured by Japan Vilene Company, LTD, or approved equal by the engineer.

6.3 Type B Air Filters: Type B air filters shall be of the sectional, replaceable, dry media type. The filtering media shall be a glass fiber material.
The media shall be supported by wire arranged so that air is distributed evenly to all surfaces.
Air filters shall be secured to diffuser of Circuit Component Lab (2) so constructed that they can be separated and reassembled easily to permit removal of the filtering media. Each filter section shall be provided with felt gaskets and latches to secure it in the diffuser as shown on the drawing.

Unless otherwise specified, the filtering media shall be 10 millimeters thick and have a 50 x 50 centimeter face.
Each filter shall be provided with a factory made sectional supporting frame constructed of not less than 9 millimeters plywood.
Type B air filters shall be of Model VS-900D, manufactured by Japan Vilene Company LTD, or approved equal by the engineer. Spare filters shall furnish twenty pieces.

7. CASINGS AND DUCT WORK

7.1 General: Unless otherwise specified or noted, all casings and ducts shall be fabricated of best quality, commercially straight and flat, galvanized steel sheet. Galvanized steel sheet shall conform to JIS G 3302. The weight of the zinc coating shall be not lighter than as specified in the following, coated on both sides:

Thickness (mm)	Weight of Coating in Grams per square meter
0.5	244
0.6, 0.8, 1.0	305
1.2, 1.6	381

All ducts and casings, unless otherwise approved by the Engineer, shall conform accurately to the dimensions indicated on the drawings and shall be straight and smooth on the inside with joints neatly finished. Shop drawings of all ductwork and casings shall be submitted to the Engineer for approval before any construction is begun. Rivets, screws and other accessories shall be made of the same materials as the duct or casing sheet, or zinc or cadmium-plated steel. Minimum rivet diameter shall be 4 millimeters.
Where indicated as concrete duct on the drawings, such ducts shall be constructed of brick or concrete and shall have an inside finish of mortar applied by the building constructor. Necessary openings in the concrete ducts or other building structures to fit the air outlet or to connect the metal ducts shall be made by the builders in accordance with

the Contractor's drawings submitted before any work is begun.
All duct construction details, in generally, shall be in accordance with Section I of the Duct Manual and Sheet Metal Construction for Ventilation and Air Conditioning Systems, published by the Sheet Metal and Air Conditioning Contractors' National Association, Inc. in the U.S.A.

7.2 Casings: Casings for field fabricated air handling equipment shall include all plenum chambers and enclosures for and air passages between the air intakes, filters. The floors finished in terrazzo or mortar under casings shall serve as the sides and tops shall be constructed of sheet metal. Joints of casings and joints between casings and floors shall be made airtight by calking or sealants appropriate for the system design pressure.
Arrangements may be modified from drawings to the extent required to fit the equipment and apparatus furnished. Distance between such equipment shall be such that the included angle, between a line perpendicular to the apparatus and a line joining the corresponding sides, the tops and bottoms of adjoining pieces of apparatus, shall not exceed 30 degree, except at the inlet to fans. If available space prevents spacing apparatus in accordance with the above requirement, spacing may be modified subject to prior approval of the Engineer. Casings shall be reduced or increased in dimension to connect to each piece of apparatus or shall be made with parallel walls using roof and filler pieces to prevent by-passing of air.
Sheet metal for casings including doors and other details, shall be galvanized sheet steel having a thickness of not less than 1.2 millimeter.
Joints in casings shall be 25 millimeter standing seams or shall be lapped and riveted. Joints backed up by angle bracing shall be riveted on 10 centimeter centers and other joints on 75 millimeter centers. Field joints may be bolted instead of riveted. Casings shall be rigidly braced with rolled angles riveted to the sheet metal on 15 centimeter centers. For casings not over 2 meters in height or width, the angles shall be 40 x 40 x 5 millimeter and for larger casings shall be 50 x 50 x 5 millimeter. Angles shall be spaced not

over 60 centimeter apart. Casings shall be joined to walls, curbs, floors, ceilings, etc., with angles of the same sizes as specified for bracing, secured with expansion bolts on 30 centimeter centers. All joints in casings shall be made substantially airtight with elastic cement, calking compound or felt strips. Casings shall fit tightly at filters to prevent by-passing of air.

7.3 Rectangular Duct Work: Ductwork shall be constructed as following and shown on the drawings.

Dimension of Longest Side mm	Galvanized Steel Sheet Thickness mm	Minimum Reinforcing Angle size mm	Joint Connection Minimum Angle Size mm	Rivet for Fitting of Angle		Bolt for Jointing	
		Maximum Longitudinal Spacing	Maximum Longitudinal Spacing	Dia. mm	Pitch mm	Dia. mm	Pitch mm
Up to 450	0.5		25 x 25 x 3 3,600	4.0	65	8.0	100
451 to 750	0.6	25 x 25 x 3 1,800	25 x 25 x 3 3,600	4.0	65	8.0	100
751 to 1,500	0.8	30 x 30 x 3 900	30 x 30 x 3 2,700	4.0	65	8.0	100
Over 1,501	1.0	40 x 40 x 3 900	40 x 40 x 3 1,800	4.0	65	8.0	100

Exhaust duct for circuit component lab. in main building and plating room in annex shall be made of Polyvinyl chloride of which thickness is 4 mm.

7.4 Duct Supports: Hangers shall be attached to the structure. Attachment to concrete beams or floors shall be by iron or steel concrete inserts, by expansion shields or by hangers with ends bent at least 180 degrees cast into a slab. Attachment to structural steel may be by power driven fasteners, welded studs or beam clamps. Power driven fasteners shall not be used to support rectangular ducts over one meter maximum dimension.

Hangers and hanger support shall be constructed as following.

Galvanized Steel Sheet Thickness mm	Hanger size Angle Steel x Steel Bar mm	Longitudinal Spacing mm	Hanger Support Angle Steel mm	Longitudinal Spacing mm
0.5	(25x25x3) x 9	2,700	25 x 25 x 3	3,600
0.6	(25x25x3) x 9	2,700	25 x 25 x 3	3,600
0.8	(30x30x3) x 9	2,700	30 x 30 x 3	3,600
1.0	(40x40x3) x 9	2,700	40 x 40 x 3	3,600

Bands shall be firmly bent over at points 25 mm from the end and from turned under corners of rectangular duct and shall be fastened with sheet metal screws at 15 centimeter intervals up the sides and into the bottom. Rod hangers shall be secured to the bottom bracing angles or to equal size trapeze support angles. Rods shall be secured to the angles with nuts and locknuts.

Where hangers are secured to form before concrete slabs are poured, all nails, strap ends and other projections shall be cut off flush after forms are removed. Vertical ducts passing through floors shall be secured by extending the bracing angles to rest firmly on the floors, without loose blocking or shimming. Vertical ducts which do not pass through floors shall be supported by bands bolted to walls, columns, etc. Size, spacing and method of attachment to ducts shall be as specified for hanger bands on horizontal ducts.

7.5 Dampers: Dampers shall be installed in ducts where shown and wherever required to permit complete adjustment of air quantities at all outlets. All dampers shall be located in such a manner that they may be adjusted after completion of the work.

Damper blades shall be made of the same metal as the ducts, except that they shall be 2 gauge numbers heavier if more than 60 centimeters in either height or width. Fastening details, etc., shall be made of the metal specified for duct bracing.

Volume dampers and splitters which must be operated regularly at

locations where they cannot be reached readily by a man standing on the floor shall be provided with suitable extended or extra control rods or handles for convenient operation and maintenance.

7.6 Fire Dampers: Fire dampers shall be furnished and installed where indicated or wherever else required.
Fire dampers shall be made of black steel and shall be weighted so that they will close promptly and tightly when released regardless of pressure and direction of air flow. Damper blades shall be hung on zinc-coated steel hinges with loose fitting brass pins and bushings.
Dampers shall close tightly against angle stops and shall have retaining springs. Blades shall be held open by fusible links having melting temperatures of not higher than 75 degrees C. Fire damper frames shall be made of 1.6 mm black sheet steel and shall extend the full thickness of the wall or floor in which they are installed. Frames shall be large enough so that there will be no obstruction to air flow when the dampers are opened.
Construction and arrangement of fire dampers shall be as approved prior to installation. Access shall be provided for replacement of links. Where fire dampers are remote from fire partition, connecting ductwork between fire damper and fire partition shall be 1.6 mm black sheet steel.

7.7 Hood: Hood installed in plating room in annex shall be made of Polyvinyl chloride which has thickness not less than 6 mm.

8. REGISTERS, GRILLS AND DIFFUSERS

8.1 General: All registers, grills and diffusers in general shall be sized and located as indicated and shall be installed and adjusted in accordance with the manufacturer's latest published installation, adjustment, and maintenance instructions to insure against drafts and dirt smudging. However, the Contractor and manufacturer shall be responsible for the proper sizing and selection of their specific equipment to secure proper air throw, air distribution and noise

level. If, after the systems are in operation, any outlet should appear noisy or deliver an improper air pattern after adjustment, the Contractor and manufacturer shall replace the register or diffuser with a larger size or one of a different type and make any other changes that may be necessary without any additional charges to the Government.

The manufacturer shall prepare a complete schedule indicating the location, air quantity, register or diffuser size and the type of outlet for each location and shall submit the schedule to the Engineer for approval.

All steel parts of air outlets shall be zinc-phosphate treated or zinc-chromate dipped after fabrication and prior to priming and finishing. Visible steel parts of all registers, grills and diffusers shall be factory finished in baked enamel or other equally suitable finish. Volume dampers, if furnished, shall be factorily finished in black enamel or other equally suitable finish.

8.2 Registers: Supply registers shall be adjustable 2-way directional type, constructed with vertical face bars or vanes and horizontal rear bars or vanes set in steel or aluminum frames and shall be provided with blade dampers for air volume control.

Exhaust and return registers shall be constructed as specified for supply registers, except that they shall have a single set of non-directional vertical face bars or vanes having the same appearance as the supply registers. They shall be installed flush with finished wall or ceiling and, where indicated.

8.3 Grills: Grills shall be either the same as specified above for registers, except that volume dampers shall be omitted.

8.4 Ceiling Diffusers: Ceiling diffusers shall be of the circular, or linear type as indicated on the drawings.

Diffusers shall be constructed of steel or aluminum and all edges of metal exposed to view shall be rolled or otherwise stiffened and rounded. All internal parts of each diffuser shall be removable as a unit to permit cleaning of the diffuser and provide access to the

ducts. Removable parts shall be constructed so that they cannot be reassembled in any manner that will produce an incorrect air distribution pattern. The internal assembly shall be fastened so that it can be removed and reassembled without special tools.
Sheet metal air duct or plenum connections to diffusers shall be secured in accordance with manufacturers' recommendations.
Each circular ceiling diffuser shall consist of two or more concentric circular elements designed to deliver air radially in a generally horizontal direction without excess smudging of the ceiling. Ceiling diffusers shall be generally similar to circular diffusers, and shall be interior elements may be circular as required to provide a suitable distribution pattern.

8.5 Linear Air Diffusers: Linear diffusers shall be similar in general characteristics to the circular diffusers, except that the air shall be delivered at right angles to the long axis. Diffusers shall be provided with alignment slots for insertion of key strips or with other concealed means to align all exposed diffuser butt edges. Corner joints of steel frames, and flanges exposed below ceiling or side wall, shall be metal filled and ground smooth. Corner joints of aluminum frames and flanges exposed below ceiling or side wall shall appear as hair line crack with unexposed sides of corner joints welded or secured with alignment keys.
Diffusers shall be furnished with separate pivoted or hinged adjustable air volume damper and separate air deflection blades. Air volume dampers shall be made adjustable without disturbing the air deflection blade setting. Volume and deflection blade sections shall have structural rigidity to operate uniformly over the entire length of the diffuser without bending, warping, buckling, or creeping during normal operation.
Diffusers and all component parts shall be constructed of extruded aluminum or of steel and shall be finished with baked enamel or other approved equivalent finish.

9. PIPING

9.1 General: Condenser water, humidifier, and drain piping shall be installed as indicated on the drawings and/or as approved by the Engineer.

Pipe shall be cut accurately to measurements established at the building, shall be worked into place without springing or forcing, and shall properly clear windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

Pipes shall have burrs removed by reaming and shall be installed so as to permit free expansion and contraction without causing damage.

Changes in direction shall be made with fittings. Piping connections to equipment shall be in accordance with shown on the drawings or as directed by the Engineer.

9.2 Materials: Water piping, drain piping, make-up water piping and their fitting shall be of galvanized screwed and socketed steel pipes to comply with JIS G 3452.

They shall be with pipe threads in accordance with JIS B 0230.

Pipe fittings shall be of galvanized malleable cast iron fittings to comply with JIS B 2301.

9.3 Valves: Valves in water piping generally shall be of the gate type, check valves shall be fitted to the main delivery pipes of each circulating pump and elsewhere as shown on the drawings.

Gate valves of 50 mm size and smaller shall be bronze in accordance with JIS B 2031. They shall have threaded ends, rough bodies and finished trimmings. Bodies, bonnets and discs shall be of composition one or two.

Check valves of 50 mm size and smaller shall be of bronze, in accordance with JIS B 2025.

Gate and check valves of 65 mm size and larger shall be designed for a working pressure of not less than 5 kilo-grams per square centimeter with iron bodies and flanged ends.

9.4 Unions or Flanges: Unions or flanges shall be required on both sides of each piece of equipment in the plant and also for facilitating removal of valves.

9.5 Water Strainers: Water strainers shall be of the pot or angle type and shall be installed at locations where required on the drawings or where indicated by the Engineer. 50 mm strainers and smaller shall have bronze bodies with screwed connections and 65 mm strainers and larger shall have iron bodies and flanged connections. All strainers shall be designed for not less than 5 kilo-grams per square centimeter gauge working pressure and shall be of the same size as the pipe lines in which they are installed.

9.6 Pipe Installation: Piping systems shall be complete and all pipes shall be of size shown or, where not shown, shall be of sizes required to produce capacities of equipment specified.
Where the suction of discharge diameter of any pump unit is smaller than the pipe size noted on the drawings, reducing elbows or fittings shall be provided at the pump connection only. All strainers, valves, flexible connections, expansion joints, etc., shall be a minimum of pipe sizes noted on the drawings.
Wherever two or more pipes are to be installed in parallel or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and servicing.
Ends of pipes shall be reamed before being made up into fittings.
Screwed joints shall be made up with red lead or an approved compound applied to the pipe threads and not to the fittings.
All piping shall be installed so as to allow for expansion. Connections to pumps and other equipment shall be made in such a manner as to eliminate undue strains in piping and equipment. Necessary fittings and bends shall be furnished to avoid springing of pipes during assembly.
Hangers must be of a design which will permit removal and replacement of band and hanger without taking down pipe and must also permit vertical adjustment of pipes.
All hanger rods, trapeze hangers, inserts and other forms of hanger

devices shall be hot-dipped galvanized or painted in an approved manner.

Maximum center to center spacing of pipe hangers except as otherwise specified shall be in accordance with the followings:

Pipe Size millimeter	Max. C to C meter
20 to 25	2.5
32 to 50	3.3
65 to 90	4.0
100 to 125	5.0

Vertical runs of pipe not over 5 meters in length shall be supported by hangers placed not over 30 centimeters from the elbows on the connecting horizontal runs. Vertical runs of pipe not over 20 meters long shall be supported on heavy steel clamps bolted tightly around the pipes and resting securely on the building structure. Clamps shall be welded to the pipes or placed below couplings. All vertical pipes not included in the above shall be supported on base elbows or base tees resting directly on the building structure or on substantial pipe stands extending to the building structure.

9.7 Passing Through Walls: Horizontal pipes passing through walls and partitions shall be provided with full thickness sleeves made of standard black steel pipe large enough to leave not less than 5 millimeters clear around the pipe and covering, if any. In new construction, sleeves shall be set in place as the walls and partitions are built.

Vertical pipes passing through floors shall be provided with sleeves of galvanized sheet steel not less than 0.5 millimeter in thick. Sleeves shall be of proper length to pass through the entire floor construction, including fill, and shall be large enough to leave not less than 5 millimeters clear around the pipe and covering, if any. Sleeves in concrete work shall be flanged at the bottom and

secured to forms before the concrete is poured.
All exposed vertical pipes passing through floors must be provided with floor plates and, where the ceiling is finished, with ceiling plates, except that where the pipe passes through a plaster cornice.
All horizontal pipes passing through finished walls must be provided with wall plates. All plates must be designed to allow for expansion and wall ceiling plates must be securely fastened to the pipe or to the sleeves.

10. MOTORS

All motors shall be suitable, and shall have adequate continuous rating required for its specified duty.
Cooling tower fan motors shall be totally enclosed fan cooled. Self-contained air conditioner compressor motors shall be totally enclosed, refrigerant cooled.
Motors except self-contained air conditioners shall be in all respects suitable for service in a tropical climate. Main conductor and slot insulation shall be in accordance with class "E" of JIS C 4003.
Motors except propeller fans shall be connected to 400 Volts, 3 Phase, 50 Hertzs.
Propeller fan motors shall be connected to the single phase supply at 100 Volts, 50 Hertzs.
20 percent shall be the minimum derating factor for motors except self-contained air conditioners.

11. AUTOMATIC CONTROL SYSTEM

11.1 General: Furnish all labour, services, materials and equipment and perform all work as necessary and required for the complete installation of all automatic control systems as herein specified and shown on the drawings. The automatic control system shall include all thermostats, humidity controllers and other control devices shown on the drawings, specified or necessary to perform specified functions.

The manufacturer of automatic control systems shall prepare and submit brochures containing control drawings, cuts of all equipment which is to be furnished and necessary control descriptions for approval prior to starting work on the job. At the completion of the job, "as built" shop drawings and descriptive literature and parts lists, etc., shall be provided for the operating staff.
The manufacturer of automatic control systems shall prepare and submit brochures containing control drawings, cuts of all equipment which is to be furnished and necessary control descriptions for approval prior to starting work on the job. At the completion of the job, "as built" shop drawings and descriptive literature and parts lists, etc., shall be provided for the operating staff.

11.2 Operation: Operation for all air conditioning equipments shall be made by the central operation panel (include electrical installation) mounted in administration room. Start-stop of systems shall be able to be made manually at the central operation panel and the push button on the self-contained air conditioners.
Start-stop operation of compressors in each self-contained air conditioners shall be controlled by manually and/or electric type thermostats (T-473C) in summer, and in winter, electric heaters shall be controlled by one thermostat (T-473C or T-42H) or two thermostats (T-42H).
Humidifier's solenoid valves shall be controlled by humidistats (H-607A).

11.3 Room Thermostat Controllers: Thermostats generally shall have minimum throttling ranges of not over 1 degree C, and room humidity controllers generally shall have minimum throttling ranges of not over 5 percent. Thermostat controllers shall be provided with means for adjusting the throttling range in the field. Thermostats shall have bimetal, vapor pressure sensitive elements.
Room thermostat controllers shall be securely attached to a suitable base mounted on the wall or other building surface. It shall be located where shown or, if not shown, where it will respond to the average temperature in the room. Thermostat controllers generally

shall be mounted with center lines 1.5 meters above the floor.

11.4 Room Humidity Controllers: Humidity controllers shall have sensitive elements of human hair or other suitable material of approximately equal sensitivity.
Room humidity controllers shall be securely attached to a suitable base mounted on the wall or other building surface. It shall be located where shown or, if not shown, where it will respond to the average humidity in the room. Humidity controllers generally shall be mounted with center lines 1.5 meters above the floor.

12. PRESSURE GAUGES, THERMOMETERS, ETC.

12.1 Pressure Gauges: Approved type Bourdon tube pressure gauges, of the sizes required and indicated, shall be furnished and installed in the locations out-lined hereinafter and as shown on the drawings, including those hereinbefore specified as mounted on each apparatus. Gauges shall have 10 centimeter or larger dials unless otherwise specified. Gauges shall be installed in such manner as to be accessible and easily read.
Gauges shall have bronze cases finished in baked enamel or approved phenol plastic cases. Gauges shall be connected by brass pipe and fittings with shut-off cocks.

12.2 Thermometers: Approved type thermometers shall be furnished and installed as shown on the drawings.
Thermometers in piping shall have separable sockets, a 20 centimeter case and a 10 centimeter stem, when extension necks are used, the stem shall be 10 centimeters longer than the neck. Proper type fittings shall be furnished for all thermometers installed in piping to receive the sockets. Where such thermometers are installed on covered piping, extension necks of the proper length shall be furnished so that the neck extends to the surface of the covering.
The scale shall be marked off in at least one degree C devisions and the scale range of all thermometers shall be as approved by the Engineer. Thermometers in piping shall be so located as to be

easily read from the floor level. They shall be of the straight stem, side angle type to meet the requirements and the final approval of the Engineer. Exact location and the angle of the stem of all thermometers shall be determined in the field to the satisfaction of the Engineer.

13. THERMAL INSULATION

13.1 General: Insulation and pipe covering shall be applied after the systems have been tested and proven tight as hereinafter specified. Insulation shall be applied in accordance with the manufacturer's recommendations and the installation shall be neat and workmanlike in appearance.

Contractor shall prepare a schedule listing each type of insulation, insulation thickness, density, type of jackets, etc., and the work and service to which each type of insulation is applied to or on. The schedule shall be submitted in reproduceable form, and no insulations shall be purchased or applied until the schedule is approved by the Engineer. Also submit, for the Engineer's approval, two samples of each type of insulation with jackets and finishes representing the finished application of the particular insulating material.

13.2 Duckwork Insulation: Except that concrete ducts will not be insulated, unless otherwise specified, all air conditioning supply ducts and outside air ducts shall be insulated with not less than the 25 millimeter in thick rigid or flexible fiberous glass insulation or rigid impregnated mineral wool insulation, having a density of not less than 24 kilograms per cubic meter, or other equally suitable material approved by the Engineer.

Insulating material shall be set in a waterproof adhesive and coated with a suitable water-repellant cementing substance that will provide an effective vapor barrier. An approved vapor barrier envelope may be furnished, if standard with the manufacturer of the insulation and suitable for the finish coating.

All exposed insulated duct shall be protected by means of a finish

of suitable asbestos board not less than 6 mm thick, applied in a manner recommended by the manufacturer of the insulation and approved by the Engineer.

Insulation shall be fixed to ducts by an approved adhesive, which shall have no corrosive effect on the duct metal. Joints and laps in the vapor barrier shall be thoroughly sealed, using vapor barrier compound or impermeable tape to prevent entry of water vapor.

13.3 Drain Pipe Insulation for Low Temperature: Drain piping from self-contained air conditioners shall be covered with 20 millimeter thick wool felt or other material covering with tar paper lining on the inside. The covering shall be secured with copper wire and wrapped factory-applied canvas jacket on the outside, paste laps over joints shall be smooth and shall be provided with lacquered bands.

14. PAINTING AND FINISHING

14.1 General: Pumps, motors and other machinery and all portions of fans, ducts, casings, pipes, etc., which are not covered or concealed by furrings, suspended ceilings, etc., shall be thoroughly cleaned and given two coats of machinery enamel. All surfaces to be painted shall be clean, dry and free from oil or grease before paint is applied. All abrasions or other damage to factory or shop painting or priming coats shall be touched up before field coats are applied.

Pumps, fans and other machinery shall have a priming coat of red lead, a suitable filler or under coat, and a finish coat of machinery enamel. If a priming coat has been applied in the shop, it may be omitted from the field painting. If two or more coats have been applied in the shop, only one finish coat of enamel will be required, unless additional coats are needed in the opinion of the Engineer, to cover properly a contrasting shop colour.

Ferrous ductwork to be insulated shall not be painted.

The insides of ducts back of grills and registers shall be painted two coats of flat black paint.

All exposed insulated piping having canvas surfaces shall be given one coat of glue sizing immediately after the covering is applied and followed by two finish coats. All exposed ferrous metal piping and iron work exposed to view such as pipe hangers, etc., shall be thoroughly cleaned of all dirt, rust and grease and given a prime coat of red lead primer and two finish coats. All exposed galvanized piping, pipe covering and fittings shall be thoroughly cleaned of all dirt, rust and grease and given a prime coat and a finish coat. Concealed insulated piping, where accessible for painting, shall have glue sizing or prime sealer applied. Concealed non-insulated ferrous metal piping, hangers, supports and other ferrous metal work, except that which is galvanized, shall have two prime coats applied. The parts which will be inaccessible for painting will be coated before installing them.
All insulation canvas covered equipment shall be given one coat of glue sizing immediately after the covering is applied followed by two finish coats.

14.2 Finishing Colour: Finishing colour shall be as directed by the Engineer.

14.3 Piping Identification: Service pipes, whether exposed or concealed in accessible pipe spaces, shall be provided with colour bands and legends. Horizontal piping shall be marked at intervals of 15 meters, and vertical piping shall be marked on each floor. Marking shall be placed adjacent to valves and fittings.
The detail of colour bands and legends shall be as directed by the Engineer.

15. SPARE PARTS, TOOLS AND INSTRUCTIONS

15.1 Spare Parts and Tools: The Contractor shall furnish the spare parts sufficient one year service.
Mechanical maintenance and overhaul good quality tools sufficient enough to enable carrying out the plant services in an easy and quick method shall be recommended and furnished by the Tenderer.

These tools shall comprise all necessary elements for the manipulation of the different types and sizes of the mechanical equipment screws, bolts, nuts pulleys, bearings, and must be provided also with all necessary adjusting tools, etc. Halide portable leak detectors and complete sets of high grade wrenches for all equipments and pipings shall be included.
These spare parts and tools shall be supplied in a special lockable steel boxes or cupboards marked on their covers with print writing "Mechanical Spare Parts and Tools" and arranged for wall or foot mounting.

15.2 Operation and Maintenance Instructions: Control charts showing the complete layouts of air conditioning systems, including piping, valves, wiring, and controls together with printed instructions covering the operation and maintenance of the system shall be installed in the machinery rooms where directed by the Engineer. In addition to the framed instructions complete layouts and instructions together with catalog cuts shall be delivered to the Engineer. Upon completion of the work, and at a time designated by the Engineer, the Contractor shall provide the services of a competent engineer at the site for a period of one week of each summer and winter season to instruct authorized representatives of the Government in the operation and maintenance of the systems and equipment.

16. CLEANING

Piping that is to be painted or insulated shall be cleaned to remove dirt and grease or oil.
Piping shall be cleaned inside to remove dirt and loose scale, etc. Water piping shall be flushed out prior to testing of equipment and all strainers, pump stuffing boxes, mechanical seals and other parts where dirt may cause faulty operation shall be cleaned.
Ductwork and casings shall be clenaed on the inside and outside before fans and filters are operated. After the equipment has been used for any purpose, such as adjusting, testing, or temporary ventilation, filters shall be cleaned or renewed and exhaust return

ducts shall be cleaned.
Should any pipe, etc., be stopped up by refuse, the Contractor will be required to disconnect, clean, and reconnect such piping.

17. ADJUSTMENTS AND TESTS

All the Tests and Adjustments shall be done by and on the responsibility of the Contractor.

17.1 Adjustments: After the completion of the Works, the Contractor shall, and as directed by the Engineer, demonstrate to the Engineer that the installation is adjusted and regulated correctly to fulfill the function for which it has been designed. The Contractor shall test, adjust, balance and regulate the section concerned as necessary until the required conditions are obtained. All such test's full records of the values obtained shall be prepared along with the final settings.
The entire temperature control system shall be adjusted and placed in operation by the manufacturer and all adjustments necessary to accomplish the specified results during the first year of operation shall be made without cost to the Government.

17.2 Tests: Water piping run in chases, in walls, above suspended ceilings or in any way concealed by structural work shall be subjected to a hydrostatic test and proved tight before being concealed. All other water piping shall be subjected to a hydrostatic test at the completion of the work and proved tight. The test pressure shall be 7.5 kg/square cm at the lowest point in the system and shall be held for a period of not less than 30 minutes. The piping system shall be considered tight if the pressure drop does not exceed 0.5 kg/square cm during the test period. If the pressure drop exceeds 0.5 kg/square cm, all repairs and alterations in the piping system necessary to meet the test shall be made.
Performance tests to prove the design conditions of all air conditioned spaces as well as the capacity specified and general operating characteristics of all apparatus under the design condition, etc.,

shall be made, and readings taken, during the above period. Capacities of self-contained air conditioners, cooling towers, humidifiers, pumps, electrical heaters, fans, and all other equipment shall be proved by performance tests of not less than 8-hours duration, after stable conditions have been established. Test procedures shall be approved in accordance with the engineer, approved test codes as far as field conditions permit.

Capacities shall be based on temperatures and air quantities measured during such tests. Temperature differences required for determining capacities shall be measured by thermometers having an accuracy of plus or minus 0.5 degree C. Air quantities may be measured by anemometer or velometer, depending on the velocity and other conditions of flow.

All instruments, facilities, labour, etc., required to properly conduct the tests shall be provided by the contractor at no additional cost to the Government. If gauges, thermometers, etc., which are to be left permanently installed are used for tests, they shall not be installed until just prior to the test to avoid possible changes in calibration.

The Contractor shall submit the following records in tabulated form, including the performance test data, to the Government and the Engineer.

(a) Date on room-temperature (D.B. & W.B.), relative humidity, etc., in each air-conditioned room and outside air temperature and relative humidity during the cooling period and the heating period, respectively.
   - These data shall be measured at the same time as the performance tests and shall be collected at every uninterrupted period of not less than 8-hours.

(b) Air volume at each supply, return and exhaust outlet.
   - These data shall be measured after the air rate adjustments have been satisfactorily completed.

(c) Data of operating, and safety tests for each apparatus.

(d) Data on hydrostatic, tests for each piping system.

(e) Self-contained air conditioners
   (1) Air quantity at return (without duct).

(2) Condensers.

- Inlet condensing water pressure.
- Inlet and outlet condensing water temperature.

(3) Inlet, outlet and outside air temperature and humidity.

(f) Cooling towers

- Inlet and outlet condensing water temperature.
- Entering air temperature (W.B. & D.B.).
- Leaving air temperature (D.B.)

(g) Fans

- Total C.M.H. supplied by supply fan.
- Total C.M.H. exhausted by exhaust fan.
- Total static pressure.
- Fan speed.
- Average velocity on intake side.
- Bearing temperature on both sides.

(h) Pumps

- Pressure in discharge line.

(i) Motors

- Motor speed.
- Bearing temperature on both sides.
- Housing temperature.

(j) Manufacturer's performance test data.

- Test performance certificates for each apparatus issued by the manufacturer or the approved authority may be used, if approved by the Engineer, as a substitute for these data.

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 recommended after the adjustment or repairs have been completed. The test shall not be made void due to circumstances beyond the Contractors control.

TECHNICAL SPECIFICATIONS

PART II

FOR

ELECTRICAL INSTALLATION

PLUMBING, GAS INSTALLATION

AIR CONDITIONING

AND

LIFT

PART II-(v)

LIFT

NIPPON SŌGŌ ARCHITECTS' AND ENGINEERS' OFFICE CORP., LTD.

(NSK) TOKYO JAPAN

TECHNICAL SPECIFICATION FOR LIFT

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1. GENERAL

1.1 General Description: Lift shall comply in all respects with American Code ref. A 17-1 - 1965, except in so far as this Specification is at variance therewith. Lift manufactured to other Standard Specifications, which are equivalent or better than those mentioned will be acceptable.

The details referring to the particular site or location of the lift are given in the attached drawings. The tenderer shall provide with his tender the information detailed in Schedule and such other information as he shall see fit or else the offer shall be rejected.

The contract shall cover the supply of all parts necessary for the operation of the lift, including machinery, car, counterweight, guides, controls, gates and all brackets and other necessary fixings whether specially mentioned or not.

1.2 Machinery Position: Details of the position and space available for machinery are given in the drawings.

1.3 Electricity Supply: Special care shall be taken in the design and construction of electrical equipment:

Power : 400 Volts 3 Phase 50 Hertzs.

Lighting: 230 Volts 1 Phase 50 Hertzs.

2. TRACTION MACHINE

2.1 Electric Motor: Electric motor driving lift shall be of specially robust construction, and shall be equipped with suitable means of operating the lift car by hand in the event of breakdown or failure of power supply. The motor rating shall not be less than 120 drives per hour, and at the end of a test period shall be capable of giving 100% overload torque for 30 seconds. Motor insulation shall be in accordance with class "E" of JIS C 4003.

2.2 Bedplate: The driving motor, brake, gearing (if any) and driving sheave shall be mounted in proper alignment and supported on a substantial bedplate of cast iron or fabricated from heavy steel sections,

adequate to resist distortion during transit, installation and operation.

2.3 Brake: A powerful brake shall be fitted with two brake shoes, acting on the periphery of the shaft coupling between motor and gearing or on a purposely fitted drum. The brake shall be applied by powerful compression springs and shall be released by a solenoid. The brake shall be instantly and automatically applied whenever the current to the driving motor is interrupted from any cause whatsoever. Means shall be provided for releasing the brake in emergency to permit movement of the lift by hand. The emergency release must be self resetting or arranged to prevent movement of the lift by power before it has been reset. The brake release solenoid shall be adequately rated for the duty concerned.

2.4 Gearing: Lift shall be driven by single stage worm reduction gearing between the motor and the driving sheave.
The worm shall be cut from a solid steel forging integral with the worm shaft, and shall be provided with a single thrust unit comprising a double ball bearing thrust with self-aligning blocks designed to take the end thrust of the worm in both directions. The thrust unit must be removable without dismantling the machine.
The worm wheel shall be hobbed from a bronze rim, which must be accurately fitted and bolted to the gear spider.
The worm wheel shall be enclosed in a suitable dust proof and oil-tight housing forming a large capacity reservoir for lubricating oil. Adequate provision shall be made for directing the lubricant onto the meshing faces of the gears whenever they are in operation, without the use of ancillary equipment.

3. ROPE SHEAVE AND SUPPORTING GEARING

The diameter of a drum, sheave or pulley should not be less than 40 times of the Diameter of ROUND STRAND Rope or 47 times of the Diameter of FLATTENED STRAND Rope.
All load carrying bearings are to be machined on their supporting faces to permit proper bedding onto their supports.

All load carrying shaft incorporated in lift shall be supported in adequate bearings on one side or both sides of all rope sheave. Sheave shall be grooved for each load bearing rope in a form calculated best to maintain the shape of the rope and to minimize abrasion.

Driving sheave shall be of the multigroove type, the rope grooves formed to give the most positive drive and long life to the ropes.

4. ROPES

The number and diameter of the ropes employed in the lift shall be such as to satisfy the following conditions:

Not less than two suspension ropes, independent of one another, shall be used. No car or rope shall be spliced, other than for the purpose of attachment to the car. The attachment of suspension ropes to car frame, counterweight shall be effected by means of spliced return loops, gripped return loops, metalled sockets or coned sockets for normal operating conditions and with pulley, sheave or drum diameters as set down in clause 3, the minimum factor of safety for suspension ropes shall be 10.

Governor ropes shall be of steel or phosphorbronze and shall have the minimum diameters 8.0 mm (5/16").

The ropes shall be comply with JIS-G 3525 and are as follows:

. Main rope ..... 8 x S (19) class "E"

. Governor rope ..... 8 x W (19) class "E"

No lift shall be supported by less than two ropes.

Approved certificates of tests covering all ropes will be required before delivery.

5. CAR CONSTRUCTION

The car shall be supported and surrounded by a substantial rigid steel sling, to which the supporting ropes are individually anchored through a load equalizing device, and which positively support the body of the

car and load.

The car shall be completely enclosed by solid panels on floor, all sides and roof, including the enclosure provided by the car door.

The car wall panels and ceilings shall be made of sheet steel finished with high grade baked melamine.

The main structure of the car shall be fireproof. All veneers and decorative materials used in passenger cars shall be fire resisting.

The use of wood and other materials liable to change dimensions with humidity, or that are combustible are to be kept to a minimum.

An escape hatch shall be provided in the car roof, accessible from both inside and outside of the car, which shall be fitted with a suitable electric switch, which will prevent the operation of the lift under power when the hatch is open.

The car shall be equipped with one or more electric lights inside, totally enclosed, the protective cover being of non-shattering material of acrylic resin, with socket for inspection lamps fitted inside the car, on the roof, and below the car.

An fan shall be provided in the car.

6. SAFETY GEAR

Emergency arrestor gear of the serrated-cam or the wedgeclamp type shall be provided, attached to the supporting sling. This arrestor gear shall be so arranged that it positively grips the car guides in the event of breakage of the supporting ropes or of the car descending at a dangerous speed due to overspeeding of the machinery by 40% or any other cause. Operation of the safety gear shall also out off the power supply to the machinery and prevent its reinstatement until the safety gear has been reset. The instantaneous type safety gear shall not be used.

7. GUIDE RAIL

7.1 Guides: Guides for car and counterweight are to be of solid rolled or drawn steel section accurately finished to size and sufficiently heavy to be self supporting between points of attachment to the building structure. Car guides and their fixings, shall be capable

of withstanding the application of the safety gears when stopping a fully loaded car.
All necessary brackets and rag bolts for fixing the guides shall be provided.

7.2 Guide Shoes: At least two shoes per guide shall be provided on both car and counterweight, to ensure correct alignment and smooth running. Guide shoes shall be designed with adjustable and renewable bearing surfaces to run on the guides. Provision shall be made for lubricating the guides for both car and counterweight. (Where applicable).

8. GATES AND DOORS

All landing entrances and car entrances shall be provided with suitable gates or doors.
All gates and doors shall be made of sheet steel finished with high grade baked melamine.
All gates and doors shall be provided with locks and interlocks as described hereafter.
All gates and doors at landings and the cars shall be automatically operated as described hereunder.
Where shaft is enclosed, all landing gates and their surroundings shall be of fire resisting construction.
Provision shall be made for the access of maintenance personnel to the interior of the shaft both above and below the car for inspection and maintenance purposes.

9. ENTRANCE

9.1 Jambs: The jambs for lift shall be made of sheet 18-8 Ni-Cr Stainless steel with satin brush finish.

9.2 Sills: The sills for lift shall be non-slip surfaced aluminum alloy.

10. COUNTERWEIGHT

The counterweight shall balance the weight of the car and 40% to 50% of the rated load. The counterweight shall consist of a suitable

frame running in guides, to which the ropes are individually attached by long adjusting screws, and a suitable number of cast iron weights secured within the frame. The guides, shoes and weights shall be so arranged that the weights cannot come in contact with guides or lift cage.

11. BUFFERS

Suitable bolsters and spring buffers shall be provided at the bottom of the shaft to absorb the kinetic energy of the loaded car and the counterweight in the event of control deficiencies.
The buffers under both car and counterweight shall be so positioned that the car reaches its maximum depression of its buffers before the counterweight comes in contact with any structural member or parts of the machinery at the top of the shaft or vice versa.

12. CONTROL GEAR

The control gear, in conjunction with the car controls, landing controls, gate locks, and limit switches described hereafter, shall control all operations of the lift in such a manner as to ensure the safety of all persons whether using the lift or in its immediate vicinity.
The control gear shall consist of a suitable cubicle containing the contactors, relays, resistances and ancillary apparatus required for the operation of the lift. The cubicle shall be so constructed and screened that no person can suffer any injury due to mechanical movement of the component parts, or electric shock.
The Controller is to be so arranged that it gives a person in the car complete and uninterrupted use of the lift until the car has reached the desired floor, the car and landing gates have been opened and the landing gates again closed.
The main control cubicle shall contain fuses, relays or other equipment designed to protect the apparatus from damage, or persons from shock should any of the following occur:

(a) Failure of supply or prolonged period at seriously reduce voltage.

(b) Overcurrent in any part of the equipment.

(c) Lack of balance of the current drawn from the supply by any motor or other component of the equipment normally connected to more than one phase.

(d) Phase reversal of the power supply due to any cause whatsoever prior to or within the control equipment.

Adequate insulation must be applied throughout on all component part of the control gear where insulated materials are used, such as, relay coils, transformer windings and control panel wiring, etc.

12.1 Signal and Control Circuits: All control or signal circuits shall be designed to operate at a voltage of not more than 120, with the exception of emergency alarm bell which will be battery operated. In case of A.C. control circuits, these shall be supplied at low voltage through a double wound transformer forming part of the control gear. Where D.C. control circuits apply, these shall be supplied through a silicon type rectifier of suitable design, housed in main control panel. No fuses or switches shall be incorporated in the lead which is earthed or any conductors connected there to. Signal and control circuits shall perform the functions described hereunder.

12.2 Landing Controls: A call push shall be located adjacent to the landing gate of door on each landing. When this push is momentarily pressed it shall initiate a sequence of movements by the controller that shall bring the lift car to the landing. A car position indicator shall be fitted at each landing.

12.3 Landing Gate/Door Interlocks: Each landing gate and car door shall be equipped with an electro-mechanical interlock which shall prevent the gate or door being opened unless the lift has stopped at the landing, and shall prevent the lift being moved (except by the hand operated emergency gear) until the gates and door are properly and securely closed. Safety interlocks are to be provided for the prevention of opening any landing gate unless the car is in the corresponding gate positions to avoid public to access the lift shaft.

The interlock shall be such that the landing gate cannot be snatched open as the car passes a landing.

12.4 Car Controls and Gate/Door Interlock: The car shall contain a control station incorporating:

(a) A push botton for each floor or landing.
(b) An emergency alarm button.
(c) A lighting switch.
(d) A fan switch.
(e) A key switch for: with attendant or without attendant use.
(f) By-pass button.
(g) Up and down buttons.
(h) Direction arrows.
(i) An emergency stop switch.
(j) An extension telephone.

The lift for passengers and freights shall be controlled by the car switch and selective collective automatic dual operation.
Car control station shall also be fitted on top of the car for inspection and maintenance purposes.
The sections of the controls supplied at different voltages or via different isolating switches from the electrical supply compartments of the same box, shall be separated by earthed steel barriers.
The car door shall be fitted with an electro-mechanical interlock which shall prevent the car moving when any person is in occupation unless the door is securely closed, whether by operation of car control push buttons or by a call button on a landing.

12.5 Speed Control: The lift should not give uncomfortable feelings of passengers due to the high acceleration at starting and deceleration at stopping.

12.6 Over-run and Limit Switches: In addition to the normal landing switches over-run or limit switches shall be provided which shall cut off the power supply to the lift machinery and stop the car before contact with the buffers, if the car should over-run the landing switches at the highest or lowest landing in its travel. It shall not be possible to operate the lift by power again until it

shall have been wound clear of the limit switches by the hand operated emergency gear.

12.7 Levelling: The car should come to rest at any landing, under any condition of load to the maximum capacity of the lift, with the car floor within 2.5 cm, of the level of the landing floor.
Where the lift speed is too great to ensure this, an additional levelling drive shall be incorporated in the machinery. This drive shall start automatically on the main drive stopping on approaching a landing and shall operate in the required direction to correct the discrepancy in level.

12.8 Power Operated Doors: On stopping at a landing, the car and landing doors shall open automatically.
Power operated doors shall be damped at both ends of their travel to prevent slamming. They shall be provided with a "No-nip" edge of resilient rubber or thermoplastic substitute. The drive shall be such that at any point in its travel the door can be arrested and released if a person should get in the doorway. The interlock permitting the car to move shall not operate until the door is fully shut, and the width of the "No-nip" edge shall be such that the interlock does not operate if a person's limb is interposed.

12.9 Alarm Signal: A loud ringing bell with a gong not less than 15 cm diameter shall be provided to operate at low-voltage (Battery-operated). The bell shall be controlled by the emergency alarm push in the lift car. The bell shall be installed in the building administration room.

13. ELECTRIC WIRING

A three phase electrical supply for the lift machinery and controls will be made available in the machinery space, and a single phase supply will be provided adjacent to the midpoint boxes in the lift shaft for the lighting circuit, and socket outlets.
All wiring shall be carried out in accordance with one of the following approved method:

(a) PVC cable in light or heavy gauge galvanized screwed steel conduit, or/and galvanized steel trunking.

(b) Cables. Circuits operating at different voltage, or energized from different sources shall be run in separate conduit, sheaths or flexibles.

At all points where movement is required for periodic adjustment, circuit wiring shall be enclosed in flexible conduit, or a loop made in cables. Where joints are unavailable in conductors, they shall be made in substantial connectors in purpose made boxes.

The tenderer shall include for supply of all special electrical equipment including multicore flexible cables, etc.

14. FLEXIBLE CABLES

Flexible cable connections between the mid point boxes and the lift car shall be anchored at both ends by being passed completely round insulators and securely lashed. The insulators shall be of high grade electrical porcelain or of tough wood. The insulators shall be supported in suitable shockless or by other approved means. Substantial connecting boxes shall be provided at both ends, of all flexible cables, and the connecting blocks or terminals shall be securely fixed within the boxes.

15. TOOLS

A complete set of case hardened spanners, to fit every nut and bolt head used in the construction of the works, together with any special tools required for the purpose of use during maintenance shall be supplied by the lift contractor. The tools shall be housed in a suitable steel cabinet and accommodated in respective lift machine room.

16. TESTS

All tests on completion are to be carried out to the entire satisfaction of the Engineer who will have the power to reject any part or parts of the installation, which in his opinion, do not fulfil the conditions of this specification. The lifts and parts thereof are

to be tested during the progress of work in manner to be determined by the Engineer, and will not be accepted until they comply with all the conditions of this Specification and the Contract.

The Contractor must test, in this work, the controller and all electrical apparatus and connections to an alternating current pressure of 2,000 volts. The insulation must be capable of withstanding this pressure for two minutes without showing any signs of breakdown.

Immediately the lift is erected the Erector will be required to make the following tests, in the pressence of the Engineer or his representative. All cages are to be loaded with standard weights until the weight on the ropes is equal to 1.25 the combined weight of the car and the specified maximum load. The apparatus must bear this weight for 30 minutes without showing any signs of weakness or permanent set. (Static test only).

Tests are to be made to determine if the various safety devices comply with all the conditions of the specification, and answer the requirements of the local Authorities and Insurance Companies.

Tests to consist of the following examination:

(a) Car will raise and lower the contract load.

(b) Car will attain contract speed carrying the contract load.

(c) The car will raise and lower a test load of 1-1/4 times the contract load, (but not necessarily at contract speed).

(d) The safety gear will stop the lift car with the contract load.

(e) Cage levelling at all floors.

(f) Cage gate lock and door safety edge.

(g) All landing gate locks mechanically and electrically.

(h) Emergency stop and alarm button.

(i) Safety gear, switch, and governor action.

(j) Overrun limit switches.

(k) Directional limit and broken tape switches.

(l) Cage and safety gear wires and their attachment.

(m) Winding gear and brake and sheave generally.

(n) Hand gear.

(o) Lift shaft, cage overhead gear and buffers generally.

The erector must supply when requested by the Engineer, all necessary and suitable instruments for the carrying out of all the above

mentioned tests, including electrical pressure, current consumption and insulation resistance, for preliminary and final tests.
On completion of the tests to the entire satisfaction of the Engineer, acceptance of the installation, either in part or in whole will be covered by a letter from the Employers.
If, as a result of the above tests, the lift are found to be satisfactory, in every respect, and in strict accordance with the specification, the Engineer will recommend their accptance, but preliminary tests of lifts and gear will not in any way be considered as part of final tests.

17. GUARANTEE AND MAINTENANCE

The Tenderer shall guarantee all equipment against all defects in materials and workmanship which are revealed by any inspection or test made in accordance with this specification or become apparent within twelve months of acceptance of the lift by the Purchaser. Where the Manufacturer (or his Agent) supervises erection of the lift, this guarantee shall also cover all defects in erection, and shall include the general maintenance mechanical and electrical, during this period. All defects coming under the scope of this clause shall be corrected, free of all charge to the Purchaser by the Manufacturer or his Agent shall be carried out under the direction of the Engineer and the costs of materials, labour and supervision involved shall become a debt due by the Manufacturer to the Purchaser.