CHAPTER T4 CONCRETE WORK

T4.1 Mass and Reinforced Concrete

T4.1.1 General

These Specifications shall apply to all works and materials in connection with the mass and reinforced concrete in the structure.

Unless specifically provided in these Specifications, concrete shall be manufactured, transported, placed, cured, finished, and tested by the Contractor in accordance with the provisions of JIS or other equivalent standards approved by the PMO/Engineer.

Prior to starting concrete works, the Contractor shall submit for the approval of the PMO/Engineer the construction program including construction facilities, method and quality control plan of the concrete work in detail with the drawings.

T4.1.2 Materials

(1) Cement

Cement for concrete and mortar shall be furnished by the Contractor. Cement to be furnished shall conform to the requirements of JIS R 5210-79, ordinary portland cement, or approved equivalent. The use of any other type of cement shall be subject to the approval of the PMO/Engineer.

Cement shall be delivered in the manufacturer's bags or in bulk. Each consignment shall be sampled at the mill and shall be accompanied by a test certificate issued by the manufacturer. The PMO/Engineer will have the right to attend the sampling and testing at the mill at any time. If delivery is not directed from the factory, the intermediate storage and delivery arrangements shall be subject to the approval of the PMO/Engineer.

Cement shall be stored in a damp-proofed storehouse having a floor more than 30 cm above the ground. Cement shall be stored in such a manner that the "first-in" can be "first-out" and inspection of stock quality can be easily performed. Proper spacing shall be provided between piles of cement. Not more than 13 bags shall be permitted to be piled up, and this number shall be limited to 7 bags when the storage period is expected to be longer than 60 days.

No cement which has been stored at the site for more than 90 days shall be used in the work unless re-test proves it to be satisfactory.

The Contractor shall make a weekly report showing on a daily basis what quantity has been received and issued during the week, and in what portions of the works the cement has been used.

(2) Aggregate

(i) General

Fine and coarse aggregate for concrete will be produced by the Contractor using the aggregate plant as provided in paragraph G5.3(3). The Contractor shall confirm the following requirements for the raw material.

The stone shall be fine or medium grained, hard, bright and uniform in colour, breaking with a clean fracture, and making a ringing sound when struck with a hammer. It shall be free from dust, decay, vesicles, holes, veins, flows, cracks, and other defects. If, after 24 hours of immersion in water, the percentage water absorption exceeds 1.5% of its dry weight, the stone shall be rejected.

(ii) Fine aggregate

Fine aggregate shall be clean, hard, solid, durable and of proper grading, and it shall be free from dirt, mud, silt, organic matter or other deleterious materials. Fine aggregate, as batched, shall be well graded to conform to the following limits:

Sieve designation mean opening (mm)	Individual percent by weight retained on screen	
	Minimum	Maximum
10	0	0
5	0	8
2.5	5	20
1.2	10	25
0.6	10	30
0.3	15	30
0.15	12	20
Pan	2	15

The grading of sand shall be controlled so that the fineness modulus of at least 9 out of 10 consecutive test samples of finished sand, when samples are taken hourly,

will not vary more than 0.2 from the average of fineness modulus of the 10 test samples. The fineness modulus of sand shall range between 2.4 and 3.2.

The amount of deleterious substance in fine aggregate shall not exceed the limits prescribed below:

Item	Percentage by weight
- Clay lumps	1.0
- Material passing 0.074mm sieve	3.0*
- Material floating on a liquid having a specific gravity of 1.95	0.5

* In the case of crushed sand, if the material finer than 0.074 mm sieve consists of rock dust free from clay or silt, this percentage may be increased to 5.0.

Fine aggregate producing a colour darker than the standard in the calorimetric test for organic impurities may be rejected. Loss of fine aggregate subjected to five cycles of the sodium sulphate soundness test shall not exceed 10 per cent.

(iii) Coarse aggregate

Coarse aggregate shall consist of solid, uncoated rock fragments, clean, hard, durable and free from objectionable quantities of flat or elongated particles, organic matter or other deleterious material.

Unless otherwise approved or directed by the PMO/Engineer, the coarse aggregate shall be separated into nominal sizes and graded as follows:

Designation	Nominal size (mm)			
of max. size	80 - 40	40 - 20	20 - 10	10 - 5
(mm)	Percent by weight (%)			
80	40 - 20	40 - 20	25 - 15	15 - 10
40	-	55 - 40	35 - 30	25 - 15
20	-	-	70 - 30	45 - 20

The amount of deleterious substance in coarse aggregate shall not exceed the limits prescribed in the following table:

Item	Percentage by weight
Clay lump	0.25
Soft particles	5.0
Material passing 0.074 mm sieve	1.0*
Material floating on a liquid having a specific gravity of 1.95	1.0

* In the case of crushed aggregate, if the material finer than 0.074 mm sieve consists of rock dust free from clay or shale, this percentage may be increased to 1.5.

Loss of aggregate subjected to Los Angeles test (500 revolutions) shall not exceed 40 %. Loss of aggregate subjected to five cycles of the sodium sulphate soundness test shall not exceed 12%.

(iv) Storage

Aggregate shall be delivered, stored and handled so as to avoid mixing of different sizes, segregation in a particular size, breakage, contamination with deleterious matter and retention of water. The aggregate shall be stored with free draining facility for at least 48 hours before use and fine aggregate shall not be drawn from the bottom 50 cm of the stockpile. All storage facilities shall be subject to the approval of the PMO/Engineer and shall be such as to permit easy access for identification and inspection.

Sufficient aggregate shall be maintained at the site at all times to assure continuous placement of concrete at a rate consistent with the requirements of the approved concreting schedule.

If the aggregate is stockpiled on the ground, the sites of stockpiles shall be cleared, graded evenly for drainage, and sprinkled if required.

(v) Moisture control

The free moisture content of the fine aggregate and of the smallest size group of coarse aggregate, as delivered to the mixers, shall be controlled so as not to exceed 4.0 % and 1.0 %, respectively, by weight of the saturated surface dry aggregates unless higher limits are allowed by the PMO/Engineer. The moisture content of the other sizes of the coarse aggregate shall be controlled so that the aggregates are delivered to the mixers with the least amount of free moisture and the least variation in free moisture as practicable under job conditions. The Contractor may accomplish the required moisture control by use of free draining storage, covered

transportation and storage mechanical dewatering devices, or any other means acceptable to the PMO/Engineer.

(3) Water

The water for washing aggregate and mixing concrete, grout and mortar shall be reasonably clean and free from objectionable quantities of silt, organic matter, alkali, salts, acids and other impurities.

(4) Admixtures

(i) General

The Contractor shall furnish and use, upon approval of the PMO/Engineer, concrete admixtures so as to improve workability and finishability of concrete or mortar. Admixtures other than those for improving workability and finishability may be used upon approval of the PMO/Engineer.

Admixtures shall be accompanied with the manufacturer's certification in compliance with specifications provided herein. The PMO/Engineer will reject admixtures proposed by the Contractor when he deems such admixtures are unsatisfactory to produce a high degree of uniformity throughout the course of the work. The Contractor shall, if the PMO/Engineer deems it necessary, submit samples and perform tests on samples of the admixtures prior to shipment, and sample and test the admixtures after delivery at the Site.

The Contractor shall be responsible for any difficulties arising or damages occurring as a result of the selection and use of admixtures such as delay or difficulty in concrete placing or damage to the concrete during form removal.

All costs incidental to the use of admixtures shall be included in the unit prices stated in the Bill of Quantities for applicable items for concrete in which the admixtures are used.

(ii) Air entraining agent

An approved air entraining agent shall be used to produce the specified amount of stable entrained air in the the concrete mixture, and shall conform to the requirement of ASTM standard C260, "Air-entraining Admixtures for Concrete". The required air content of the concrete is as follows:

Maximum aggregate size of concrete (mm)	Total air % by volume
20	6.0 ± 1.0
40	4.5 ± 1.0
80	3.5 ± 1.0

(iii) Water reducing admixture

A water reducing admixture that does not retard the initial set of the concrete shall be added to the concrete during mixing in the amount approved by the PMO/Engineer. This admixture shall conform to the requirements of ASTM C 494, Type A.

(iv) Initial set retarding admixture

An initial set retarding admixture shall be added to the concrete during mixing where and in the amounts as approved by the PMO/Engineer in order to obtain the retardation of the initial set of the concrete. This admixture shall conform to the requirements of ASTM C 494-82, type B and D.

(v) Compatibility

The compatibility of admixtures, where two or more kinds of admixture are used in one batch, shall be tested in a manner as directed by the PMO/Engineer.

(vi) Storage

Liquid or powdered admixture for concrete shall be kept in waterproof stores with adequate provision for the prevention of water absorption. Storage shall be so arranged that the materials will be used in the order in which they arrive at the Site.

Sufficient quantities of admixture shall be kept in storage to ensure uninterrupted concrete placing.

T4.1.3 Mix proportions

(1) Mix proportions

The mix proportion of all concrete shall be as approved by the PMO/Engineer. The Contractor shall propose the mix proportion of concrete for the approval of the PMO/Engineer together with sufficient data for the judgement by the PMO/Engineer, sufficiently in advance to the intended placing of concrete for the examination by the

PMO/Engineer and,if directed, the adjustment of mix proportion by the Contractor. The PMO/Engineer may direct the Contractor to change the mix proportion from time to time at his discretion. In such case the Contractor shall no longer be entitled to use the previous mix proportion and he shall propose a new mix proportion for the approval of the PMO/Engineer. The table below gives particulars of classes of concrete to be placed in the various types of structures.

Class	Max. size of aggregate (mm)	Design strength at 28 days (kg/cm^2)	Slump (cm)	Tentative cement content (kg/m^3)
A	20	210	16 ± 2	345
B	20	180	13 ± 1	308
C	40	180	13 ± 1	322
D	40	140	9 ± 1	262
E	80	120	9 ± 1	220
F	40	100	9 ± 1	227
G	20	270	9 ± 1	310

Compressive strength of concrete at the age of 28 days measured by the testing method as stipulated in sub-clause T4.1.4 shall be more than 80% of the design strength stated above in a probability not less than 95% and more than the design compressive strength in a probability not less than 75%.

Unless otherwise specified, water-cement ratio by weight of each class of concrete shall not be more than 60 %.

Cement contents stated above are only tentative and the PMO/Engineer may order the Contractor to vary the cement contents of any class or classes of concrete during the course of the Works, and for such change in cement contents within 10% the Contractor shall not claim any compensation above the unit prices stated in the Bill of Quantities.

If the change in cement contents will occur beyond 10%, adjustment of unit prices for concrete will duly be made on the basis of its breakdowns to be submitted by the Contractor.

For various structures specified herein, the classes of concrete to be used are designated in principle in the following list and on the Drawings. They are subject to revision as directed by the PMO/Engineer.

Class	Location work
A	2nd concrete for blockout, building work
B	Drain ditch, drain pipe, side channel
C	Tunnel lining, inspection gallery, tunnel portal, concrete facing, spillway pier and side channel weir, chuteway, abutment, guide wall, entrance apron, stilling basin, training wall in outlet apron, retaining wall in road, valve chamber, access shaft, intake structure, slope protection, guide wall, stilling basin, parapet wall
D	Gravity wall, side channel, abutment wall, concrete for intake step, concrete plug and pipe protection
E	Backfill concrete, foundation of building in side-channel, plug concrete for core foundation
F	Lean concrete for levelling
G	Slab of composite girder bridge of spillway

(2) Trial mixes

At least 60 days prior to the start of permanent concrete work, the Contractor shall produce trial mixes for each of the classes of concrete specified under the supervision of the PMO/Engineer, using the entire aggregate producing, batching and concrete mixing plant provided for the execution of the Work. Such trial mixes shall be produced until concrete complying with these Specifications is produced.

No separate payment for trial mixes will be made and all cost incidental to trial mixes except furnishing and installing testing equipment shall be included in the unit prices stated in the Bill of Quantities for the applicable items of concrete.

T4.1.4 Tests of concrete and concrete material

Except where otherwise specified, sampling and testing of concrete material, fresh concrete and hardened concrete shall be conducted by the Contractor under the direction of the PMO/Engineer in accordance with JIS or approved equivalent. Such tests of concrete aggregates, fresh concrete and hardened concrete will include, but will not be necessarily restricted to, those listed below:

Test	Designation No
- CONCRETE -	
Sampling of concrete	JIS A 1115 - 75
Compressive strength	JIS A 1108 - 76, JIS A 1132 - 76
Slump	JIS A 1101 - 75
Air content	JIS A 1118 - 75
Unit weight	JIS A 1116 - 75
- AGGREGATE -	
Material passing 0.074 mm sieve	JIS A 1103 - 76
Surface moisture	JIS A 1111 - 76
Organic impurities	JIS A 1105 - 76
Sodium sulphate soundness	JIS A 1122 - 76
Grading of aggregate	JIS A 1102 - 76
Los-Angeles Abrasion	JIS A 1121 - 76
Units weight	JIS A 1104 - 76
Specific gravity and absorption	JIS A 1109 - 76, JIS A 1110 - 76

The Contractor shall execute the routine test of concrete to determine the compressive strength, slump and air content. The number and frequency of the tests of fresh concrete shall be as directed from time to time by the PMO/Engineer, provided that such tests shall be made at least once for each class of concrete which is produced during a shift. The compressive strength of the concrete shall be determined by tests of 15 cm diameter and 30 cm high cylinders, three of which shall be tested at 7 days and three at 28 days for each class of concrete which are produced during the shift. The tests of concrete aggregates shall be made as directed from time to time by the PMO/Engineer. Results of the routine test shall be submitted to the PMO/Engineer in the approved forms and in such intervals that the PMO/Engineer may direct.

The PMO/Engineer will make the check test of concrete material, fresh concrete and hardened concrete when he deems necessary. The Contractor shall fully assist the PMO/Engineer in the check test.

If at any time, the 7-day test indicates the strength at 28 days may not be achieved as specified, the PMO/Engineer will suspend concreting operations till the reasons are investigated and corrected, and/or the mix has been redesigned. This decision will be binding on the Contractor, and such suspension shall not be made a reason for any claims.

The Contractor shall provide such facilities, material and labour as may be necessary for producing, handling and waste disposal of representative test samples for tests specified in this sub-clause. Samples will be required of all concrete ingredients and fresh concrete at aggregate plants, batching and mixing plants and at the forms where concrete is being placed. All batching and mixing plants as provided in Clause G5.3 will be equipped with sampling devices and facilities for obtaining samples of water, cement, aggregates, admixtures and fresh concrete. Such sampling devices will

be used frequently and should be designed to ensure that representative samples of appropriate size of the required material are obtained with the minimum disruption of the Contractor's production of aggregate and concrete.

No separate payment for the provisions specified in this sub-clause will be made and all cost incidental to samplings, testings and providing sampling devices and facilities except furnishing and installing testing equipment shall be included in the prices stated in the Bill of Quantities for the applicable items for concrete. The Contractor shall not be entitled to any additional compensation for any delays or cost incurred in the provisions of samples.

T4.1.5 Batching

(1) General

Batching of cement, admixtures, fine and coarse aggregates entering each batch of concrete shall be made by weighing measurement. Unavoidable use of volumetric measurement of ingredients because of special circumstances of the jobsite shall be strictly subject to the approval of the PMO/Engineer.

All measuring devices shall be capable of ready adjustment to compensate for the varying moisture content of the aggregate and to change the weights of the materials being batched.

The combined accuracy of batching equipment in feeding and measuring the material shall be within the following limits :

Cement and water	1 %
Aggregate and admixtures	3 %

(2) Calibration of measuring devices

Unless otherwise directed by the PMO/Engineer, check tests of equipment used for measuring water, cement, and the admixtures shall be made in the presence of the PMO/Engineer, at least once in every two weeks, and of equipment used for measuring fine and coarse aggregates at least once every month. After completion of check test, the Contractor shall make such adjustment, repair or replacements as the PMO/Engineer may deem necessary to secure satisfactory performance before further use of the measuring or recording devices will be allowed.

The Contractor shall provide standard test weight and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device.

Periodical tests according to the manufacture's instruction shall be made in the presence of the PMO/Engineer in such a manner and at such intervals as may be directed by the PMO/Engineer.

(3) Batching and weighing equipments

Each weighing unit shall include a visible springless dial which will register the scale load at any stage of the weighing operation or shall include an over-and-under indicator which will show the scale in balance at no load and when loaded to the beam setting. The weights of the components of each batch shall be automatically recorded and the records shall be submitted to the PMO/Engineer, in such intervals that the PMO/Engineer may direct.

Each weighing indicator and water measuring device shall be in full view of the operator and the weighing equipment shall be so arranged that the operator may conveniently observe the operation of the bingates and also the materials discharging into the mixer. The arrangement for controlling the measuring and mixing operations shall be such that the mixer cannot be changed with a fresh batch until it has been emptied of the previous one.

The batching equipment shall be so constructed and arranged that the sequence and timing of the batcher discharge gates can be controlled to produce an intermixing of the aggregate, water and cement as the materials pass through the changing hopper into the mixer. The batching control shall be so interlocked that a new batching cycle cannot be started until all the weighing hoppers are completely empty.

The weighing hoppers shall be constructed in a manner which will permit convenient removal of overweight material in excess of the prescribed tolerances, and acceptable facilities shall be provided for readily obtaining from the batches representative samples of the materials for testing.

The operating mechanism in the water measuring device shall be such that no leakage will occur when the valves are closed and that the discharge valve cannot be opened until the filling valve is closed.

The device for adding admixtures shall be interlocked with the batching and discharging operation of the water so that the batching and discharging of the admixture will be automatic. The measuring device for cement shall be automatic.

The batching equipment shall include an accurate recorder for marking a continuous visible combined record on a single chart of the separate measurement of each concrete ingredient, including all mixing water and admixture and of consistency of the concrete during the mixing process.

T4.1.6 Mixing

The batched ingredients of concrete shall be so mixed in power-driven batch mixer as to produce a homogeneous mass of uniform consistency. Hand-mixing shall not be used for permanent structures and, when used for temporary structures, it shall be strictly subject to the approval of the PMO/Engineer.

The quantity of material in each batch shall not exceed the normal continuous rated capacity of the mixer and the speed of rotation shall be controlled within the deviation of 1 rpm from the manufacture's recommended speed. Components shall be fed into the mixing drum so as to ensure the most efficient use of the mixing period and to avoid any loss of material.

Unless otherwise directed or approved by the PMO/Engineer, the mixing of each batch shall continue for not less than the following numbers of minutes, after ingredients including the full amount of water and admixtures are in the mixer.

Capacity of mixer (cubic meter)	Time of mixing (minutes)
3 to 2	2.5
2 to 1.5	2
1.5 or less	1.5

The minimum mixing period specified above is predicated on proper control of the speed of rotation of the mixer and of the introduction of the materials including water into the mixer. The mixing time shall be increased when, in the opinion of the PMO/Engineer, the charging and mixing operations fail to result in the required uniformity of composition and consistency.

The efficiency of mixing operation shall be determined by means of measuring the difference in unit weight of mortar mixed in the batch mixer in conformity with JIS A 1119 - 76. The unit weight of two samples of air-free mortar taken from the first and last portion of the batch as discharged from the mixer shall not vary more than 1 per cent from the average weight of the two mortar samples. Furthermore, the weight of coarse aggregate per cubic meter in samples taken from the first and last portion of the batch as discharged from the mixer, each of which is 50 litres in volume, shall not vary more than 8 per cent from the average weight of the two coarse aggregate samples. These measurements shall be made by the Contractor in the presence of the PMO/Engineer at the time as directed by the PMO/Engineer. No separate payment will be made for these measurement and the cost thereof shall be included in the unit prices of the applicable items for concrete stated in the Bill of Quantities.

The remixing of partially hardened concrete with or without additional cement, aggregate, or water will not be permitted.

Mixers shall be periodically cleaned as directed by the PMO/Engineer.

T4.1.7 Transportation

The method and equipment used for transporting concrete shall be such that concrete having the required composition and consistency will be delivered to the point of placement without objectionable segregation or, unless otherwise approved by the PMO/Engineer, loss of slump in excess of 2.5 cm.

Addition of water to concrete after it has been discharged from the mixer or "retempering" will not be permitted.

In case that concrete is transported by the following types of equipment, the equipment shall be installed and handled according to the following specifications.

(1) Agitator truck

The agitating speed of the drum shall be between 2 and 4 rpm. The volume of mixed concrete in the drum shall not exceed the manufacturer's rating nor exceed 70 per cent of the gross volume of the drum. The interval between feeding of water into the mixer drum and final discharging of the concrete from the agitator shall not exceed 1.0 hour. During this interval, the mixture shall be agitated continuously at the speed above mentioned. Upon approval of the PMO/Engineer, truck mixer may be used instead of agitator trucks for transportation of central-plant-mixed concrete.

(2) Chute

In general, transportation of concrete by the use of chutes will not be permitted unless approved by the PMO/Engineer. The chute shall have a section with round corner and shall have a proper fixed slope so as to allow the concrete to flow satisfactory and without segregation. The lower end of chute shall be provided with a drop chute not less than 0.6 m in height to avoid segregation of falling concrete. Chutes shall be protected from the direct rays of the sun.

(3) Concrete pump or placer

Delivery pipes shall be so installed as to permit easy removal. Before starting pump or placer operation, about one cubic meter of mortar with the same proportions of water, admixture, cement and sand as designated for the regular concrete mix shall be passed through the pipe. The pipe shall be set as straight as possible. Air boosters shall not be used except in conditions that the outlet of pipes is completely embedded at least 2 meters in fresh concrete.

The use of concrete pump or placer shall in general be limited to tunnel work and locations where other transportation and placement methods are deemed impracticable by the PMO/Engineer.

(4) Belt conveyer

Transporting concrete by belt conveyers will not be permitted unless approved by the PMO/Engineer. Belt conveyers shall be such that belts are protected from rain, wind and sunlight, and that a proper hopper or vertical chute at least 0.6 m in depth is used at the end of each conveyer.

(5) Bucket

Buckets shall be such that concrete will be delivered to the point of placement without segregation. The bucket shall be equipped with a flexible drop chute not less than 0.6 m in height.

T4.1.8 Placing of concrete

(1) General

At least 30 days before placing concrete for the permanent works, the Contractor shall submit construction procedures showing the methods of concrete placement he proposes to use, to the PMO/Engineer for his approval.

No concrete shall be placed until all formwork, installation of parts to be embedded and preparation of surfaces involved in the placing have been completed by the Contractor and the completion has been inspected and approved by the PMO/Engineer.

Unless otherwise permitted by the PMO/Engineer, no concrete shall be placed in rain and standing water, and no concrete shall be placed in running water.

Communication facilities between the mixing plant and placing site shall be furnished by the Contractor where necessary or desirable as determined by the PMO/Engineer.

(2) Preparation for placing

Immediately before concrete is placed, all surfaces of rock foundations to which concrete is to be bonded shall be cleaned of oil, mud, organic matter, wooden pieces, objectionable coating, debris, loose rock fragments, or other perishable materials by the use of high-velocity air-water jets or other effective means approved by the PMO/Engineer.

Sharp projections of rock shall be knocked off. Faults, veins, crushed zones or any other weakness shall be treated as directed by the PMO/Engineer. This treatment may include consolidation grouting if necessary. Anchorages shall be provided if found necessary, and as directed the PMO/Engineer.

The surfaces of rock foundation shall be moistened thoroughly at least 18 hours before placing concrete and standing water shall be removed.

The surfaces of soil or sand and gravel foundations to which concrete is to be placed shall be free from standing or running water, wooden pieces or other objectionable materials above-mentioned. For soil or sand and gravel foundation, the foundation shall be in damp condition before placing concrete.

The surfaces of construction joints of old concrete including the surface of blockouts, on which new concrete to be placed shall be roughened and cleaned by chipping, high-velocity air-water jet, wire brushing or other approved method, and kept moist for at least 18 hours prior to placing the new concrete after the above mentioned treatment of the joints. Cleaning shall consist of the removal of all laitance, loose or defective concrete, coating, and foreign materials.

The surfaces of all contraction joints shall be cleaned thoroughly of accretions of concrete or other foreign materials by scrapping, chipping or other means satisfactory to the PMO/Engineer. Contraction joints shall be given a coat of compound approved by the PMO/Engineer to prevent bond.

(3) Placing

After the surface have been prepared satisfactorily, all approximately horizontal surface of rock and construction joints of mass concrete shall be covered with a layer of over-sanded mix. The mix shall have a proportion of cement and sand as directed by the

PMO/Engineer. The over-sanded mix shall be spread uniformly in a layer of 1.5 - 2 cm in thickness and concrete shall be placed immediately upon it.

Any concrete which has become so stiff that proper placing cannot be assured unless retempered shall be wasted at the Contractor's expense.

Concrete shall be deposited in vertical dropping to minimize segregation and be placed so carefully as not to exert unfavorably impact on the reinforcing bars or forms assembled. The vertical free drop of falling concrete shall not exceed 1.5 m. Care shall be taken in placing concrete through reinforcing bars to minimize segregation.

All formed concrete, except lining concrete for underground structures, shall be placed in horizontal layers, the thickness thereof shall not exceed 0.5 meter or any lower limit specified by the PMO/Engineer. The height of one lift of concrete placing shall not be more than 1.5 m unless approved by the PMO/Engineer. The time between successive lifts shall be at least 24 hours for all structures. This time may have to be extended to 96 hours in case of massive structures during critical periods of high internal heat generation in the concrete. Time limits shall be subject to the approval of the PMO/Engineer.

Unless otherwise approved by the PMO/Engineer, all concrete shall be placed in its final position within 1 hour after feeding of water into the mixer drum.

Cold joints shall be avoided where practicable. In the event of equipment breakdown, or if for any other reason continuous placing will be interrupted, the Contractor shall thoroughly consolidate the concrete at such joints to a reasonably uniform and stable slope while the concrete is plastic. The concrete at the surface of such cold joints shall be cleaned and wetted as required for construction joints before being covered with fresh concrete.

(4) Temperature of concrete

Temperature of concrete when it is being placed shall be not more than 32 °C. If the PMO/Engineer deems it necessary to do so, the Contractor Shall employ effective means, such as precooling of mixing water and placing at night, to maintain the temperature of the concrete, as it is placed, below 32 °C.

(5) Consolidation

Each layer of concrete shall be immediately consolidated with suitable appliances so that the concrete is compacted to the maximum practicable density and closes snugly against all surfaces of forms and embedded materials. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified.

In general, concrete shall be consolidated with electric or pneumatic power-driven internal-type vibrators, operating at a speed of at least 7,000 rpm when immersed in concrete. The vibrating head shall be inserted in concrete vertically and at least 5 cm into the underlying layer. Where it is difficult to use internal vibrators, concrete may be consolidated with the external-type vibrator or compacted with the hand-plunger as directed by the PMO/Engineer. The external-type vibrator shall be operated at a speed of 8,000 rpm and be large enough to effect consolidation.

Care shall be exercised to avoid contact of the vibrating head with surfaces of the forms or embedded objects to avoid excessive local vibration. Application of the vibrators shall be made systematically and at such intervals that the zones of influence overlap and the concrete is properly compacted. Over-vibration, causing segregation and surface laitance, or tending to bring an excessive of water to the surface, shall be avoided.

Any such excess water that rises to the surface shall be removed by mopping or sponging. In no case shall it be covered by concrete or dry concrete to soak up the excess water.

T4.1.9 Curing and protection of concrete

The Contractor shall protect all concrete against injury or harmful effect due to sudden drying, loading, shock or vibration until it has hardened sufficiently to prevent damage. Exposed finished surfaces of concrete shall be protected from the direct rays of the sun for at least the first 3 days after placement. All concrete and mortar surfaces shall be kept continuously moist for at least 14 days after placement.

The method of keeping concrete moist shall be by continuous sprinkling or spraying with water, as may be necessary to keep the concrete from drying, or by other methods approved by the PMO/Engineer. Water curing shall be handled so as to prevent the formation of unsightly stains on concrete surfaces which will be permanently exposed. The water shall be free from oil and salts which may stain the concrete.

All concrete shall be adequately protected from damage. No fire or excessive heat, including the heat resulting from the welding of steel or reinforcing bars, shall be permitted near or in direct contact with concrete at any time. All conduits and other openings in the concrete, if any, shall be closed during the entire curing period.

In case the curing actions are inadequate or unsatisfactory, the PMO/Engineer shall be entitled to take such steps as he deems necessary to make up the deficiencies or defects at the Contractors risk and cost.

Should the concrete perish, i.e., become dry or powdery through negligence in curing, or get damaged through negligence in protection, such work shall be demolished and rebuilt as directed by the PMO/Engineer, at the Contractor's risk and cost.

T4.1.10 Construction joints

The location of construction joints shall be as shown on the Drawings or approved by the PMO/Engineer.

The surfaces of the construction joint shall be prepared for receiving the succeeding lift concrete by cleaning and roughening with chipping, high-velocity air-water jet, wire brushing or other approved means.

High pressure air-water jet shall be used as directed by the PMO/Engineer. The surface shall be cut with a high-pressure air-water jet by removing all laitance and by exposing clean,sound aggregate, but not so as to undercut the edges of larger particles of aggregate. The air pressure used in the jet shall be 7 kg/cm2 and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. The surface shall again be washed with an air-water jet just prior to placing the succeeding lift.

The method used in disposing of waste water employed in cutting, washing and rinsing of concrete surfaces shall be such that the waste water does not stain, discolour, or affect exposed surfaces of the structures.

T4.1.11 Contraction joint and waterstop

Contraction joint as indicated on the Drawings or elsewhere as directed by the PMO/Engineer shall be provided by the Contractor. The joint material will consist of a layer of bituminous coating on the face of the first concrete.

Waterstops shall be furnished by the Contractor and shall be placed at such positions as shown on the Drawings or as directed by the PMO/Engineer. Waterstops shall be of flexible polyvinyl chloride meeting JIS K 6773-74 or approved equivalent. Waterstops prescribed in this Clause shall include groutstop.

All waterstops shall be stored in a place as cool as practicable and in no case shall waterstops be stored in the open or exposed to direct rays of the sun. All waterstops shall be stored so as to permit free circulation of air about them.

All field splices and intersections of waterstops shall be made so as to provide watertight connections by such means as specified by the manufacturer or as indicated on the Drawings.

The Contractor shall provide suitable support and protection during the progress of work to protect the Waterstops from damage, deterioration, or warping.

Waterstops shall be installed with equal widths of the material embedded in the concrete on each side of the joint. The concrete shall be carefully placed and vibrated around the waterstop for a complete bond between the concrete and all embedded areas of the waterstop. After installation and before, it is embedded in concrete, the waterstop shall be protected from direct rays of the sun.

The Contractor shall replace or repair, at his expense, any waterstops torn, punctured or otherwise damaged before final acceptance of the work.

The watertightness of joints for which waterstops are provided shall be the Contractor's responsibility. The Contractor shall supply all materials and labour and perform all the work necessary to rectify leaking joints to the PMO/Engineer's satisfaction.

T4.1.12 Formwork

(1) General

Forms shall be used, wherever necessary or particularly directed by the PMO/Engineer, to confine concrete and shape it to the required lines.

The forms shall have sufficient strength and rigidity to hold the concrete and to withstand the pressure resulting from placement and vibration without deflection from the prescribed lines. The surfaces of all forms to be in contact with the concrete shall be clean, rigid, smooth, and sufficiently tight to prevent loss of mortar or cement slurry.

All exposed joints, edges, and external corners shall be chamfered not less than 2 cm at 45° except as otherwise directed. Internal corners shall be filleted where indicated or required by the PMO/Engineer.

Immediately before concrete is placed, precaution shall be taken to see that all forms are in proper alignment, and that all form supports are thoroughly secure and tight.

In case of sliding formwork used for tunnel lining, and also in case of any other formwork as directed by the PMO/Engineer, the Contractor shall submit the design drawings of the formwork for approval of PMO/Engineer, before manufacturing the forms. Such approval shall not relieve the Contractor of his responsibility for adequacy and strength of the formwork.

(2) Material

All materials used in the forms shall be subject to the approval of the PMO/Engineer. Lumber shall be sound, straight, free from warp, decay and loose knots and shall be dressed smooth and uniform in width and thickness prior to fabrication of formwork.

Form to be used in water passages and for concrete which will ultimately be exposed to view shall be faced either with plywood or steel and shall be free of all defects which will be reproduced as blemishes on the concrete surfaces.

Particular care shall be taken for curved formwork, which shall be such that it will not warp or spring up during concreting.

Where plywood is used, it shall be non-warping, non-wrinkling and manufactured with special waterproof glues. In so far as is practicable, plywood sheets shall be of uniform width and length.

(3) Construction tolerances

Variation in alignment, grade and dimensions of the structures from the established alignment, grade and dimensions shown on the Drawings shall be within the tolerances specified in this Paragraph. Concrete work that exceeds the tolerance limits specified herein shall be remedied or removed and replaced by the Contractor at his own expense.

(i) Construction tolerances for reinforced concrete structure

a. Variation from vertical		Tolerance
- In the lines and surfaces of columns, piers, walls and towers	In 3 m	5 mm
	In 6 m or maximum	8 mm
	In 12 m or more	16 mm
- For exposed columns, control joints, grooves and other conspicuous lines	In 6 m maximum	5 mm
	In 12 m or more	10 mm

b.	Variation from the level or from the grades indicated on the Drawings:		
	- In floors, inverts, ceilings, and beam soffits	In 3 m	5 mm
		In any bay of 6 m maximum - Minus	8 mm
		In 12 m or more - Minus 16 mm	
c.	Variation of linear structure lines from established position in plan and related position of walls and columns	In any bay of 6 m maximum	12mm
		In 12 m or more	25 mm
d.	Variation in locations of sleeves and sizes and locations of floor openings and wall openings	.....	5 mm
e.	Variation in cross-sectional dimensions of columns, beams and in the thickness of slabs and walls	Minus	5 mm
		Plus	10 mm
f.	Variation in steps:		
	- In a flight of stairs	Rise	3 mm
		Tread	5 mm
	- In consecutive steps	Rise	2 mm
		Tread	3 mm

(ii) Construction tolerances for mass concrete structure

a.	Variation of the constructed linear outline from established position in plan	In 6 m	12 mm
		In 12 m	18 mm
b.	Variation from the level or from the grades indicated on the Drawings	In 3 m	6 mm
		In 9 m	12 mm
c.	Variation in cross-sectional dimensions	Minus	6 mm
		Plus	12 mm
d.	Variation in the thickness	Minus	6 mm
		Plus	12 mm

(iii) Construction tolerances for tunnel

a.	Departure from established alignment or from established grade but parallel to it:	.....	12 mm
b.	Variation from inside dimensions	In 5 m	3 mm
c.	Variation in thickness, at any point	Minus	0 mm

(iv) Construction tolerance for placing reinforcing steel

a. Variation of protective covering	With 50 m cover or less.....	5 mm
	With more than 50 mm cover.....	10 mm
b. Variation from indicated spacing (any one bar)	.....	25 mm

(4) Installation and preparation

Forms shall be installed so that the joint marks on concrete surfaces are in alignment both horizontally and vertically, and the joints between surfaces shall be smooth. All edges or corners of the concrete exposed permanently shall be chamfered as prescribed.

Before placing concrete, all forms be rigid and tight and shall be thoroughly cleaned, and all wooden chips, saw dust, dry mortar lumps, foreign matter and excess water shall be removed from between the forms. The surfaces of the forms shall be oiled with a non-staining commercial mineral oil of a type approved by the PMO/Engineer. The form oil shall be applied before the reinforcement is placed. Forms, which have been left in place for such a period that they have dried out, shall receive further surface treatment as directed by the PMO/Engineer.

Care shall be taken to prevent the oil from coming in contact with construction joints or reinforcement.

Where forms for continuous surfaces are placed in successive lifts, care shall be taken to fit the forms tightly over the entire surface so as to prevent leakage of mortar or cement slurry from the concrete and to maintain accurate alignment of the surface. Forms to be used more than once shall be maintained in serviceable condition and shall be thoroughly cleaned before being reused. Forms on exterior faces on walls shall be kept clean by means of splash boards.

(5) Internal ties

Internal ties consisting of bolts and rods shall be so arranged that embedded metal shall terminate not less than 3 cm from the formed surface of the concrete after forms are removed where the maximum size of aggregate is 40 mm, and not less than 5 cm where the maximum size of aggregate is 80 mm or larger. Wire ties through forms shall not be used unless authorized by the PMO/Engineer. Holes left after the removal of ties shall be filled with dry pack mortar.

(6) Removal

Forms shall not be removed until the concrete has hardened and is of sufficient strength to carry its own weight safely, together with any construction loads likely to be imposed upon it. Forms shall be removed only with the approval of the PMO/Engineer and, in general, the forms shall be left for the periods not less than the following number of hour after the concrete is placed:

Arches, conduit roofs, beams and deck-type slabs	168 hrs
Columns and walls	72 hrs
Mass concrete	48 hrs
Tunnels and shafts	
Invert	16 hrs
Arch	24 hrs
Wall poured separately from arch	48 hrs
Conduit in open cut	72 hrs

Care shall be taken in removing forms to prevent damage to the concrete.

T4.1.13 Finishes and finishing

(1) General

The classes of finishes and the requirements for finishing concrete surfaces shall be as specified in this Clause. Surface irregularities in finishes, as described herein, shall be distinguished from construction tolerances which are allowable deviations from established lines, grades and dimensions and are described in paragraph T4.1.12 (3).

Surface irregularities are designated "abrupt" and "gradual" for the purposes of classifying finishes. Off-sets resulting from displaced, misplaced, or mismatched forms or loose knots in forms, or other similar form defects shall be considered "abrupt" irregularities and will be checked by direct measurement. All other surface irregularities shall be considered "gradual" irregularities and will be measured as a departure from the testing edge of a 1.5 m template for formed surfaces and of a 3 m template for unformed surfaces.

Finishing of concrete surfaces shall be performed only by skilled workmen.

(2) Formed surfaces

The classes of finish for formed surfaces are designated by use of symbols F1, F2, F3 and F4.

F1 - Finish F1 is a finish applied to formed surfaces which will be covered by fill material or by concrete. Correction of surface irregularities, measured as previously described, shall be required only for depression which exceed 25 mm, when measured as previously described.

F2 - Finish F2 is a finish applied to formed surfaces which will be permanently exposed and where a reasonably attractive appearance is required. Surface irregularities, measured as previously described, shall not exceed 6 mm for abrupt irregularities and 15 mm for gradual irregularities.

F3 - Finish F3 is a finish applied to formed surfaces which will be permanently exposed to public view and where an attractive appearance is paramount. Surface irregularities, measured as previously described, shall not exceed 3 mm for abrupt irregularities and 6 mm for gradual irregularities

F4 - Finish F4 is a finish applied to formed surfaces for which alignment and evenness of surface are of paramount importance from the standpoint of eliminating destructive effects of water action. Surface irregularities, measured as previously described, shall not exceed 3 mm for abrupt irregularities not parallel to the direction of flow, 6 mm for abrupt irregularities parallel to the direction of flow, and 10 mm for all gradual irregularities. Gradual irregularities that have a slope steeper than 1 vertical to 20 horizontal and all abrupt irregularities in excess of the allowed limits shall be ground to a slope of 1 vertical to 20 horizontal, except that abrupt irregularities such as pitting shall be remedied in accordance with the provisions in sub-clause T4.1.14.

(3) Unformed surface

The classes of finish for unformed surface are designated by use of symbols U1 and U2.

Finish U1 is a screeded finish applied to unformed surfaces which will be covered by fill material or by concrete. Finish U1 is also the first stage of finish U2. Finishing shall consist of sufficient levelling and screeding to produce uniform surfaces. Surface irregularities measured as previously described shall not exceed 10 mm.

Finish U2 is a floated finish applied to unformed surfaces of waterway or surfaces which will be generally exposed to view. Floating shall be started as soon as the screeded surface has stiffened sufficiently, and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities for waterways shall be measured in accordance with the requirements of finish F4. Surface irregularities of areas other than waterways measured as previously described shall not exceed 3 mm.

No separate payment shall be made for the work under this Clause. The cost thereof shall be included in the appropriate unit prices of concrete work stated in the Bill of Quantities.

T4.1.14 Damaged or defective concrete surface

Defective concrete and concrete damaged from any cause shall be removed and replaced with acceptable concrete by the Contractor at his own expense. Irregularities of alignment due to inaccurate finishing of surfaces, bulging of forms, or other defects shall be rectified by and at the expense of the Contractor.

Patching and finishing work shall be done only by skilled workmen and shall be subject to the PMO/Engineer's inspection. Before final acceptance of the work, the Contractor shall clean all exposed concrete surfaces of all encrustations of cement, mortar, or grout, and shall remove all unsightly stains to the satisfaction of the PMO/Engineer.

All porous and fractured concrete and surface concrete, to which additions are required to bring it to prescribed lines, shall be removed by chipping openings into the concrete to bare the reinforcement. The extent and dimensions of the chipped openings shall be as directed by the PMO/Engineer. The chipped openings shall be sharpedged and keyed and shall be filled to the required lines with fresh concrete or dry patching mortar, as directed by the PMO/Engineer. Where concrete is used for filling, the chipped openings shall not be less than 8 cm in depth and the fresh concrete shall be reinforced and dowelled to the surface of the openings, as directed by the PMO/Engineer.

Mortar for patching shall consist by volume of one part of cement, two parts of regular concrete sand, and just enough water so that after thorough mixing of the ingredients the mortar will barely hold together when compacted by squeezing with the hand. The mortar shall be fresh when placed and any mortar that is not used within two hours after preparation shall be wasted. Immediately prior to mortar application, the surface to which the mortar is to be bonded shall be dampened, then scrubbed with a small quantity of mortar using a wire brush.

Where repairs are more than 3 cm deep, the mortar shall be applied in layers not more than 2 cm thick to avoid sagging. After each layer, except the last, is placed, it shall be thoroughly roughened by scratching with a trowel to provide an effective bond with the succeeding layers. The last of finishing layer shall be smoothed with a trowel to form a continuous surface with the surrounding concrete. The addition of a small quantity of water to the finished surface of the patch to aid in securing a smooth finish will be permitted, but other than this no additional water shall be used.

All patches on exposed surfaces shall be neat and smooth and as near as possible of the same colour as the adjoining concrete as possible. All patches shall be thoroughly bonded to the surfaces of the chipped opening and shall be sound and free from shrinkage, cracks and drummy areas.

In repairing damaged or defective concrete at important locations, the Contractor shall use epoxy resin bonding if directed by the PMO/Engineer.

All patches and repairs shall be kept continuously damp for a period of not less than 7 days and kept out of the direct rays of the sun for at least 7 days immediately following completion of the patch or repair.

T4.1.15 Reinforcing bars

(1) General

Reinforcing bars required for all permanent construction shall be furnished, fabricated and placed by the Contractor.

Reinforcing bars shall be deformed steel bars and shall comply with JIS G 3112-85, SD 30 or approved equivalent.

During the course of the Works, the PMO/Engineer will issue to the Contractor reinforcing bar drawings showing the position and size of all required reinforcing bars. The Contractor shall submit to the PMO/Engineer for his approval reinforcing bar bending and cutting drawings, and bar list for each reinforcing bar bending and cutting drawing. Bends, hooks, splicing and anchorage shall conform to the standard details shown on the Drawings.

(2) Fabrication and placing

Bending bars with the aid of heat shall not be permitted unless otherwise approved by the PMO/Engineer.

The position of joints or splices of reinforcing bars shall be approved by the PMO/Engineer and those in adjacent bars shall be staggered if directed by the PMO/Engineer. The number of joints or splices shall be kept to a minimum.

Before the reinforcement is placed, the surfaces of the bars and the surfaces of any bar supports shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease, or other foreign substances, which, in the opinion of the PMO/Engineer, are objectionable. If necessary as

determined by the PMO/Engineer, exposed, previously placed bars shall be cleaned of rust and debris before being covered by concrete.

Reinforcing bars shall be accurately placed and fixed in position so that they will not be displaced during the placing of concrete.

Bars shall be tied at all intersections, and splicing tied at several points, by using annealed iron wire more than 0.9 mm in diameter or suitable clips.

Distances from the surfaces or forms of foundations shall be maintained correctly by means of metal hangers, mortar blocks, metal supports, or other supports approved by the PMO/Engineer.

T4.1.16 Concrete in tunnel

(1) Form

Forms used for tunnel concreting which are generally either sliding forms or collapsible forms shall have structures adequate for construction conditions and have sufficient strength.

Sliding forms shall meet the following requirements.

(a) Sliding forms for the arch and sidewall lining shall be provided with ample openings through which concrete may be deposited and inspected as it moves into space, or concrete may be compacted, or sliding forms may be cleaned.

(b) The length of a sliding form shall be such that:

- Total concrete volume per sliding form does not exceed the volume of concrete which is continuously placed, or the capacity of concreting equipment.
- Sliding forms can be shifted smoothly in a curve of tunnels without any contact or collision with excavated surface or lined concrete.
- No shrinkage crack takes place on the concrete surface due to temperature change and drying.
- Construction tolerances for tunnel specified in paragraph T4.1.12 (3) shall be met.

Collapsible forms shall have structure easy to assemble and dismantle.

Shifting and setting of forms shall be made, paying full attention to the following points.

(a) Prior survey is prerequisite to place forms at the exact locations.

(b) Rails for shifting forms shall be firmly placed, being free from vertical and horizontal movement.

(c) Forms shall be shifted in a manner that forms are kept off the surface of concrete.

(d) To prevent sticking of concrete, the surface of forms shall be treated with a suitable oil or other coating material in a manner described in paragraph T4.1.12 (4) of the Technical Specifications.

(e) Forms shall be fixed firmly by tightly fastening bolts and nuts. Because there is a large possibility that sliding forms loosen due to vibration, the bolts and nuts of sliding forms shall be examined as often as possible and tightened if required.

Removal of forms shall be made as stipulated in paragraph T4.1.12 (6) or as approved by the PMO/Engineer.

Necessary finish shall be as shown on the Drawings, unless otherwise directed by the PMO/Engineer.

(2) Concrete placement

Concrete in tunnels may be placed by pumping or any other methods approved by the PMO/Engineer. Equipment and methods used in placing shall be such as will introduce the concrete into forms without high velocity discharge and segregation.

In the event of equipment breakdown, or if for any other reason continuous placing is interrupted in one block, the Contractor shall thoroughly consolidate the concrete at such joints to a reasonably uniform and stable slope while the concrete is plastic. If cold joints occur, the concrete at the surface of such joints shall be cleaned as required for construction joints as stipulated in sub-clause T4.1.10, and wetted before being covered with fresh mortar and concrete. Concrete required to be placed incidental to the installations of tunnel supports or to other temporary work shall be removed before any permanent concrete is placed, unless it is at least equal in all respects to the permanent concrete specified.

The transportation of concrete for tunnel shall be made by using agitators unless otherwise approved by the PMO/Engineer in order to prevent the segregation of concrete and the intrusion of harmful foreign materials.

The concrete shall be placed and sufficiently compacted with vibrators in such manners that it is free of segregation, that it is deposited as level as possible in both sides, that entrapment of air is avoided within partially enclosed spaces to be filled, and that any openings do not remain behind the steel supports.

The arch crown shall be filled with the blow-up method by connecting the discharge pipe end to a feeding hole provided in the form plate. When this method is impracticable in the opinion of the PMO/Engineer, the discharge pipe end shall be kept continuously embedded at least 2 m in fresh concrete and the air booster shall be installed to the discharge pipe near the arch crown and used intermittently for filling the arch crown. During filling of the arch, the operation shall be managed by maintaining constant observation through openings in the form.

Curing shall be made in manners as stipulated in sub-clause T4.1.9. When concrete with large slump is used, special care shall be taken to prevent shrinkage crack.

T4.1.17 Concrete in blockouts

Blockouts shall be made as shown on the Drawings or as directed by the PMO/Engineer, to permit the installation and adjustment of metalwork of the hydromechanical equipment to be embedded in concrete, and shall be filled with mortar or concrete after the installation is completed.

Unless otherwise directed by the PMO/Engineer, the concrete surfaces of the blockouts shall be chipped and roughened by suitable means before mortar or concrete is placed in the blockouts.

After cleaning the roughened surface in blockouts and keeping it moist for at least 18 hours, and after approval by the PMO/Engineer, the blockout shall be filled with mortar or concrete.

Exceptional care shall be taken in placing mortar or concrete in blockouts to insure satisfactory bond with the concrete previously placed, to secure complete contact with all metalwork in the blockouts, and to ensure that the metalwork is not displaced.

T4.1.18 Measurement and payment

(1) Concrete

A systematic record of all concreting operations shall be maintained by the Contractor in the form approved by the PMO/Engineer.

Measurement for payment of concrete required to be placed directly upon or against surfaces of excavation will be made to the lines for which payment for excavation is made, provided that where shotcrete intervenes between concrete and the said lines, measurement for payment of concrete will be made only to the designated surface lines of shotcrete. Measurement for payment of all other concrete will be made to the neatlines of the structures, unless otherwise specifically shown on the Drawings or prescribed in these Specifications.

In measuring concrete for payment, the volume of all openings, recesses, ducts, embedded pipes, woodwork, metalwork, and blockouts each of which is larger than 0.05 m2 in cross section, will be deducted.

Payment for concrete in various parts of the work will be made at the unit prices per cubic meter stated in the Bill of Quantities, which unit prices shall include the cost of all labour, materials and equipment required in the construction. These unit prices shall also include the cost of all concrete materials, mixing, transportation, placing, finishing, curing, preparation of joint including bituminous coating, mortar placing on joints or rock surfaces, trial mixes, tests and other items necessary to complete the work. All waste concrete shall be at the expense of the Contractor.

Where the item of concrete or mortar in blockout is not provided in the Bill of Quantities, payment or such concrete or mortar will be made at the same unit price for the concrete surrounding the blockout.

(2) Contraction joints, joint material, waterstops and grout stop

Measurement for payment of joint material will be made on the basis of actual installed area of the coating in square meters determined by the dimensions as shown on the Drawings or directed by the PMO/Engineer.

Payment will be made for the number of square meter measured as provided above at the respective unit price stated in the Bill of Quantities, which unit price for joint material shall constitute full compensation for the cost of all labour, tools, equipment and materials including furnishing, transporting, fabricating, installing and other items necessary to complete the works.

Measurement for payment of furnishing and placing waterstop or grout stop will be made of the length of waterstop in place with no allowance made for laps at splices and intersections.

Payment for furnishing and placing waterstop or grout stop will be made at the unit prices per linear meter stated in the Bill of Quantities, which unit prices shall include the cost of furnishing all material, making field splices and installing the waterstop or grout stop.

(3) Formwork

Measurement for payment of formwork will be made of the area of formed surfaces of concrete. The measurement will include sloping surfaces steeper than 1 vertical to 2 horizontal, the formed surfaces of contraction joints and construction joints shown on the Drawings or as directed by the PMO/Engineer, and the formed surfaces of blockouts larger than 0.1 m2 in cross-sectional area. The formed surface of contraction joints and construction joints not shown on the Drawings, and grooves and chamfers at joints and elsewhere shall not be measured for payment.

Payment for formwork will be made at the unit prices per square meter stated in the Bill of Quantities, which unit prices shall include the cost of all labour, materials and equipment. These unit prices shall also include the cost of furnishing, transporting, fabricating, erecting, surveying, fixing, dismembering, removing the form and other items necessary to complete the work. Unless otherwise shown on the Drawings or directed by the PMO/Engineer, the cost of formwork for surfaces of contraction joints and construction joints shall be included in the various unit prices for concrete stated in the Bill of Quantities. Formwork to fill unauthorized overexcavation shall be at the expense of the Contractor.

(4) Reinforcing bars

Measurement for payment of furnishing, cutting, bending and placing reinforcing bars will be made only of the weight of the bars embedded in the concrete in accordance with the bar lists approved by the PMO/Engineer or as directed. Anchor bars for erection, dowel bars and hooks made of reinforcing bars shall also be measured as reinforcing bars.

Accurate records shall be maintained by the Contractor, and shall be made available for the scrutiny of PMO/Engineer when demanded, indicating the number, size, and length of all bars placed in position and embedded in concrete.

Joints or splices approved by the PMO/Engineer will be measured for payment.Additional joints or splices which are provided at the Contractor's convenience will not be measured for payment.

Payment for furnishing, cutting, bending and placing reinforcing bars will be made at the unit prices per ton except building works and per kilogram for building works stated in the

Bill of Quantities, which unit prices shall include the cost of all labour, materials and equipment required for transporting, cutting, bending, cleaning, attaching ties, supporting and placing, and the cost for providing steel bar bending, cutting and arranging drawings.

(5) Concrete blocks to repair existing municipal dike

Measurement for payment of concrete blocks to repair the existing municipal dike will be made of the volume of the concrete blocks to be set, as shown on the Drawings or as directed by the PMO/Engineer.

Payment for concrete blocks will be made at the unit price per cubic meter stated in the Bill of Quantities, which unit price shall include the cost of furnishing all materials, making and installings blocks and others required to complete the work.

T4.2 Shotcrete

T4.2.1 General

Shotcrete shall be applied to permanently exposed excavated surface, temporary exposed foundation surface, tunnel roof and side surfaces and elsewhere as shown on the Drawings or as directed by the PMO/Engineer.
The program and method of and equipment to be prepared by the Contractor for shotcrete shall be approved by the PMO/Engineer.

T4.2.2 Material

Aggregate (fine aggregate), cement and water to be used in shotcrete shall comply with the requirements of sub-clause 4.1.2. Wiremesh shall be of 3.2 mm diameter (#10) iron wire mesh which shall comply with the requirements of JIS G 3551-80, Welded Wire Mesh 100 mm opening, or approved equivalent. Pipes for weepholes shall be polyvinyl chloride (P.V.C) pipes of 50 or 75 mm in diameter.

T4.2.3 Mix proportion

The cement-sand ratio shall be 1:4 to 1:4.5 by weight. The exact proportion will be determined in place by the PMO/Engineer. The water content shall be limited to prevent overwetness causing the mortar to slough from initial position and the optimum mix shall contain a little less water than that which will cause sloughing and just enough cement for the desired water-cement ratio.

The fine aggregate and cement shall be thoroughly mixed before being put into the spraying equipment. The mixing period shall not be less than 1.5 minutes.

Any mixed material that stands longer than one hour after being mixed shall be wasted.

Use of admixtures such as hardening accelerator or retarder or air entraining agent shall be subject to the approval of the PMO/Engineer.

T4.2.4 Preparation for spray

Before spraying, the rock or concrete surfaces shall be wetted and thoroughly cleaned of loose rock fragments, dirt, oil and all other materials objectionable for the bond of the shotcrete mixture with rock or concrete.

The wire mesh, when its placing is directed by the PMO/Engineer, shall be securely fixed to designated positions with anchor pins in rock to avoid movement due to spraying operation. Each anchor pin shall be driven into rock so that one end projects from rock surface to fix the wire mesh. The wire mesh shall be placed at a position at least 3 cm above the surface to be coated and 2 cm below the finishing surface. The wire mesh shall be lapped at joint sections of mesh by a minimum width of 15 cm. The plastic pipes for weeping shall be installed securely in each 4 m^2 (square meter) of slope surface.

T4.2.5 Placing and curing

For proper application, the nozzle shall be held normal to and about 0.9 m from the surface to be coated. The nozzle shall be so moved to place a layer in uniform thickness. The thickness of shotcrete shall be minimum 2 cm above wire mesh.

The water pressure shall be greater by at least 1 kg/cm^2 than the air pressure and shall be uniform. Maximum, minimum, and average air pressure and water pressure shall be as follows:

	Maximum	Minimum	Average
Air pressure (kg/cm^2)	5.0	2.5	3.5
Water pressure (kg/cm^2)	9.0	3.5	5.0

The surface of the sprayed shotcrete shall be kept wet continuously for at least 7 days after the spray.

T4.2.6 Test

The test cylinders shall be taken once during each shift. Sampling and testing shall be performed in accordance with the requirements of sub-clause 4.1.4.

T4.2.7 Measurement and payment

Measurement for payment of shotcrete will be made only of the area of shotcrete actually placed as directed by the PMO/Engineer, and only for the quantities which, in the judgment of the PMO/Engineer, are necessary for satisfactory construction.

Payment for shotcrete will be made at the unit prices per square meter stated in the Bill of Quantities, which unit prices shall include the cost of all labour, materials and equipment including furnishing and installing plastic pipes for weeping as required and of furnishing and placing wire mesh.

T4.3 Cooling of Concrete

T4.3.1 Cooling operation

Concrete in the plug of the diversion tunnel shall be cooled by the coolest available river water through pipes embedded in the concrete as shown on the Drawings. The rate of circulating water through each pipe of the cooling systems shall be not less than 60 cm/s.

Cool river water shall be circulated through each pipe of the cooling systems as long as practicable immediately following the placing of concrete around the pipes, and for a period of time approved by the PMO/Engineer. If the circulation of water is interrupted, the time of cooling shall be extended by a period of time equal to the period of interruption so that the net time of circulating water through the pipe or tubing for the cooling period is not less than the period of time approved by the PMO/Engineer. Circulation shall be controlled so that the maximum temperature of concrete does not exceed 40°C.

For the control of cooling operations, concrete temperature will be observed by the PMO/Engineer by resistance type thermometers embedded in the tubing by the Contractor for such purposes.

The Arrangement, housing, location, and capacity of the pumping plant and equipment, pipe headers, connections to the embedded pipe, and outlet piping shall be such as to insure dependable and continuous operation and shall be subject at all times to the approval of the PMO/Engineer. The connections to the individual embedded pipe may be controlled positively at any time without

interfering with the flow through the other pipes of the system. Provisions shall be made in the layout of pipe connections for reversing the direction of flow of water through the embedded coils. The direction of flow through the cooling pipes shall be reversed once not more than 24 hours. The intake for the cooling water shall be screened and shall be kept clear of mud and debris, and all necessary precautions shall be taken to prevent any part of the cooling system from becoming clogged or otherwise inoperative.

The Contractor shall provide all necessary facilities, such as catwalks, ladders, and platforms, for easy and convenient access for observing the cooling operations.

T4.3.2 Embedded pipe for cooling system

The Contractor shall furnish and place, as shown on the Drawings, pipes through which water will be circulated for the purpose of cooling concrete in the plug.

The cooling pipe shall be of 25 mm diameter plain-end metal pipe in accordance with JIS C 8305-82, or approved equivalent. The lengths of pipes shall be joined together with expansion-type coupling. Pipe nipples used for surface connections shall be galvanized. All pipes shall be clean and free from scale, inside and outside, and shall be so maintained until it is embedded in the concrete.

All pipes shall be supported and securely held in place by metal ties in a manner approved by the PMO/Engineer.

All cooling systems shall be washed clean and shall be tested for leakage in the presence of the PMO/Engineer at a pressure of 3.5 kg/cm^2, and shall be watertight at that pressure before being embedded in concrete. The Contractor shall protect the cooling systems from displacement or damage during the placing of concrete and other work following the placing and testing of the cooling systems.

Removable nipples shall be placed where the inlet and outlet ends of the cooling pipes extend through the formed surfaces of the concrete. The Contractor shall cap and otherwise suitably protect the end of pipes from damage until the cooling operations are completed and the pipes are filled with grout.

Straight lengths of tubing shall be embedded as shown on the Drawings for insertion of resistance thermometers for determining the temperature of the concrete during cooling operations.

After the cooling pipes have served their purposes as determined by the PMO/Engineer, the pipes shall be filled with grout, after which the nipples at the pipe ends shall be removed and the resulting holes patched with mortar.

T4.3.3 Measurement and payment

Payment for cooling system and cooling operation for plug concrete in the diversion tunnel will be made at the lump sum price stated in the Bill of Quantities, which lump sum price shall include all the cost necessary to complete the cooling operation with 40 mm diameter thermometer, 200 mm diameter drain pipe, drilling 46 mm diameter and 250 mm in depth holes, etc.

CHAPTER T5 ROAD WORK

T5.1 Scope of Work

These Specifications cover the construction and maintenance of access roads around the damsite and along transmission pipeline and haul road to the quarry site lots including excavation, embankment, concreting, drainage, pavement and other incidental works concerning service roads. The Contractor shall construct all the access roads except the roads constructed by the contractor of Lot-I as shown on the Drawings or as directed by the PMO/Engineer. Service roads in this Contract consists of, but is not limited to, the following items.

Location and layout of the access and haul roads are shown on the Drawings.

T5.2 Access Roads

T5.2.1 General

The access roads defined herein include the following:

- Access road around the damsite
- Access road along transmission pipeline
- Haul road to the quarry site

The Contractor shall construct and maintain the access/haul roads as listed above and as directed by the PMO/Engineer in accordance with these Specifications as stipulated in CHAPTER T2 EARTHWORK for excavation, embankment, etc. and CHAPTER T4 CONCRETE WORK for concrete structures unless otherwise specified herein.

The finishing of access/haul roads and parking lots is classified as, but not limited to, gravel metalling surfaces or penetration macadam asphalt surfaces with subbase course.

T5.2.2 Subbase course

(1) Subbase course material

The Contractor shall construct the subbase course using the excavated rock materials which have been temporarily stockpiled along the roadway or deposited in the spoil banks as specified.

(2) Aggregate requirements

a. Subbase course materials shall conform to the following quality requirement or the direction of the PMO/Engineer.

Kind of tests	Standard	Requirement
CBR-value	JIS A 1211-80 or equivalent	30% min.

b. Gradation

The subbase course aggregates shall be less than 50 mm in size and its gradation shall be approved by the PMO/Engineer before commencement of the work.

c. Sampling and Testing

The Contractor shall execute the tests for all aggregates and shall submit the test results thereof to the PMO/Engineer for his approval not less than 30 days in advance of the time when they will be required in the work.

(3) Placing

The Contractor shall make adjustments in processing and placing procedures as specified in the Specifications or as directed by the PMO/Engineer to obtain the required thickness and grades, and to minimize segregation and degradation in order to ensure a satisfactory subbase course.

(4) Compaction and finishing

The Contractor shall compact the subbase course with steel drum smooth roller, vibratory roller or by pneumatic type roller approved by the PMO/Engineer to ensure a minimum of

95% of the maximum dry density. The compaction shall be done under nearly the optimum water content.

The subbase course shall be shaped and finished to the lines, grades, and cross-sections as shown on the Drawings or as directed by the PMO/Engineer.

T5.2.3 Base course

(1) Base course material

The Contractor shall construct the base course using the crushed stone which will be produced at the quarry site and transported to the Site as directed by the PMO/Engineer.

(2) Aggregate requirements

a. Gradation

Gradation of base course aggregate shall conform to the following gradient or conform to the direction of the PMO/Engineer.

JIS sieve size (mm)	Percentage by weight passing (%)
38.1	100
19.1	60 - 90
4.76	35 - 75
2.00	20 - 50
0.42	5 - 25
0.074	1 - 7

b. Sampling and testing

The Contractor shall execute the tests for all aggregates and shall submit the test results thereof to the PMO/Engineer for his approval not less than 30 days in advance of the time when they will be required in the work.

(3) Placing

The Contractor shall make adjustments in processing and placing as specified in the Specifications or as directed by the PMO/Engineer to obtain the required thickness and

grades, and to minimize the segregation and degradation in order to ensure a satisfactory base course.

(4) Compaction and finishing

The Contractor shall compact the base course with steel drum smooth roller, vibratory roller or by pneumatic type roller approved by the PMO/Engineer to ensure a minimum of 95% of the maximum dry density. The compaction shall be done under nearly the optimum water content.

The base course shall be shaped and finished to the lines grades, and cross-sections as shown on the Drawings or as directed by the PMO/Engineer.

T5.2.4 Surface course

(1) General

The Contractor shall construct the surface course of penetration macadam, including spreading and shaping, compacting, finishing, maintenance and other incidental operations pertaining to the construction of surface course to the lines and grades as shown on the Drawings or as directed by the PMO/Engineer. Gravel metalling surfaces shall conform to the specifications in sub-clauseT2.7.5 or as directed by the PMO/Engineer.

(2) Quantities of materials for surface course

The quantities of materials and the sequence of operations shall conform to the following requirements.

Quantities of penetration macadam materials

(per 100 m^2)

Sequence of operation	Straight asphalt (litres)	Aggregate (m^3)
1st stage	110	1.0
2nd state	90	0.5

(3) Materials of surface course

a. Bituminous materials

Bituminous materials to be applied shall be a penetration of 80 - 120 in range, and conform to the requirement of JIS Designation or other approved equivalent.

Kinds of bitumen	Grades	Temperature	Standard
Straight asphalt	80 - 120	140 - 180°	JIS K 2207-80 or equivalent

Samples of the bitumen shall be submitted to the PMO/Engineer for approval not less than 45 days before it requires for use in the work. A certificated refinery analysis shall accompany each shipment of the bitumen, and shall be approved by the PMO/Engineer.

b. Aggregates

Aggregates shall consist of crushed stone, crushed gravel and sand conforming to the following gradation.

Aggregate gradation; the combined aggregates for each stages shall be as follows:

Sequence of operation	Sieve size
1st stage	20 - 5 mm
2nd stage	5 - 2.5 mm

The aggregates shall be clean, hard, durable and free from clay, mud and other foreign matter.

When requested by the PMO/Engineer, the Contractor shall conduct the material testing in accordance with the direction of the PMO/Engineer.

(4) Water limitation

Surface course shall be constructed only when the surface of the base course is clean and dry.

When it has begun to rain, paving work shall be stopped immediately and resumed at the direction by the PMO/Engineer.

(5) Equipment

All equipment, tools and machines shall be subject to the approval of the PMO/Engineer and shall be maintained in satisfactory working condition at all times.

The operation weight shall be as directed by the PMO/Engineer.

(6) Construction

Penetration macadam shall be applied using quantities and sequence of operations as described in paragraph T5.2.4 (2).

Prior to placing the first stage of surface treatment, loose dirt and other objectionable materials shall be removed from the surface of course.

Spreading and shaping of each stage of aggregate for the designations of surface treatment shall be done with the aggregate spreading equipment specified.

Each stage of aggregate shall be rolled and broom dragged thoroughly until the surface is fully compacted and bonded to full width of surface course.

T5.2.5 Measurement and payment

(1) Subbase course

Measurement for payment for subbase course will be made on the basis of actual placed quantity in cubic meter determined by designed lines shown on the Drawings or directed by the PMO/Engineer.

Payment will be made for the quantity of cubic meter measured as provided above at the representative unit price per cubic meter stated in the Bill of Quantities for subbase course which unit prices for subbase course shall constitute full compensation for the cost of all labour, tools, equipments and materials including loading, hauling, unloading, spreading, compacting, shaping and finishing the subbase course materials and other items necessary to complete the works.

(2) Base course

Measure for payment and payment for base course shall be of the same procedure as described in the above paragraph (1).

(3) Surface course

Measurement for payment for surface course will be made on the basis of placed area in square meters determined by designed lines shown on the Drawings or directed by the PMO/Engineer.

Payment will be made for the number of square meters measured as provided above at the respective unit price per square meter stated in the Bill of Quantities, which unit price for surface course shall constitute full compensation for the cost of all labour, tools, equipments and materials, except production cost of aggregates, including loading, hauling, unloading, spreading, compacting, shaping and finishing the surface course materials, prime coating and other items necessary to complete the works.

T5.2.6 Roadway accessories

(1) Scope of work

These Specifications cover furnishing, fabricating, transporting and installing of guard rails except for the spillway steel bridge, which is referred to CHAPTER T11.

The Contractor shall install the guard rails as shown on the Drawings or as directed by the PMO/Engineer.

(2) Guard rails materials and installation

a. Materials to be used for steel beam shall conform to the requirements of JIS G 3101-76, Rolled Steel for General Structure, or approved equivalent.

b. Pipes to be used for posts shall conform to the requirements of JIS G 3452-84, Carbon Steel Pipes for Ordinary Piping or JIS G 3444-82 Carbon Steel Tubes for General Structural Purpose, or approved equivalent.

c. Material for concrete, Class D, shall conform to the requirements specified in CHAPTER T4, CONCRETE WORK.

(3) Lighting pole base and concrete guard block

The Contractor shall perform concrete work and installation work to construct lighting pole base and concrete guard block on crest of dam to the lines, grades and dimensions as shown on the Drawings or as directed by the PMO/Engineer. Lighting pole base and concrete guard block will be made of reinforced concrete or non-reinforced concrete as shown on the Drawings.

T5.2.7 Measurement and payment

(1) Guard rails

Measurement for payment for guard rails will be made on the basis of installed length of guard rails in linear meters measured at the centre line between posts of guard rails as shown on the Drawings or as directed by the PMO/Engineer.

Payment will be made for the number of linear meters measured as provided above at the respective unit price per meter stated in the Bill of Quantities, which unit price for guard rails shall constitute full compensation for the cost of all labour, tools, equipments and materials including excavation and backfill for the foundation, setting posts, assembling beams, painting, production and concrete placing in foundation and other items necessary to complete the works.

(2) Lighting pole base and concrete guard block

Measurement for payment for lighting pole bases and concrete guard block will be made for the number of each base actually constructed.

Payment for lighting pole bases will be made at the unit price per each base stated in the Bill of Quantities, which unit price shall include the cost of all the work materials, and furnishing and placing lighting pole base.

Payment for concrete guard blocks will be made at the unit price per each guard blocks stated in the Bill of Quantities, which unit price shall include the cost of all the work, materials and gravel bedding.

T5.2.8 Replacement of existing channel

The Contractor shall remove the existing channel running along the haul road and newly construct drain ditch including concrete catch basins and drain pipes as shown on the Drawing or directed by the PMO/Engineer.

Payment will be made for the number of linear meters measured as provided above at the Contract unit price per linear meter stated in the Bill of Quantities, which unit price for replacement of existing channel shall constitute full compensation for the cost of all labour, tools, constructional plant and materials including excavation, compaction and backfill for the removal of existing concrete channel, furnishing and installation of concrete drain pipe, concrete works for catch basin and drain ditch and other items necessary to complete the Works.

CHAPTER T6 BUILDING WORKS

T6.1 General

T6.1.1 Scope of work

These Specifications cover supply of all labours, materials and plants and the performance of all works necessary for construction of the buildings including building service works, such as domestic water supply system, drainage system, sanitary and sewerage system, air conditioning and ventilation system and fire protection system.

T6.1.2 General

(1) Materials and works

The Contractor shall supply all materials required for completion of the works in accordance with these Specifications.

If the Drawings do not identify incidental materials and works which are obviously necessary for the proper completion of the works, all such materials and works shall be deemed to have been included in the unit price stated in the Bill of Quantities for the appropriate items of the buildings construction works.

Unless otherwise specified, all materials and equipment which will become a part of the Works shall be new and of good quality, and shall be subject to inspection, examination and/or test according to the proper industrial standards.

(2) Standards

Unless otherwise specifically provided, the quality of materials, equipment and workmanship shall comply with JIS, BS or other equivalent standards approved by the PMO/Engineer.

(3) Working drawings and samples

Working drawings, shop drawings or full size drawings shall be prepared and submitted by the Contractor to the PMO/Engineer for his approval as specified herein at no extra cost.

The Contractor shall also submit samples or catalogues of materials for approval as specified without extra cost. The PMO/Engineer will check such samples or catalogues for the assurance of compliance with the design concept and the Specifications.

(4) Scaffold and runway

The Contractor shall furnish, erect and maintain during the work as required all scaffoldings, runways, guardrails, and all other temporary constructions as may be necessary for the construction of the works.

(5) Cleaning

The Contractor shall from time to time remove all dirt and rubbish caused by the work from the construction site. At completion of the work, the Contractor shall thoroughly clean the interior and exterior of the buildings.

T6.2 Earthwork

T6.2.1 General

Unless otherwise provided herein or directed by the PMO/Engineer, the works under this Clause shall be performed in accordance with the provisions of CHAPTER T2 EARTHWORK hereinbefore.

T6.3 Concrete and Formwork

T6.3.1 General

Unless otherwise provided herein or directed by the PMO/Engineer, the works under this Clause shall be performed in accordance with the provisions of CHAPTER T4 CONCRETE WORKS hereinbefore.

The type of concrete to be used for the building works shall be of Class A for structures, and Class F for leveling concrete.

The class of concrete formwork to be used shall be of type F1, type F2 and type F3, use of which for various places shall be as directed by the PMO/Engineer.

T6.4 Masonry Works

T6.4.1 Concrete block masonry

(1) Materials

Concrete blocks to be used shall be hollow blocks of approved design having exterior dimensions of 390 x 190 x 100 mm and 390 x 190 x 190 mm. The concrete blocks shall have

a compressive strength of not less than 40 kg/cm^2 and an apparent specific gravity, air dried of not less than 1.7.

(2) Concrete block laying

The concrete block shall be laid in straight and struck joints of about 1 cm thick with 1:3 cement mortar.

The concrete block walls shall be reinforced with 9 mm steel bars in 80 cm interval in horizontal and vertical directions. Anchor steel bars shall be preinstalled to the surrounding floor, columns, walls and ceiling at intervals and locations to enable connection to the reinforcement bars. All splices shall be taken 30 times the bar diameter.

The hollows through which the reinforcement bars run shall be thoroughly filled with 1:3 cement mortar.

The wall shall, when large in height and width, be divided into sections with reinforced concrete frames in compliance with the applicable standard or as directed by the PMO/Engineer. This reinforcement work shall be paid separately under pertinent pay items.

Where required to install doors, windows and any other opening in the concrete block wall, reinforced concrete lintels shall be provided. The Contractor shall design the lintel and shall obtain the approval of the PMO/Engineer.

Laying of the concrete blocks shall not exceed 1.2 meters in height per day.

T6.4.2 Measurement and payment

Measurement for payment for concrete block wall will be made on the basis of the areas in square meters of block walls constructed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price for concrete block masonry works shall include supplying and placing concrete blocks plus bonding and filling cement mortar, reinforced concrete lintels and any other relevant works required. Reinforcement bars shall be paid for under a separate item.

T6.5 Bituminous Waterproof Roofing

T6.5.1 Built-up roofing

The bituminous waterproof roofing shall be of 3-Ply built-up roofing and 2-Ply built-up roofing for roof and the interior floor respectively applied with the following layers.

3-Ply built-up roofing

- Asphalt primer
- Asphalt compound
- Asphalt felt (1st layer)
- Asphalt compound
- Special asphalt felt (2nd layer)
- Asphalt compound
- Asphalt felt (3rd layer) with slag surfacing

2-Ply built-up roofing

- Asphalt primer
- Asphalt compound
- Asphalt felt
- Asphalt compound
- Asphalt felt
- Asphalt compound

T6.5.2 Materials

Asphalt primer shall be factory mixed primer composed of blown asphalt, solvent naphtha and bezine in an approximate weight ratio of 4.5:3.0:2.5.

Asphalt compound shall be of blown asphalt having the following characteristics :

Penetration index	:	15 - 25
Melting point	:	100°C or over
Malleability (Daw Smith 25°C)	:	2 or over

Asphalt felt shall be a bituminous sheeting with a coating of high penetration index asphalt with fabric reinforcement.

The Contractor shall submit specifications sheets and sample of the roofing materials to the PMO/Engineer for approval.

T6.5.3 Application

Substrate for the roofing shall be made by applying cement mortar plastering on concrete surface. All external and internal angles shall be made round in a radius of not less than 50 mm.

Asphalt primer shall be applied only on the base cement mortar completely dried at not less than 0.3 l/m^2. Then the first layer of asphalt felt shall be fixed using asphalt compound applied hot at not less than 1.0 kg/m^2. The second and third layers shall be fixed following the first layer with asphalt compound at not less than 1.0 kg/m^2. Top asphalt coat shall be applied not less than 2.0 kg/m^2 over the entire face of roofing.

All laps shall run parallel to the slope of the roof and joints staggered with 50 mm side laps and 75 mm end laps. Care shall be exercised not to leave air bubble inside the layers of roofing.

Roofing work shall be performed by skilled workmen in this trade. The work shall not be performed on a dump or rainy day or in the time considered unsuitable by the PMO/Engineer.

T6.5.4 Alternative system

The Contractor may propose an alternative waterproofing system upon approval of the PMO/Engineer. The alternative shall in no way be inferior to the one specified above and shall not entail extra cost to the Employer.

T6.5.5 Measurement and payment

Measurement for payment for the bituminous waterproofing works will be made on the basis of area in square meters of waterproofing performed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer. The overlap joints shall not be considered in the measurement of the area.

The unit price shall include supplying and applying the built-up roofing including caulking with approved caulking materials and any other relevant works required. The substrate cement mortar and water-proof cement mortar plastering shall be paid for under separate items.

T6.6 Terrazzo Works

T6.6.1 Materials

The marble chips to be used for terrazzo works shall be of hard and durable marble and of colours approved by the PMO/Engineer. The grading of the chips shall be as follows:

Percentage (by weight) passing through 12 mm mesh screen 100%

Percentage (by weight) passing through 2.5 mm mesh screen..... 0%

Colour pigments shall be added to produce the required colour pattern. Samples of terrazzo shall be submitted for approval of the PMO/Engineer.

T6.6.2 Application

(1) Terrazzo in-situ

In case the Contractor uses cast-in-situ terrazzo finish instead of the terrazzo tile, the Specifications of work shall be as follows:

The marble chips shall be mixed with white cement paste to a ratio of 1:2.5 in volume. The total thickness of terrazzo in-situ including base mortar shall be 50 mm thick.

The base for the terrazzo finish shall be of cement mortar rendering 18 mm thick performed as specified in plastering works hereinafter.

After sufficient hardening of the finish coat, the surface shall be ground with emery powder ranging from coarse to fine and polished with wax to a luminous and satisfactory finish using appropriate grinding machine or hand tools.

Brass dividing strips, 5 x 16 mm in size shall be installed prior to the application of the base mortar, anchored and set in place to the dimensions and alignment as shown on the Drawings.

(2) Terrazzo tile

Terrazzo tiles and blocks shall be precast to the dimensions as selected by the PMO/Engineer. The method of precasting terrazzo tiles shall be the same as for the terrazzo in-situ described above.

The precast terrazzo tiles shall be laid over a base cement mortar and laid level and plumb as the case may be with butt joints.

After sufficient lapse of time for cement mortar and paste to harden, the terrazzo shall be ground smooth by mechanical means, washed down with water and polished with wax.

T6.6.3 Measurement and payment

Measurement for payment for terrazzo floor, skirting and ledge will be made on the basis of the area in square meters of floor and the length in linear meters of terrazzo skirting, and terrazzo ledge supplied and laid respectively in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price shall include the base mortar, dividing brass strips and anchors and any other relevant works required.

T6.7 Tile Works

T6.7.1 Material

Only first-class quality tiles shall be used in the works. The Contractor shall submit to the PMO/Engineer samples of the tiles for approval.

(1) Ceramic tiles for interior walls

Ceramic tile for interior use shall be 100 x 100 x 6 mm approximately in size. The ceramic tiles shall have glazed surface and round arris. Colours shall be selected by the PMO/Engineer. Different type of ceramic tile may be proposed by the Contractor for approval, but without extra cost.

(2) Porcelain floor tile

Porcelain floor tile shall be 100 x 100 x 10 mm approximately in size and shall have unglazed surfaces. Colours shall be selected by the PMO/Engineer. Different type of floor tile may be proposed by the Contractor for approval but without extra cost.

(3) Porcelain wall tile

Porcelain wall tile shall be 200 x 100 x 12 mm approximately in size and shall have glazed surface. Colores shall be selected by the PMO/Engineer. Different type of wall tile may be proposed by the Contractor for approval, but without extra cost.

T6.7.2 Ceramic tile, and porcelain tile

Concrete and/or concrete hallow block surfaces to receive the tiles shall be cleaned free from dirt, oil, grease and other deleterious substances and soaked with clean water prior to application of the rendering cement mortar base.

The rendering cement mortar base for the tile works shall be prepared as specified in plastering works hereinafter.

Porcelain tile for the floors shall be set with 1:3 cement mortar to the level and slope specified. Ceramic tile and porcelain tile for the walls shall be set with 1:3 cement mortar.

Joints for ceramic tile for interior shall be 2 mm wide, uniform and true to line and flushed with white cement paste. Joints for porcelain floor and wall tiles shall be 10 mm wide and grouted with cement paste.

After completion of setting, the tile surfaces shall be washed down until clean with plain water or muriatic acid according to the manufacturer's instructions.

Plumbing fixtures and any others to be built in the tile surface shall be installed as tiling work progress.

T6.7.3 Measurement and payment

Measurement for payment for tile works will be made on the basis of the actual surface areas in square meters covered with each type of tiles supplied and laid in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer

The unit price shall include all special moldings, bedding cement mortar, joint filling cement paste, bonding adhesives and any other relevant works required.

T6.8 Plastering Works

T6.8.1 Cement screed and plaster

The sand to be used in the cement mortar shall be clean, hard, solid and durable and shall not contain harmful amounts of dust, mud, organic materials or other objectionable matter. The grading of the sand shall be within the following limits.

Classification	Sieve designation	Percentage by weight passing screen
Scratch coat	5 mm 0.15 mm	100% 10% or under
Finishing coat	2.5 mm 0.15 mm	100% 10% or under

The mix proportions of the cement mortar shall be as follows:

Substratum	Place of application	Scratch coat cement : sand	Finish coat cement : sand or cement: sand : lime
Concrete	Floor	-	1 : 2
	Interior wall	1 : 2	1 : 3 : 0.3
	Ceiling	1 : 2	1 : 3 : 0.3
	Exterior wall	1 : 2	1 : 3
	Interior wall	1 : 3	1 : 3 : 0.3
Concrete block	Interior wall	1 : 3	1 : 3 : 0.3
	Exterior wall	1 : 3	1 : 3

T6.8.2 Waterproof cement mortar

Waterproof cement mortar shall be applied to canopy, balcony, parapet, eaves and other places as shown on the Drawing or as directed by the PMO/Engineer.

Cement mortar shall conform to the specifications as provided for in this Clause. Waterproof admixture shall be used in the cement mortar in accordance with the manufacturer's recommendations to effect waterproofing. Catalogues of waterproofing admixture shall be submitted to the PMO/Engineer for his approval.

T6.8.3 Expanding grout

An expanding grout shall be used around any pipe passing through a concrete or masonry wall where water may stand on one or both sides of the wall and where the pipe is not embedded in the initially constructed structure. Such grout shall expand upon setting to effect bonding to the concrete and the pipe. An approved expanding agent shall be used and the grout composition shall conform to the manufacturer's instructions

T6.8.4 Application

The surfaces which are to receive a scratch coat shall be roughened, brushed or washed clean, free from all laitance, scum, loose carbonate scale, loose aggregate, dirt and other foreign matter. In case of concrete block or brick surfaces, they shall be sufficiently and uniformly dampened immediately before the application of mortar.

Concrete surface shall be kept thoroughly wet for 24 hours prior to application of mortar.

Cement mortar shall be used within 30 minutes from the time of mixing. Retempering will not be permitted.

The rendering for tile work shall be made 18 mm thick and its surface shall be cross scratched. In case of cement mortar finish, the total thickness of scratch and finishing coat shall be 30 mm for the floors, and 20 mm for walls and other places. When the finishing coat is applied, the entire bay of wall or ceiling shall be finished in one operation in order to minimize joint marks. Where expansion and control joints exist in the base structure, provision shall be made to prevent cracking of the cement mortar by inserting galvanized steel expansion beads within the coating thickness in a manner approved by the PMO/Engineer. The finished surface shall be perfectly plumb, level or sloped as the case may be without any bulging, runs, bruises or stains.

After application of the finishing coat, the surfaces shall be kept continuously damp for not less than 48 hours and then allowed to become thoroughly dry. Moistening shall be started as soon as the surface has hardened sufficiently to prevent displacement or damage.

T6.8.5 Measurement and payment

Measurement for payment for cement mortar plaster, waterproofing cement mortar plaster will be made on the basis of actual areas in square meters plastered and troweled and for stair curbs on the basis of length in linear meters plastered in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price shall include all necessary materials including admixtures, and any other relevant works required.

T6.9 Painting Works

T6.9.1 Materials

Paints shall be of the best quality of its kind. The Contractor shall submit catalogues and specifications of all paints to be used to the PMO/Engineer for his approval.

T6.9.2 Application

(1) General

All metal components other than galvanized steel shall be prepared and primed in the shop and finish painted after erection. Metal cabinets and machinery shall be prepared, primed and given two coats of paint in the shop and all damaged places shall be cleaned and touched-up after installation is completed.

Metal surfaces shall be cleaned with metal scrapers and wire brush to remove all mill scale, weld spatter, rust and any other deleterious materials. Oil and grease shall be removed by an approved solvent. The surfaces shall be wiped clean of any dust prior to priming. Priming shall be done immediately after cleaning to prevent new rust. Any primed surfaces that show rusting, flaking, powdering or peeling shall be recleaned and repainted.

All wood surface to receive paint shall be cleaned of all dirt, grease, dust or any other deleterious matters. All surfaces shall be thoroughly sanded and all nail holes, cracks and any other defects shall be puttied, re-sanded to a smooth and flush finish. The painted surface shall

show a smooth, level and uniform finish, free from any stains and shall be uniform in colour and shade.

Spray painting equipment shall be adequate for the work to be performed and shall have suitable air pressure and paint flow controls. Air lines shall be equipped with moisture and dirt traps. The paint shall be continuously stirred during the painting process. The paint shall be mixed and applied in accordance with the manufacturer's recommendations. The equipment and painting process shall be subject to the approval of the PMO/Engineer.

All painting work shall conform to the manufacturer's specifications and instructions.

Painting shall not be done in rain, fog or mist, or at any other time considered unsuitable by the PMO/Engineer.

All the surrounding works shall be protected in a suitable manner from paint drops and overspray. All smeared and damaged surfaces shall be cleaned or repaired to the PMO/Engineer's satisfactions.

Colour shall be later designated by the PMO/Engineer.

(2) Oil paint to metal surfaces

Steel doors, steel louvers and all other miscellaneous steel surfaces shall be painted with one coat of anti-corrosive paint and 2 coats of oil paint. Sufficient time shall be allowed for drying between each new coat.

Galvanized metalwork to be painted shall be first etched with 5% acetic acid and washed clean before priming.

(3) Oil paint to wooden surfaces

Paints shall be applied in 3 coats including one coat of primer paint. Sufficient time shall be allowed for drying between each new coat.

(4) Vinyl emulsion paint to cement mortar and asbestos cement sheet

The cement mortar shall be left to dry for a minimum period of 3 weeks after application. The vinyl emulsion paint shall be applied in 3 coats including a primer coat. Minimum 12 hours shall be allowed before application of each successive coat.

(5) Acidresistant painting

Acidresistant painting shall be one of the emulsion type synthetic resin paints which has a proven quality of acidresistance.

T6.9.3 Measurement and payment

Measurement for payment for painting work will be made on the basis of the actual area in square meters of painted surface supplied and applied in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer. The unit price shall include all surface preparation and making good painting after damage by other trades and any other relevant works required.

T6.10 Carpentry and Joinery Works

T6.10.1 Materials and workmanship

The Contractor shall submit shop drawings of respective work items in this Clause to the PMO/Engineer for his approval.

Timber shall be of suitable kinds for the purposes and the best grade of each kind. Selection of timber shall be subject to the approval of the PMO/Engineer.

All timber shall be well-seasoned and shall be free from large knots, flaws, shakes or blemishes of any kind. Timber with loose, rotten or dead knots will not be accepted. Sawn timber shall have the shape and size shown on the Drawings and twisted or warped materials shall not be used.

All wooden members shall be brought and fixed exactly as shown on the Drawings and planed wherever exposed to view. Wood members not to be painted and having direct contact with concrete shall receive a coat of creosote prior to fixing, while those to be painted or exposed shall be painted with an approved clear type preservative.

(1) Curtain boxes

Curtain boxes shall be fabricated and installed using 25 mm thick wood board with adequate ribs. They shall be carefully fixed to the walls above windows and ceiling joists. The surfaces of the blind boxes shall be coated with oil paint.

(2) Wooden door frames

All wooden door frames shall be made of hard wood and mortise jointed. The door frames shall be moulded as shown on the Drawings or as directed by the PMO/Engineer, and sanded and putty applied to a smooth surface to receive oil paint.

T6.10.2 Measurement and payment

Measurement for payment for curtain boxes will be made on the basis of the nominal lengths in linear meters of curtain box installed in accordance with the Drawings and the Specifications and as directed

by the PMO/Engineer. No payment shall be made for the wooden door frames; the cost for these shall be included in door leaves.

The unit price for curtain boxes shall include supplying and fixing of curtain box including fixing device and any other relevant works required.

Painting finish to the wooden surfaces shall be paid for under separate items.

T6.11 Interior Finishing Works

T6.11.1 Materials

All materials shall be of the best quality and shall comply with the applicable standards. The Contractor shall submit samples and/or catalogues of the finishing materials to the PMO/Engineer for his approval.

(1) Rockwool acoustic tile

Rockwool acoustic tiles shall be of a product of plaster and rockwool having a fissued surface simulating travertine stone with a white finish, and shall be approximately 300 mm x 600 mm x 12 mm in size.

(2) Asbestos cement sheet

Asbestos cement sheets shall be of hard asbestos flat sheet, 6 mm thick.

(3) Vinyl floor tile

Vinyl floor tiles shall be of 300 mm x 300 mm x 2 mm thick.

(4) Vinyl strip base

Vinyl strip base to skirting shall be of 100 mm high.

T6.11.2 Installation

(1) Rockwool acoustic tile

Ceiling suspension system shall be constructed of wood, steel or aluminium complete with anchors, hangers, clips, main runners furring strips, and such other accessories as ceiling moulding.

Main runner shall be provided at intervals of approximately 90 cm, installed with allowance for adequate camber. They shall be designed for ceiling loads of 70 kg/m^2.

Furring strips shall be provided at intervals of 30 cm or according to the ceiling material. Adequate reinforcing and metal training shall be provided for mounting the lighting fixtures and ceiling access holes.

Ceiling tiles shall be securely fixed to the furring strips with galvanized screws true to level and line. Ceiling trims shall be of plastic moulding and fixed to the wall before cement plastering is carried out. The entire suspended ceiling shall be to the level shown on the Drawings with adequate camber and shall not have a deviation in levels and lines of more than 3 mm in 4 m bay.

The ceiling tile shall be so arranged that the fractional tile cut to fit the room is minimum. Ceiling access hole shall be provided in the rooms as directed by the PMO/Engineer. The access hole covers shall match the surrounding ceiling and continuity of the ceiling pattern shall be maintained as much as possible.

(2) Asbestos cement sheet

Asbestos cement sheet shall be of hard asbestos flat sheets, 6 mm thick and shall conform to JIS A5403 or approved equivalent. The asbestos cement sheet ceiling shall include the complete suspending ceiling system same as specified for the rockwool acoustic tile in this Clause. The sheets shall be fixed securely to the ceiling joist with stainless flat head screws. Joints shall be of open joints 5 mm wide, straight and uniform. Ceiling access holes shall be provided in the same manner as specified for the rockwool acoustic tile. Surface of the sheet shall be finished with vinyl emulsion paint as shown on the Drawings.

(3) Vinyl floor tile

Floor surfaces upon which tiles are to be placed shall be covered with cement plaster bed 30 mm thick bonded to the structural concrete as specified in Plastering Works hereinbefore. The plastered surfaces shall be clean and free from dust, oil and moisture. The back surfaces of the tiles shall be clean.

Vinyl floor tile shall be applied with adhesives upon the primed surface in such a manner that adjacent tiles are butted tightly together to form straight continuous joints and uniform regular patterns as shown on the Drawings or as prescribed by the PMO/Engineer. The colour and pattern of tile shall be selected by the PMO/Engineer.

Adhesive for applying tiles shall be furnished in sealed containers bearing the manufacturer's label and instructions for application.

(4) Vinyl strip for base

Vinyl strip shall be applied on a smooth surface, dry and clean. Adhesive shall be applied and vinyl strip firmly placed with its toe in contact with the finished floor. The base shall then be rolled with a roller. External and internal corners shall be installed with preformed pieces.

T6.11.3 Measurement and payment

Measurement for payment for rockwool acoustic tile, and asbestos cement sheet ceilings will be made on the basis of the actual areas in square meters of ceiling installed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer. Holes made for lighting fixtures, air diffusers and the like shall not be deducted from the area measurement.

The unit price shall include supplying and installing the ceiling materials plus complete suspending system, the provision of access holes and covers and any other relevant works required. Painting finish for the asbestos cement sheet shall be paid for under a separate item.

Measurement for payment for vinyl floor tile and vinyl strip to skirting will be made on the basis of the actual areas in square meters of vinyl floor tile and the length in linear meters of vinyl strip applied respectively in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price shall include supplying and applying the vinyl floor tile or vinyl strip plus adhesive and other relevant works required.

T6.12 Wooden Doors

T6.12.1 General

Before manufacturing wooden doors, the Contractor shall submit shop drawing showing details of the doors to the PMO/Engineer for his approval.

All wood surfaces shall be sanded and putty applied to smooth surfaces to receive oil painting or varnish.

T6.12.2 Wooden door leaves

All wooden door leaves shall be flush type, 40 mm thick, with panes or louvers as shown on the Drawings and shall be faced with 6 mm thick first-grade waterproof plywood.

The plywood shall be covered with lauan lamina, putty polished and oil painted or varnished. Panes or louvers, if provided, shall be fixed with adequate beads.

T6.12.3 Hardware

The Contractor shall supply and install the hardware for the wooden doors as listed in the Drawings.

The Contractor shall submit catalogues or samples of the hardware to the PMO/Engineer for his approval.

The hardware shall comply with the following requirements:

Hinges	Bronze or stainless steel, 13 cm in approximate size, 3 hinges for each door leaf
Knobs or lever handle	Stainless steel or bronzed aluminium
Lock sets	Bronze, cylindrical lock, 3 sets of key to be furnished
Door closers	Cast aluminium body, oil and spring activated rack and pinion with 90 degree stop device
Push and pull	For toilets door, plastic made 15 cm x 25 cm in approximate handle size

The Contractor shall supply master key set as directed by the PMO/Engineer.

T6.12.4 Measurement and payment

Measurement for payment for wooden doors will be made on the basis of the actual total area in square meters of door leaves supplied, fabricated and fixed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price shall include supplying and installing wooden door leaves plus door frames, hardware and any other relevant works required.

Painting finish and glazing shall be paid for under separate items.

T6.13 Steel Doors and Frames, and Rolling Shutter

T6.13.1 General

All steel doors, frames and hardware shall be of first-class quality.

The Contractor shall submit shop drawings showing details of various parts, method of anchoring and any other pertinent details to the PMO/Engineer for his approval.

Before placing orders, the Contractor shall submit catalogues or samples of hardware to the PMO/Engineer for his approval.

All exposed surfaces to view shall be oil paint finished.

T6.13.2 Hollow steel door leaves

Hollow steel door leaves shall be fabricated of cold rolled steel sheet. The sheet thicknesses shall be as follows:

Panel	1.6 mm
Stiffener plate and anchor plates	2.3 mm

The door leaves shall be full flushed seamless panel type, 40 mm in thick unless otherwise specified. All four edges shall be sealed and ground smooth.

Door leaves shall be adequately reinforced for rigidness and for fixing hardware.

Where shown on the Drawings, panes and louvers shall be provided with metal beads.

T6.13.3 Steel door frames

Door frames shall be formed of cold rolled steel sheet. The sheet thickness shall be as follows unless otherwise specified.

Frame	1.6 mm
Architrave	1.2 mm
Threshold	2.3 mm

Door frames shall be profiled accurately to details and dimensions shown on the shop drawings approved by the PMO/Engineer. Door frames shall be reinforced, drilled and tapped to receive hardware and shall be provided with rubber bumpers.

Door frames shall be fixed to the wall by means of welding to the pre-embedded anchors. Perimeters of door frames facing outdoor shall be securely caulked with approved caulking material.

T6.13.4 Hardware

Hardware for the steel door shall comply with the requirements specified on the Drawings. The Contractor shall submit catalogues or samples to the PMO/Engineer for his approval.

Each door shall be provided with the following hardware:

Floor hinge	Cast iron body with stainless steel cover, oil and spring activated rack and pinion with 90 degree stop device
Hinge	Pivot hinge, 2 pieces for each door leaf
Knob or lever handle	Stainless steel
Lock sets	Bronze, cylindrical lock, 3 sets of key to be furnished
Door bolt	Bronze, surface or flush type
Door closer	Cast aluminium body, oil and spring activated rack and pinion, with 90 degree stop device.

The Contractor shall supply master key set as directed by the PMO/Engineer.

T6.13.5 Measurement and payment

Measurement for payment for steel doors will be made on the basis of the total area in square meters of door leaves fabricated and fixed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit prices for steel doors shall include supplying and installing each item plus frames, louvers, hardware, caulking materials and any other relevant works. Painting finish and glazing will be paid for under separate items.

T6.14 Aluminium Door, Windows and Louvers and Frames

T6.14.1 General

All aluminium doors, windows, louvers and frames shall be of first-class quality.

The Contractor shall submit shop drawings showing details of various parts, method of anchoring and any other pertinent details for approval of the PMO/Engineer. Before placing orders, the Contractor shall submit catalogues of hardware to the PMO/Engineer for his approval.

T6.14.2 Materials and workmanship

All aluminium members shall be of extruded aluminium and fabricated pieces before delivery shall be protected with strippable plastic. The plastic shall be removed after the major construction work has been completed.

Doors, windows, and louvers shall be furnished with frames, fixing lugs and glazing beads.

Prior to installation of doors, windows and louvers, the Contractor shall ensure that the surface of the concrete or steel to receive the frames are free from all loose and foreign material. The frames shall be set true to the planes without warping and shall be fixed in place through the fixing lugs by means of welding to the pre-embedded anchors. Spaces between the frames and wall shall be grouted with cement mortar and outdoor perimeters sealed with approved caulking materials.

Insect screen shall be fabricated of aluminium wires secured in frames to the inner side of windows and louvers by means of spline. Screen unit shall be removable and rewirable.

The hardware shall comply with the following requirement:

Floor hinge	Cast iron body with stainless steel cover, oil and spring activated rack and pinion with 90 degree stop device.
Push and pull handle	For entrance door, stainless steel, 20 cm x 20 cm approximate in size.
Hinge	Bronze or stainless steel, 13 cm in approximate size, 3 hinges to each door leaf (less than 2.1 meters high)
Knob or lever handle	Stainless steel or bronzed aluminium
Lock set	Bronze, cylindrical lock, 3 sets of key to be furnished
Door closer	Die-cast aluminium body, oil and spring activated rack and pinion with 90 degree stop device
Door bolt	Bronze, surface or flush type
Sash fastener and handle	Cast aluminium

The Contractor shall supply master key set as directed by the PMO/Engineer.

T6.14.3 Measurement and payment

Measurement for payment for the aluminium doors, windows, and louvers will be made on the basis of the areas in square meters of interior opening of the frames supplied, fabricated and installed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price shall include insect screen, hardware, caulking materials and any other relevant work required.

T6.15 Glazing Works

T6.15.1 Glass

Door and window panes shall consist of the following types of glass:

a.	Plate glass	- 5 mm thick
b.	Plate glass	- 3 mm thick
c.	Figured glass	- 4 mm thick
d.	Wired glass	- 6.8 mm thick

The brand and quality of glass shall be subject to the PMO/Engineer's approval.

T6.15.2 Glazing

All glasses shall be accurately cut to fit in the frames with 3 mm clearance all around. Glasses in metal windows and door leaves shall be set in glazing mastic applied on all four sides for the full length using spacer shims or with vinyl splined glazing bead as recommended by the manufacturer. Panes for wooden frames shall be fixed with wood stops.

All door and window panes shall be cleaned and polished when the building work is completed.

T6.15.3 Measurement and payment

Measurement for payment for glazing will be made on the basis of the actual areas in square meters of openings glazed under each category in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price shall include supplying and installing each type of glasses plus glazing mastic, beads, shims and any other relevant works required.

T6.16 Miscellaneous Metal Works

T6.16.1 Materials

All materials to be incorporated in the works shall be of the best of its kind.

Catalogues or samples of stair nosing, roof drains and floor drains shall be submitted to the PMO/Engineer for approval. The Contractor shall prepare and submit shop drawings showing details of parts, assemblies, components, supports and connections to the PMO/Engineer for his approval. The work shall be shop fitted or shop assembled where possible.

Wherever necessary, metals shall be insulated to prevent electrolysis due to contact with dissimilar metals. Insulation shall be made by means of bituminous paint or other approved means.

T6.16.2 Materials and installation

(1) Roof and floor drains

Roof and floor drains shall be of cast iron body, heat coated with asphalt. Care shall be exercised in accommodating the surrounding waterproofing works to prevent any damage to the water proofing membrane. Caulking shall be applied as required.

Floor drains shall be fitted with flat removable chronium plated brass grate. Roof drain grates shall be convex in profile at least as high as the pipe diameter and the total area of the openings of the grate shall be not smaller than 1.5 times the cross-section area of the drain pipe. Grates shall be fixed with noncorrosive screws.

Roof drains shall have two flanges. The bottom flange shall be integral with the drain body and shall be set to coincide with the waterproof membrane or with top surface of the surrounding concrete. The top flange shall be screwed to the bottom flange and shall be set lower than the surrounding roof finish. The two flanges shall be used to clamp the waterproof membrane.

(2) Stair nosings

Stair nosings shall be of stainless steel with serrated surface or embedded with plastic tire for non-slip. The stair nosing shall be approximately 40 mm wide and installed on the full width of each stair tread. Anchorage shall be provided to the under side of the nosing.

(3) Steel handrails

Steel handrails shall be provided for the stairs and other places as shown on the Drawings. Steel handrails shall be fabricated of mild steel structural pipes. Embedded part of blusters shall

be welded to the reinforcement bars in the structure. Oil paint finish shall be applied to all exposed steel surfaces.

(4) Steel ladders and steel caged ladders

Steel ladders shall be fabricated and installed to concrete structure as shown on the Drawings. Anchor plates shall be embedded in concrete at the proper locations while the concrete is placed, or recesses shall be left in the concrete for anchoring which shall be grouted with cement mortar after anchoring. Oil paint finish shall be applied to all exposed steel surfaces.

(5) Coping metal

Coping metal on roof shall be of factory-made aluminium, accompanied with purpose-made backing and fixing metal. The Contractor may propose alternative coping metal upon approval of the PMO/Engineer.

(6) Cable trench covers

Cable trench covers for floor cable duct shall be of checkered steel plate 4.5 mm thick unless otherwise specified. Bearings shall be fabricated of steel angles with floor trimmings and anchorages. The checkered steel plates shall be properly reinforced with steel angles depending on the sized of the floor duct, provided with lifting devices and set flush with the floor finish. Concealed surfaces shall be anti-corrosive painted and exposed surfaces to view oil paint finished.

(7) Steel grating hatch cover

Steel grating hatch covers shall be provided where shown on the Drawings or directed by the PMO/Engineer. The grating shall be galvanized and withstand a static uniform load of 300 kg/m^2. The grating, support beams, floor bearings shall all be hot-dip galvanized.

T6.16.3 Measurement and payment

Measurement for payment for roof and floor drains will be made on the basis of number of the item in pieces installed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

Measurement for payment for stair nosing, steel handrails, steel ladders, and aluminium copings will be made on the basis of nominal lengths in linear meters of each item installed under each category in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer. Balusters and intermediate rails shall not be counted in the measurement of steel handrails.

Measurement for payment for cable trench covers and steel grating hatch covers will be made on the basis of the area in square meters of checkered steel plates and steel gratings respectively installed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price for each item shall include supplying and installing each item plus any other relevant works required. Paint finish will be paid for under a separate item.

Payment for items not mentioned here shall be made at the unit prices stated in the Bill of Quantities and by the same manner as described above.

T6.17 Miscellaneous Works

T6.17.1 Materials

Each item shall be of the best of its kind in design, quality and appearance and free from any defect that would impair strength, durability or appearance. Catalogues and/or shop drawings shall be submitted to the PMO/Engineer for his approval.

T6.17.2 Materials and installation

The work shall be fitted and assembled in the shop as much as possible. The work shall be erected true and straight, accurately fitted with tight joints and intersections. All works shall be reinforced where required. The rims shall be neatly and accurately mitred. Where screws are used, the heads shall be concealed.

(1) Kitchen units

Kitchen sink units shall consist of a sink unit, a range table unit and a suspended cupboard unit having dimensions as shown on the Drawings. The counter tops of the unit shall be made of stainless steel not less than 0.6 mm thick. The remaining parts shall be of wooden fabrication finished with melamine or polyester resin. Metal flashing shall be provided along the backsprash. The metal flashing shall be of stainless steel sheet 0.6 mm thick and securely fixed to the wall.

(2) Downspouts

Downspouts shall be of polyvinyl chloride or steel pipe. The downspouts shall be securely fixed to the walls with steel ring supports at 150 cm intervals.

T6.17.3 Measurement and payment

Measurement for payment for the kitchen sink unit will be made on the basis of the number of the unit installed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

Measurement for payment for the downspouts will be made on the basis of the nominal lengths of downspout in linear meters installed in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

The unit price shall include supplying and installing each item plus all necessary fixing devices, chalking where required and any other relevant works required.

Payment for items not mentioned here shall be made at the unit prices stated in the Bill of Quantities and by the same procedure as described above.

T6.18 Plumbing Works

T6.18.1 General

The works under this Clause shall comprise water supply, waste water and sewage drainage works for the buildings.

Because of the small scale of the Drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the structural and finish conditions affecting all his work and shall arrange such work accordingly, at no additional cost to the Employer.

The general arrangement of the plumbing shall be as indicated on the Drawings. Detailed drawings of proposed departures due to actual field conditions or other causes shall be submitted for approval. Materials and equipment installed in the plumbing system shall be suitable for the pressures and temperatures encountered. Installation shall be as required by applicable national plumbing code of the country and local regulations around the site and as specified herein.

Installation shall be accomplished by workmen skilled in this type of work.

(1) Shop drawings and working drawings

At least 60 days prior to starting installation of any materials or equipment, the Contractor shall submit to the PMO/Engineer for his approval the following shop or working drawings:

- Layout drawings of equipment including list of equipment and materials to be incorporated,

- Details of piping and valving,
- Details of sleeves for piping,
- Details of supports, hangers, attachments and anchoring,
- Details of foundation for equipment,
- Detailed layout of electric wiring and conduiting,
- Complete electrical connection diagrams, and
- Other drawings as required by the PMO/Engineer.

(2) Data and samples

The Contractor shall submit for approval of the PMO/Engineer a complete list of materials and equipment to be incorporated in the works under this Clause including sufficient descriptive materials such as catalogues, diagrams, performance curves, charts, layout drawings and other data published by the manufacturer to demonstrate the conformance to the Specifications and the Drawings.

(3) Operation and maintenance manuals

Six complete sets of operation and maintenance manuals for the plumbing system shall be furnished as specified hereafter. The manuals shall be furnished at the time of performance tests of the system. The manuals shall include but not limited to the following:

(a) Explanation of system

- General description of system including function, design conditions, system design and equipment incorporated,
- Schematic diagrams of piping including equipment, valves and controls,
- Schematic diagram of electric power supply and controls, and
- Layout plan of equipment.

(b) Operation and maintenance instructions

- Method of operation including procedures for safe starting and stopping of equipment, preventive procedures, and checking methods,
- Manufacturer's instructions on each piece of equipment including lubrication instructions,
- Daily, weekly, monthly and yearly inspection items on each piece of equipment and systems, and
- Method of finding causes of breakdown of each piece of equipment and systems and countermeasures to be taken.

(c) Manufacturer's bulletins

- Manufacturer's specifications, shop drawings and catalogues of each piece of equipment.
- Manufacturer's certifications
- Any guarantee, test data and engineering data furnished by the manufacturers.

(d) Spare parts list

- List of spare parts and consumables furnished with the equipment as standard appurtenances as required by the Specifications

(e) Service and maintenance organizations

- Name and address of nearest recommended service and maintenance agent who can practically be addressed by the Employer at the time of breakdown of an equipment.

(4) Attachments and spare parts

The Contractor shall furnish with each piece of equipment standard attachments and spare parts which the manufacturer supplies under normal commercial transactions. In addition to these the Contractor shall furnish spare parts, consumables or stand-by equipment as specified hereinafter. The Contractor shall also furnish a complete list of spare parts as recommended for operation of each piece of equipment for a period of one year with current prices and source of supply.

(5) Tools

The Contractor shall provide sufficient special tools as recommended by manufacturers for field maintenance of the system. One complete set shall be provided at no extra cost to the Employer.

(6) Field instructions

Upon completion of the work, the services of one or more instructors shall be provided by the Contractor for a total period of not less than 2 days to instruct the representative of the Employer in operation and maintenance of the equipment and the systems. These field instructions shall cover all the items contained in the bound instructions as specified for operation and maintenance manuals, and all costs for the services shall be borne by the Contractor.

(7) Tests

The Contractor shall submit his proposed testing programs and procedures at least 2 weeks prior to the scheduled tests and obtain the PMO/Engineer's approval. All tests shall be conducted in the presence of the PMO/Engineer. Any materials, equipment, instruments,

personnel, water and electricity required for the tests shall be provided and all expenses thereof shall be borne by the Contractor.

Accurate data of each test shall be recorded and reports of test data shall be submitted.

(8) Floor, wall and ceiling escutcheons

Escutcheons shall where directed by the PMO/Engineer be provided at finished surfaces where exposed piping, bare or insulated, passes through floor, walls or ceilings. Escutcheons shall be fastened securely to pipe or pipe covering and shall be of chromium plated iron or chromium plated brass, either one piece or split pattern, held in place by internal spring tension or setscrew.

(9) Foundation for equipment

All foundations for equipment shall be designed at the responsibility of the Contractor. Loading data of the equipment shall be submitted to the PMO/Engineer as required for him to check the structural strength of the buildings. All costs for foundations including grouting and plastering on all exposed faces of concrete with cement mortar shall be included in pertinent pay items in this Clause, except the concrete, formwork and re-bar works which shall be paid for under separate pay items.

T6.18.2 Plumbing materials and installation

(1) General

All pipes, fittings and fixtures shall be of the kind, grade, type and qualities as shown on the Drawings and as specified.

All pipes shall be jointed with fittings compatible with the pipe and of the suitable type for the intended service.

Union joints shall be properly provided in piping to allow disassembly of the piping for maintenance services or for any modification of the system.

Flanges shall be provided for pipes 75 mm in dia. and larger. The flanges shall be compatible with and shall have the same rating as the companion flange of the valve or the fittings. Full face rubber gaskets shall be provided to all flanged joints.

All piping shall be fitted and assembled to introduce minimum stress to the pipe and fittings. All pipe shall be supported where shown on the Drawings and as required. Polyvinyl chloride (P.V.C.) pipe shall be supported at the spacing recommended by the pipe manufacturer.

The same standard of thread shall be used throughout the works.

All piping to be embedded shall be tested and approved by the PMO/Engineer prior to being embedded.

Sleeves or check-outs shall be provided where pipe passes through concrete structure. The space shall be filled or caulked with suitable materials. Where pipe passes through a wall or floor where watertightness is required, the space shall be filled with yarn and lead or with approved expanding grout.

Cleanout and manhole shall be provided as shown on the Drawings and as directed by the PMO/Engineer.

All pipes embedded in the ground shall be at the pipe top minimum 30 cm below the grade where no heavy traffic is expected and minimum 90 cm below the grade crossing the road and where heavy traffic is expected. Pitch of the pipe line shall comply with the applicable code, regulations and as directed by the PMO/Engineer.

Change in pipe size shall be made with reducing fittings, use of bushings will not be allowed.

Change in direction shall be made with fittings except that bending of galvanized steel pipe 100 mm and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center line radius of bends shall not be less than 6 times the diameter of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted.

Exposed piping shall be run parallel with the lines of the buildings unless otherwise indicated.

Connections between ferrous and nonferrous metallic pipe installed underground shall be made with dielectric unions or flanges.

(2) Pipes

(a) PVC pipes

Polyvinyl chloride pipes (PVC) shall conform to JIS K-6741 and shall be laid and jointed in accordance with the manufacturer's instructions and to the PMO/Engineer's approval.

(b) Galvanized steel pipes

Water pipes shall be of standard weight galvanized screwed and socketed pipe conforming to JIS-G-3454 or G-3456 and G-3452.

Threaded joints shall be sealed with an approved graphite compound or with equivalent tape applied to the male threads only.

(3) Valves

Gate valves and check valves 50 mm in dia. and smaller pipe shall be of brass or bronze construction. Valves 65 mm in dia. and larger in the pipe line shall have cast iron body and brass trim. Valves 75 mm in dia. and larger shall be flanged.

Gate valves shall be of solid wedge disc type and shall have rising stem or non-rising stem. Check valves shall be horizontal swing type having a lightweight brass disc. Globe valves shall have replaceable resilient plugs and shall have rising stem. Globe valves for use in regulating flow shall have replaceable seats.

Air vent valves shall be either float type, ball type or combined float and heat sensing or diaphragm type to be selected according to the service intended.

All valves throughout this Clause shall be of the same manufacture in principle.

(4) Unions, hose faucets

Unions on ferrous pipe 50 mm in diameter and smaller shall be malleable iron zinc-coated. Unions shall not be concealed in walls, ceilings or partitions.

Hose faucets shall be brass or bronze with male inlet threads, hexagon shoulder and hose connection.

(5) Flexible joints

The flexible joint shall be either of the following:

(a) a rubber tube type formed with a flexible reinforced rubber tube with bolted flanges and split backing flanges for attachment to the pipe.

(b) a bellows type formed with copper or stainless steel, activated by internal pressure and retained by flange rings and tension lug bolts.

(6) Plumbing fixtures

Plumbing fixtures shall be obtained from a reputable supplier and the Contractor shall submit catalogues to the PMO/Engineer for his approval.

Generally, all fixtures except water closets shall have the water supply above the rim. Angle stops, straight stops, stops integral with the faucets and the like for supplies shall be furnished and installed with fixtures. Exposed fixture trimming and fittings shall be chromium-plated or nickel-plated brass with polished, bright surfaces.

Urinal screen shall be provided where a urinal abuts another urinal or lavatory sink on either side. The screen shall be of vitreous china, wall mounted.

(a) Fixture connections and support

Where space conditions will not permit standard fittings in conjunction with the cast iron floor flange, soft lead tubes shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made absolutely gas-tight and watertight with a closet-setting compound or with a neoprene gasket and seal. Bolts shall be equipped with chromium-plated nuts and washers.

Wall-hung fixtures shall be fastened to the wall by through bolts where appearance of the bolts is not objectionable. For solid concrete or masonry and where through bolting is objectionable, fixtures shall be fastened with machine-bolt expansion shields or stud type expansion bolts. For concrete,masonry unit construction, fixtures shall be fastened with through bolts or toggle bolts as required. Exposed bolt heads in finished areas shall be hexagonal. Exposed nuts shall be chromium-plated hexagonal cap nuts. Washers shall be painted or chromium-plated to match bolt heads or nuts.

(b) Connections to equipment and fixtures

The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with an integral stop, shall be equipped with a cutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures.

(7) Traps

Each fixture, floor drain and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tube shall be recess-drainage pattern, or tube type. Traps for acid-resisting waste shall be of the same material as the pipe.

(8) Pipe cleanouts

Pipe cleanout shall be the same size as the pipe except that cleanout plugs larger than 100 mm will not be required. A cleanout installed in connection with cast iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place indicated.

Cleanouts in connection with other pipe, where indicated shall be T-pattern, 90-degree branch drainage fittings with screw plugs. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks. Cleanouts on pipe concealed in partitions and walls and where installed in finished floors subject to foot traffic shall be provided with chromium-plated cast-brass covers secured to plugs.

(9) Pipe insulation and vapor barrier

Exposed water supply and drainage pipes shall be insulated.

(a) Insulation materials

The insulation material shall be fibrous glass or mineral faber. The insulation thickness shall be as indicated in the following table for mineral fiber and fibrous glass. Exposed insulation in traffic area shall be fitted with a metal jacket to protect the insulation.

Mineral Fiber and Fibrous Glass
Minimum Thickness in mm

Range of temperatures, degree C	6 thru 32	40 thru 75	80 thru 125	150 thru 250
Above 10	18	18	25	25
10 to 0	25	25	38	38
0 to -15	38	50	50	50
-15 to -10	38	50	65	65

(b) Vapor-barrier jacket

The insulation shall be provided with field-applied or factory-applied non combustible vapor-barrier jacket. The jacket shall consist of lamination of aluminium foil glass fiber reinforcement and kraft paper where exposed to view, and where concealed the kraft paper may be omitted. The kraft paper shall be enamel painted.

(c) Application

After pressure tests have been completed in the piping system, insulation shall be applied to the pipe with end joints tightly butted and the vapor-barrier jacket lapped not less 38 mm at longitudinal joint and adhered with adhesive. At circumferential laps, a 75 mm wide strip of jacketing material shall be applied and adhered with the adhesive. On jacket facing to receive finish painting, the aluminium foil shall not be exposed.

- Insulation through hangers and sleeves

The insulation shall be continuous through pipe hangers and pipe sleeves.

- Flanges, union, valves, anchors and fittings

  Unless otherwise indicated, all flanges, union, valves, anchors and fittings shall be insulated with factory-premolded, or pre-fabricated or field-fabricated segments of insulation of the similar material and thickness as the adjoining pipe insulation.

(d) Piping exposed to weather

Piping exposed to weather shall be insulated as specified above for applicable service except thickness required shall be double that specified. The exposed piping shall be finished with 0.4 mm thick corrugated, smooth or embossed aluminium sheet with factory fabricated "Z" type longitudinal joints or field applied seam joints, lapped not less than 50 mm at butt joints.

The joints shall be properly constructed to shed water or otherwise sealed with adhesive compound. Where jacketing abuts an uninsulated surface the joint shall be sealed with weatherproof compound. Fittings and other irregular surfaces shall be protected with two coats of weatherproof coating compound with glass tape embedded between coats. The total thickness of the dry film shall be 3 mm minimum. In lieu of glass tape covering for elbows factory fabricated aluminium sheetmetal elbows may be provided. The metal thickness shall be not less than 0.4 mm.

When steel pipes and fittings except for cast iron pipe are buried in the ground, they shall be insulated with either of the following with approval of the PMO/Engineer:

(i) Asphalt with jute
(ii) Glasswool cloth impregnated with waterproof insulation compound
(iii) Vinyl tape with adhesive

(10) Pipe hangers, inserts and supports

The Contractor shall submit to the PMO/Engineer for his approval detailed drawings of the type of inserts, hangers and supports for the piping he proposes to provide.

The location of hangers and supports shall be coordinated with the structural work to assure that structural members will support the intended load.

Hangers and supports shall be provided at intervals specified below, at locations not more than 1.0 m from the ends of each runout and not over 30 cm from each change in direction of piping. Hangers shall be adjustable.

Vertical cast iron and steel pipe shall be supported at each floor, or at intervals of not more than 4.5 m and at not more than 2.5 m from end of riser. Horizontal cast iron pipe shall be supported near each hub and hubless joint.

Horizontal steel pipe shall be supported at not more than the following intervals:

Pipe dia.	Interval
ø/20 - ø/25 mm	1.8 m
ø/32 - ø/40 mm	2.0 m
ø/50 - ø/80 mm	3.0 m
ø/90 - ø/150 mm	4.0 m
over ø/200 mm	5.0 m

Underground piping shall be laid on a firm bed for its entire length, except where support is otherwise provided.

(11) Painting

All hangers, supports and other iron works shall be painted with one coat of anticorrosive primer and with two coats of oil paint. All galvanized steel pipes exposed to view shall be painted with two coats of oil paint. Colour code shall be as directed by the PMO/Engineer.

(12) Testing of pipe lines

The Contractor shall test all pipe lines as directed by and in the presence of the PMO/Engineer. If the pipe fails in test, the Contractor shall repair, replace and retest the piping until being accepted by the PMO/Engineer. All piping system shall be flushed clean before testing.

(a) Pressure testing of water service pipe

Pipes shall be subject to a hydraulic pressure test of 5 kg/cm^2.

If piping is tested in sections, temporary cap shall be fitted. Each section shall be slowly filled with water and air inside the pipe shall be carefully expelled.

For acceptance, the test pressure shall remain constant for one hour without additional water.

(b) Testing of sewage and waste water pipe

No pipe shall be covered or concealed before it is tested. If any sections of pipe lines are tested, the Contractor shall obtain approval of the PMO/Engineer.

All openings and pipe ends shall be securely plugged and filled up with water up to the top of the highest opening. This water shall remain at the same level for 2 hours.

All pipes shall also be inspected visually to ensure that there is no projections in the pipe and the pipe line is straight and void of abrupt kinks. At least three-quarter of the pipe opening of any sections between manholes shall be visible when viewed from opposite end of the pipe section.

Exposed pipes shall further be subject to a leakage test. Leakage tests shall be made after a minimum of 24 hours after the pipe has been filled with water. No leakage shall be found for duration of another 2 hours on the pipe line.

T6.19 Air Conditioning and Ventilation Systems

T6.19.1 General

(1) Codes and standards

All equipment, materials and installation shall comply with the following standards where applicable in so far as they do not conflict with what specified herein.

(a) Japanese Industrial Standard (JIS)
(b) Heating, Air Conditioning and Sanitary Standard in Japan (HASS)
(c) Other approved standards or codes

The Contractor shall obtain the approval of the PMO/Engineer if he proposes to deviate from the above codes or standards.

(2) Shop drawings and working drawings

The Contractor shall submit to the PMO/Engineer for his approval the following working drawings:

- Layout drawings of equipment including list of equipment and materials to be incorporated,
- Details of piping and valving,
- Details of sleeves and opening for piping,
- Details of supports, hangers, attachments and anchoring,
- Details of vibration isolation,
- Details of foundation for equipment,
- Detailed layout of electric wiring and conducting,
- Complete electrical connection diagrams and
- Other drawings as required by the PMO/Engineer.

The working drawings shall be submitted at least 60 days prior to starting installation of materials or equipment.

(3) Safety requirements

Belts, pulleys, chains, gears, coupling, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto, shall be fully enclosed or properly guarded.

(4) Electrical work

Electric-motor-driven equipment specified herein shall be provided complete with motors, motor starters and controls. Electric equipment and wiring shall be in accordance with Electrical Works hereinafter. Electrical characteristics shall be as indicated. Motor starters shall be provided complete with properly sized thermal overload protection and other appurtenances necessary for the motor control specified. Manual or automatic control and protective or signal devices required for the operation herein specified and any control wiring required for controls and devices, but not shown on the electrical plans, shall be provided.

(5) Basic design data and conditions

(a) Climate data

Mean monthly maximum temperature	:	35°(Drybulb)
Mean monthly maximum humidity	:	85% (Relative humidity)

(b) Design conditions

Design conditions for the air conditioning system for the building shall be as follows :

Room conditions	:	30°C (Drybulb temperature)

(6) Other particulars

The provisions set out in the foregoing Plumbing Works shall be applied here as applicable in its spirit regardless of the wording as listed below:

- Shop drawings and working drawings,
- Data and samples,
- Operation and maintenance manuals,
- Attachments and spare parts,
- Tools,
- Field instructions,
- Tests,
- Floor, wall and ceiling escutcheons, and
- Foundation for equipment.

T6.19.2 Air conditioning system

(1) Airconditioning system

The airconditioning system shall be an energy conservation type controlled by electronic remote controller according to the variations of load in the rooms.

The system shall be of split type consisted of indoor units and single or multiple outdoor units ; the indoor units are cooling units and the outdoor units condesing units.

The indoor units shall be of split type ceiling mounted type unless otherwise directed by the PMO/Engineer, which shall house cooling coils and fan(s).

The outdoor units shall be air-cooled type housing condensor coils, fan(s) and compressor(s), connected with the indoor units with refrigerant piping system.

A room controller shall be provided in each room which shall enable an automatic control of the indoor unit in air floor rates (hi/low), temperature setting, on/off timer, slef-diagnosis function etc.

(2) Refrigerant piping

(a) Cooper tubing

Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 35 mm. Joints shall be brazed except that joints on lines 20 mm and smaller may be flared.

(b) Fittings for copper tubing

Fittings for flare joints shall be standard forged-brass flare type with short-shank flare units. Fitting for brazed joints shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type fittings shall not be allowed for brazed joints.

(c) Pipe insulation

Refrigerant piping line shall not be insulated until after the pipe have been proven tight under the required test pressures. The insulation material shall be fibrous glass, mineral fiber or flexible foamed plastics. The insulation thickness shall be as recommended by the manufacturer of the air-conditioning equipment. Exposed insulated piping in traffic area shall be fitted with a metal jacket to protect insulation.

(3) Drain lines

Drain lines shall be provided for each indoor unit. Drain lines shall be sloped in the direction of flow with at a rate of 20 mm per meter. Drains when connected to the sanitary sewer system shall be done so indirectly. Cleanouts shall be provided where indicated or required.

(a) Pipe and fittings

All piping shall be standard-weight galvanized steel. Fittings shall be standard-weight galvanized malleable iron of drainage pattern.

(b) Water seals

Water seals shall be provided in the condensation drain lines. The depth of each seal shall be equal to the total static pressure rating of the unit to which the seal is connected. Water seals shall be constructed of two tees and an appropriate U-bend with the open end of each tee plugged.

T6.19.3 Ventilation system

(1) Air moving devices

Fans may be directly connected to the motor shaft or indirectly to the motor by means of a V-belt drive. Where V-belt drives are used, such drives shall be designed for not less than 150 per cent of the connected driving capacity, and motor sheaves shall be adjustable to provide not less than 20 per cent speed variation. Sheaves shall be selected to drive the fan at such speed as to produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable rails or bases. Fans shall be provided with personnel screens or guards on both suction and supply ends except where ducts or dampers are connected to the fan. Fans and motors shall be provided with vibration isolation supports or mountings. Each fan shall be selected to produce the specified capacity at outlet velocity not exceeding the recommendations of an applicable code unless otherwise indicated.

(2) Propeller fans and motors

Propeller fans and motors shall be supported on heavy metal frames designed for wall opening mounting. Fan wheels less than 60 cm in diameter shall be directly connected to the motor, and fans 60 cm in diameter or larger shall be connected to the motor by a V-belt drive. Motors shall have totally enclosed enclosures. Motor starters shall be manual type with general-purpose enclosures. Gravity dampers and rainhood shall be provided on the exterior side of wall. Remote manual switch with pilot indicating light shall be provided.

T6.20 Fire Protection System

T6.20.1 General

The fire protection system shall comprise supplying fire extinguishers.

T6.20.2 Fire extinguisher

Fire extinguishers shall be of dry chemical, heavy-duty, portable, 6 kg capacity, CO_2 pressure operated type.

Each fire extinguisher shall be supplied with a free flowing, moisture repellent fire extinguishing chemical powder. The chemical powder shall extinguish fires in paper, wood, rags, gasoline, petroleum products, gas and chemical and electric fires.

T6.21 Measurement and Payment for Plumbing Works, Air Conditioning and Ventilation and Fire Protection Systems

T6.21.1 General

Measurements for payment and payment method hereinafter specified will be applied for the plumbing, air conditioning and ventilation and fire protection system work items in the Bill of Quantities. All works shall be complete in every respect; furnished, installed, constructed and tested in accordance with the Drawings and the Specifications and as directed by the PMO/Engineer.

All work items shall include costs for incidental works, spare parts and consumables as specified and any other relevant works which are not explicity mentioned but reasonably inferable. In establishing the unit prices, however, attention shall be paid to the fact that the incidental works herein have been specified taking the representative work items into consideration, therefore some of them may be irrelevant to some work items.

Should any new work items similar in nature to those in the Bill of Quantities arise during the course of construction, unit prices for these shall be made out arithmetically in one of the following manners:

(1) For pipes, valves, steel sheet and the like, extrapolation or interpolation outside or inside the two nearest unit prices shall be employed.

(2) For airconditioners, fans and pumps, extrapolation or interpolation shall be employed if there are more than two similar work items in the same manner as above (1), and if not percentage of increase or decrease in capacities shall be considered for the new items. In this case, said capacities shall mean cooling capacity (Kcal/hr) air volume (m^3/min or m^3/hr) and delivery volume (1/min or m^3/hr) respectively.

(3) For other items either of the above methods shall be used as applicable.

No price adjustment shall be made for minor changes or deviations from the Drawings or the Specifications which are due to the manufacturer's standard specifications and which are accepted by the PMO/Engineer as such.

No price adjustment shall be made either for upgraded the quality of materials or equipment which has resulted from the industrial advancement in the country of origin during the course of construction period.

T6.21.2 Measurement and payment

Measurement for payment for each work item will be made on the basis of the following factors, and payment for these shall be made at the unit prices in the Bill of Quantities so established according to the measurements.

Work item	Basis of incidental works measurement/(scope of works)
(1) Galvanized steel pipes:	Length of pipe measured in linear meters with all fittings, supports, hangers, sleeves and earthwork.
(2) Flexible joint pipes:	Number of flexible joint measured in pieces.
(3) Valves and flow meters:	Number of valves and flow meters in pieces with valve casing and earthwork.
(4) Thermal insulation for pipe:	Length of pipe insulated measured in linear meters with vapor varier and jacket.
(5) Painting for pipe:	Length of pipe painted measured in linear meters.
(6) Spare parts and consumables :	Total cost measured in lum sum.
(7) Cess pool:	Number of cess pool measured in pieces with cast iron manhole cover, bottom inverting and earthwork.
(8) Catch basin:	Number of catch basin measured in pieces with cast iron manhole cover and earthwork.
(9) PVC drainage pipes:	Length of pipe measured in linear meters with all fittings, supports, hangers, soldering, sleeves and earthwork.
(10) Septic tanks:	Number of septic tank measured in sets with all accessories specified, and earthwork.
(11) Plumbing fixture	Number of plumbing fixture and shower set measured in set with all accessories specified, mirrors, shelves, paper holders, soap dispensers, faucets and stops.
(12) Swing faucets and wall faucets:	Number of faucet measured in pieces.

(13) Lawn faucets:	Number of lawn faucet measured in sets with cast iron faucet boxes and earthwork.
(14) Floor drains:	Number of floor drain measured in pieces.
(15) Cleanouts:	Number of cleanout measured in pieces.
(16) Vent caps:	Number of vent cap measured in pieces.
(17) Air conditioner : (outdoor and indoor units)	Number of units measured in set with all auxiliary equipment and accessories
(18) Electrical control:	Total cost measured in wiring: lump sum. (The works shall include all conduiting and cabling for equipment from the local control panel.)
(19) Copper pipes:	Length of pipe measured in linear meters with all fittings, supports, hangers, insulation and painting.
(20) Galvanized steel pipe for condensing water (drain) pipes:	Same as (1) galvanized steel pipes.
(21) Exhaust fans:	Number of fan measured in set with hangers, supports, rainhood, gravity damper and painting.
(22) Fire extinguishers:	Number of fire extinguishers measured in pieces with all accessories.

CHAPTER T7 HYDROMECHANICAL WORKS

T7.1 General

T7.1.1 Scope of works

These specifications cover the designing, manufacturing, testing before shipment, finishing, painting, packing, insuring, shipping and delivering to the site, erection, site testing, tests on completion and remedying defects of all the following:

Water Supply Facilities

(a) Three (3) complete sets of intake gates, guide frame and hoist, covering each opening of 2.10 meters wide by 2.10 meters high,

(b) Three (3) complete sets of intake trash racks, covering each opening of 3.00 meters wide by 3.00 meters high,

(c) One (1) complete lane of steel conduit for water supply, having diameters of 1.50 meters and 0.40 meter and length of approximately 210 meters,

(d) One (1) complete set of discharge valve for water supply, having diameter of 0.40 meter,

(e) One (1) complete set of guard valve for water supply, having diameter of 0.40 meter,

River Outlet Facilities

(f) One (1) complete set of inlet bulkhead gate for river outlet, covering 1.50 meters by 1.50 meters square,

(g) One (1) complete set of trash racks for river outlet, covering each opening of 2.60 meters square by 2.50 meters high,

(h) One (1) complete lane of river outlet steel conduit, having diameters of 1.50 meters and 1.00 meter and length of approximately 20 and 37 meters for upstream and downstream portions of the conduit respectively,

(i) One (1) complete set of river outlet discharge valve, having diameter of 1.00 meter,

(j) One (1) complete set of river outlet guard valve, having diameter of 1.00 meter.

The Works covered in these Specifications shall also include the supply and installation of all mechanical and electrical equipment associated with the foregoing scope of works. The Works shall also include the supply of maintenance equipment and tools, and the services of instruction to the project staff.

All shall be in accordance with these Specifications, the accompanying Drawings and tender schedules.

T7.1.2 Permanent electricity supplies

The power for the Plant shall be alternative current of:

3 phase, 4-wire, 50 Hz	
Voltage between phases	400 V
Voltage between phase and neutral	230 V
Voltage variation	+ 15%, - 20%
Neutral point	Solidly grounded

The 3-phase supply shall be used for power circuits and the single phase supply for lighting, indication, motor control and similar small power circuits.

The public electricity power supply will be available for the permanent equipment supplied under these Specifications for normal condition and the electric power supply of alternating current shall be made emergency stand-by the diesel engine generating set supplied and installed under another chapter of this Contract.

The contractual electric terminal point for power supply shall be as follows:

Gate control house : at the secondary terminals of the Dam Distribution Board to be supplied and installed in the gate control house under another chapter of this Contract.

Dam control house : at the secondary terminals of the Main Distribution Board to be supplied and installed in the dam control house under another chapter of this Contract.

T7.1.3 Instruction to project staff

During the erection work at the Site, the Contractor shall instruct the employees, designated by the Employer, who will subsequently be responsible for the adjustment, operation, and maintenance of the Plant. The course of instruction shall be carried out upon approval of the PMO/Engineer.

The materials, place etc. to be required to carry out the instruction to project staff shall be prepared by the Contractor. The cost of such instruction shall be deemed to be included in all the lump sum and unit prices in the Bill of Quantities and no separate payment shall be made for these services.

T7.1.4 Standards

The Japanese Industrial Standards (JIS) provided by the Japanese Standards Association of Japan have been used throughout these Specifications. Other national or international standards may be accepted provided that the requirements therein are, in the opinion of the PMO/Engineer, equivalent to or better than the current issue of the Japanese Industrial Standards.

Unless otherwise specified, design, fabrication, installation and tests of the equipment shall conform to the applicable provisions of "Technical Standards for Gates and Penstocks" provided by the Hydraulic Gate and Penstock Association in Japan.

If the Contract Documents conflict in any way with any or all of the above standards or codes, the Contract Documents shall have precedence and shall govern, only upon confirmation of the PMO/Engineer.

All equipment, material and details of installation shall comply with the requirements and the latest revisions of the following Standards and Codes where applicable:

(a) Japanese Industrial Standards (JIS),

(b) Standard of the Japanese Electro-Technical Committee's Standards (JEC),

(c) Japanese Engineering Standards (JES),

(d) Standards of the Japan Electrical Manufacturer's Association (JEM),

(e) Japanese Cable-makers Association Standards (JCS),

(f) International Electro-technical Commission (IEC),

(g) International Organization for Standardization (ISO), and

(h) Standards of local regulatory bodies having jurisdiction over installation.

T7.1.5 Working stresses and design

The design, dimensions and materials of all parts of the Plant shall be such that they will not suffer damage under the most adverse conditions nor result in deflections and vibrations which might adversely affect the operation of the equipment. Mechanism shall be so constructed to avoid sticking due to rust or corrosion.

All parts which will have to be dismantled or which might have to be dismantled, for purposes of servicing or replacement shall be retained with anti-corrosive fasteners. The type, material and size of all fasteners shall be selected to safely withstand the maximum superimposed direct, alternating, kinetic and thermal loads and all loads induced by workmen when installing or removing the fasteners during the life of the equipment.

All design shall be such that the installation, replacement and general maintenance may be undertaken with the minimum of time and expense. The tolerances used for dimensions and finishes shall be selected in due consideration of the particular properties and functions of the parts and the corresponding accuracy required to obtain proper operation and tight sealing.

Wherever possible, all similar parts, including spare parts, shall be made to gauge and interchangeable. Such parts shall be of the same materials and workmanship and shall be constructed to such tolerances as to enable substitution or replacement from spare parts to be made easily and quickly.

Suitable structural steel bases or frames shall be provided where necessary to transmit to the concrete foundations all loads imposed by the various parts of the equipment. Such bases or frame shall be supplied complete with suitable anchor bolts and shall be so proportioned that the bearing loads imposed on the concrete foundations will not exceed 50 kilogram force per square centimeter.

All Plant shall be designed to minimize the risk of fire and consequential damage, to prevent ingress of vermin, dust and dirt, and accidental contact with electrically live parts or moving parts. The Plant shall be capable of continuous operation with minimum attention and maintenance in the exceptionally severe conditions likely to encounter in a tropical climate.

Complete information regarding the design assumptions, loading and operating conditions, deflections and unit stresses used in the design shall be provided with appropriate drawings by the Contractor to the PMO/Engineer.

The Contractor shall be deemed to have examined the Specifications and Drawings herewith and to have concurred with the design and layout of the Works, as being sufficient to ensure reliability and safety in operation, free from undue stresses, adequate drainage and other essentials for a satisfactory operation of the Plant.

It should be noted that the Specification drawings show only the general type of equipment and the governing dimensions and are not intended to define the exact details of the equipment to be furnished. As the drawings indicate the outline of the structure in which the equipment is to be installed, special attention shall be paid to the arrangements of the equipment so as to make optimum use of the available space. Any recesses required in this structure for alignment and grouting of embedded parts other than those indicated in the Drawings shall be determined by the Contractor subject to approval of the PMO/Engineer.

T7.1.6 Unit of measurement

In all correspondence, in all technical schedules and on all drawings, metric units of measurement shall be employed. Drawings or printed pamphlets in which other units have been used, the equivalent metric measurement shall be marked in addition.

T7.1.7 Tropicalization

In choosing materials and their finishes due regard shall be given to the humid tropical conditions under which the equipment will be called upon to work. The Contractor shall submit details of his practices which have proven satisfactory and which he recommends for application on the parts of the Plant which may be affected by the tropical and local conditions. The materials and finishes used shall be approved by the PMO/Engineer.

T7.1.8 Grounding

Grounding electrodes and wiring shall be supplied and installed by the Contractor for the whole of the electrical equipment to be provided under this Clause.

The grounding systems shall have adequate capacity for the maximum ground fault current and the protection of personnel and safety of property.

T7.1.9 Change to material or equipment

The Contractor shall not make any changes to the equipment or in the materials to be incorporated in the Plant from that specified or implied by these Specifications without the written approval of the PMO/Engineer. Such changes or alterations shall in no way be detrimental to the interests of the Employer and shall not result in any increase to the Contract Price.

T7.1.10 Labels and plates

The Contractor shall supply and install at least each one name plate made and engraved of bronze or corrosion-resisting steel in approximately 500 millimeters wide by 400 millimeters high, to indicate the design data of all equipment.

All duty labels and instruction plates on cubicle and equipment, including above name plates, shall be in English language.

T7.2 Drawings and Documents to be Supplied by the Contractor

T7.2.1 Drawings and documents for approval

The Contract award does not imply approval of the PMO/Engineer on the technical documentations prepared for and submitted with the Tender.

The technical documentations as required in the Specifications should be subject to approval of the PMO/Engineer under the terms and conditions of the Contract.

The Contractor shall include in his Tender for the cost of all drawings, operating instructions and other information to be provided under this Contract.

Before manufacturing of the equipment and site construction works are to commence, the Contractor shall submit the design criteria, calculations, specifications, dimensioned drawings and diagrams showing all details of the equipment and materials to be used to the PMO/Engineer for approval and to the Employer simultaneously. These drawings and data with stamp of "FOR APPROVAL", "DATE OF SUBMISSION" and "CONTRACTOR's SEAL" shall be submitted with times mentioned in sub-clause T7.2.6 "Target on submission of drawings and documents". The drawings and documents which are required to be modified as necessary by the PMO/Engineer shall be submitted for reapproval. The Contractor shall allow a minimum net period of four (4) weeks for such reviewing after receipt by the PMO/Engineer and another one (1) week for return mail purposes. Claims or extensions of time will not be permitted on account of the late submission of drawings and documents to the PMO/Engineer or for delays caused by drawings and documents being returned not approved and for resubmission by the PMO/Engineer.

It shall be understood, that approval of drawings and documents by the PMO/Engineer will not exonerate the Contractor from any of his liabilities under the Contract.

The title of the drawings, the signature of the Contractor's responsible engineer, the date prepared, the drawing number, etc. shall appear in the bottom right-hand corner of the drawing. The size of drawings shall be as follows:

Drawing size (A1)	594 mm x 841 mm
Ledger size (A3)	297 mm x 420 mm
Letter size (A4)	210 mm x 297 mm

The blank of 200 millimeters wide by 100 millimeters high shall be kept above the title block of all drawings for the PMO/Engineer's comments.

T7.2.2 Procedure for submission of drawings and documents for approval

All drawings submitted for approval or sent to the Employer and to the PMO/Engineer for any other reasons shall be sent by registered mail with quickest possible means.

The PMO/Engineer will return one copy marked and signed with one of the following classifications:

"APPROVED"

"APPROVED WITH MODIFICATION"

"RETURNED FOR CORRECTION AND RESUBMISSION"

Upon receipt of any drawings and documents which have been marked "APPROVED" and "APPROVED WITH MODIFICATION", the Contractor shall submit copies of such drawings and documents as "FOR WORK DRAWING' upon making any correction(s) if indicated thereon by the PMO/Engineer.

When the returned drawings and documents have been marked "RETURNED FOR CORRECTION AND RESUBMISSION", the Contractor shall make the necessary corrections and/or revisions to the drawings and documents in a timely manner and shall resubmit the,m to the PMO/Engineer. When the returned drawings and documents are submitted for approval again, the PMO/Engineer will try to complete his review and/or approval of the drawings and documents within four (4) weeks or twenty (20) working days, whichever is longer, however, this will be depend on the number and complexity of the corrections/revisions which have to be checked. This procedure will continue until the drawings and documents have eventually been marked as shown in "APPROVED" or "APPROVED WITH MODIFICATION", at which time they will become part of the Contract Documents.

T7.2.3 For work drawings

After approval of the drawings and documents by the PMO/Engineer, the Contractor shall supply copies of the approved-drawings with stamp of "FOR WORK DRAWING" to the Employer and to the PMO/Engineer. Only FOR WORK DRAWINGS can be used for manufacturing and erection purpose.

Should any modification is required with the drawings, however, the PMO/Engineer may instruct the Contractor to do so and the drawings so modified shall be resubmitted.

T7.2.4 Final drawings and documents

After all items of the Works have been manufactured, erected and have passed the Tests on Completion, a complete set of the negatives of the drawings previously approved and/or modified

consequentially according to the requirements at the Site shall be submitted to the Employer. Negatives of the drawings to be submitted to the Employer shall be of "Mylar film" or other approved permanent transparent materials.

The reduced size of drawings into ledger size shall be bound in letter size covers and be submitted to the Employer and to the PMO/Engineer.

T7.2.5 Required numbers of drawings and documents

Numbers of the drawings and data to be submitted to the Employer and to the PMO/Engineer shall be as follows:

Within times mentioned	To the Employer	To the PMO/Engineer
Drawings and data for approval	2 copies	5 copies
FOR WORK DRAWINGS and data		
Full size	3 copies	2 copies
Reduced size (ledger size)	2 copies	2 copies
Within one (1) months		
Upon completion of the Works		
Complete set of negatives of drawings and data	1 set	NIL
Complete set of bound print of drawing and data		
Full size	3 sets	NIL
Reduced size (ledger size)	2 sets	2 sets
Complete set of bound print of Operating and Maintenance Instructions	5 sets	2 sets

Further copies of particular drawings and data are to be provided at the Contractor's own expense if requested by the PMO/Engineer or the Employer.

T7.2.6 Target on submission of drawings and documents

The drawings and documents shall be submitted for approval with the following times reckoned in calender month from the issuance of the PMO/Engineer's Order to Commence the Works.

(1) Within five (5) months

General layout drawings of all Plant.

Detailed drawings and data related to civil work such as the drawings showing the blockouts and foundations of the Plant, loading conditions, size and location of anchor bars, hooks, grounding wiring system, etc.

(2) Within ten (10) months

General and shop fabrication drawings, calculation sheet and data.

(3) Documents for approval specifically stated in the Specifications:

(a) Erection Instructions in sub-clause T7.3.2 "Instructions for erection works" and test procedure at the shop and at the Site in sub-clause T7.3.3 "Test procedure instructions":

Following after approval of drawings for main components of the Plant.

(b) Qualification documents of welding procedure and for welder and welding operator's qualification in sub-clause T7.4.11 "Welding":

Before three (3) months of commencement of fabrication work.

(a) Painting Specifications, color scheme and painting example in sub-clause T7.4.13 "Protection, cleaning and painting": following after approval of drawings for main components of the Plant.

Operating and Maintenance Instructions in sub-clause T7.3.1 "Operating and maintenance instructions", spare parts list in Clause T7.8 "Spare Parts" and maintenance equipment and tools list in Clause T7.9 "Maintenance Equipment and Tools": following after approval of drawing for main components of the Plant.