G.7 EMBANKMENT

G.7.1 General

The embankment for the access roads shall be constructed at the locations and to the lines, grades and dimensions as shown on the Drawings or as directed by the Supervision.

The earthfill material for the access road embankment shall consist of suitable material excavated from cut sections of the access roads or from any other area as directed by the Supervision and shall be free from brush, roots, vegetation, large boulders and other unsuitable material. The embankment materials shall not be placed in the road embankment until the foundation for it has been suitably prepared and approved by the Supervision.

After being compacted, the gradation of the embankment material shall conform to the following:

(1) The maximum particle size shall be thirty (30) cm.

(2) Less than fifty (50) percent of the material shall be in the range of plus No. 4 (4.76 mm) to thirty (30) cm.

(3) The material shall contain minus No. 200 sieve fraction in the amount of less than ten (10) percent.

G.7.2 Moisture Control and Density

Unless otherwise approved or directed by the Supervision, the moisture content of the embankment material during and after compaction shall be within the range from minus four (4) % to plus two (2) % of the optimum moisture content, and this moisture content shall be uniform throughout each layer which is placed.

The optimum moisture content of the embankment material shall be that moisture content which is required to produce the maximum dry density obtained from the compaction test in accordance with Sub-paragraph C.8.4 of Section C. The moisture content and optimum moisture content of the material placed in the road embankment shall be determined by the Supervision from selected samples at random. If the moisure content as determined from the samples does not meet the Specifications, the Contractor shall treat the material in such a manner that the moisture content is brought within the required range, as indicated by a further series of tests.

It is the Contractor's responsibility to obtain the specified moisture content for the access road embankment, and this shall be accomplished by a method which has been approved by the Supervision.

Each layer of the embankment shall be compacted to not less than 92 % of the maximum dry density in accordance with ASTM D 698, JIS A-1210 or other approved standards.

G.7.3 Placing and Compaction

The road embankment shall be built in approximately horizontal layers carried across the entire width of the embankment to the required slopes. The depth of each layer before compaction shall not exceed thirty (30) cm. Each layer shall be compacted to the satisfaction of the Supervision by means of vibratory or other approved rollers. The road embankment shall not be widened with loose materials dumped from the top. Any travel of equipment over the road embankment during construction shall be routed so as to obtain maximum consolidation of the embankment.

The Contractor's operations in handling, spreading and compacting the material for the roadway embankment shall be such as those which will result in an acceptable distribution and gradation of the materials throughout the embankment. The density shall be uniform throughout each compacted layer. Rock pockets and clusters of rock which would interfere with the proper compaction of the material will not be permitted.

When each layer of the material has been conditioned to have the specified moisture content, it shall be compacted with rollers until the dry density throughout the layer is equal to or in excess of the specified dry density. Full details on the type of rollers to be used by the Contractor shall be submitted to the Supervision for approval.

The loading, operation and speed of travel of the rollers shall be such as required to obtain the specified compaction. The immediately proceeding and adjacent roller tracks shall be lapped by at least fifty (50) cm. If more than one roller is used on any one layer of fill, all rollers so used shall be of the same type and essentially of the same dimensions. Tractors used of pulling rollers shall have sufficient power to pull the rollers satisfactorily when the drum are fully loaded.

If, in the opinion of the Supervision, the rolled surface of a layer of material is too dry or smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or worked with a harrow, scarifier, or other suitable equipment, in an approved manner to a sufficient depth to provide a satisfactory bonding surface before the next succeeding layer of material is placed. If, in the opinion of the Supervision, the rolled surface of a layer of material in place is too wet for proper compaction of the layer of material to be placed thereon, it shall be removed and dried or be worked in place with a harrow, scarifier, or other suitable equipment to reduce the moisture content to the required amount. It then shall be recompacted before the next succeeding layer of material is place. No adjustment in the unit price will be made on account of any operation of the Contractor in regard to work which may be required as described in this Sub-paragraph.

When the Contractor is reasonably sure that the necessary number of passes by the roller has been made to obtain the specified density, he will request that the Supervision make a field density test to verify as such.

This test will be in accordance with JIS A-1214, ASTM D 1556 or other approved methods. After the test has been made, the Supervision will inform the Contractor of the results and if

the specified density has been obtained, the Supervision will allow the Contractor to start placing and compacting the next layer.

Where embankment material is to be deposited on only one side of the culvert headwalls, wingwalls, etc., such care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it causes overturning of or excessive pressure against the structure.

The roadway embankment material shall be placed to the design subgrade line shown on the Drawings and shall be trimmed to a surface tolerance of ± 3 cm in 5 m. Any part of the subgrade line that has been completed shall be protected against drying out and cracking and any damage resulting from default of the Contractor shall be repaired as directed by the Supervision without additional payment.

G.7.4 Measurement and Payment

Measurement, for payment, of the compaction of original ground to be placed the embankment material will be made for the actual compacted plan area in square meters according to the Drawings or as directed and approved by the Supervision.

Payment for the compaction of original ground will be made at the unit price per square meter tendered therefor in the Bill of Quantities, which unit price shall include the cost of all labor, equipment and materials required for completion of this work.

Measurement, for payment, of the access road embankment will be made for the material compacted in place in the embankment to the lines and grades shown on the Drawings or as directed by the Supervision.

Payment for the access road embankment will be made at the respective unit prices per cubic meter tendered therefor in the Bill of Quantities, which unit prices shall be for all related costs of labor, equipment and materials including loading the previously excavated material, hauling, (up to 500 m and more than 500 m), placing, spreading, wetting or drying as required, compacting, levelling, all required testing in accordance with the Specifications, and maintenance during the Contract period.

G.8 IMPROVED SUBGRADE

G.8.1 General

The Contractor shall construct the improved subgrade course using materials excavated from the cut sections of the access roads or other materials approved by the Supervision. The material for the improved subgrade course shall be placed and compacted in layers not to exceed twenty (20) cm after compaction. The overall thickness of the improved subgrade course shall be as shown on the Drawings or as directed by the Supervision. The improved subgrade course shall not be placed in cut sections of rock unless otherwise directed by the Supervision.

After being compacted, the gradation of the improved subgrade course material shall conform to the following:

(1) The maximum particle size shall be less than five (5) cm.

(2) Less than fifty (50) percent of the material shall be in the range of plus No. 4 (4.76 mm) to five (5) cm.

(3) The material shall contain minus No. 200 sieve fraction in the amount of less than ten (10) percent.

G.8.2 Moisture Control and Density

The Specifications for the moisture control and density of the improved subgrade material shall be the same as stipulated in Sub-paragraph G.7.2, except that the moisture content shall be within the range of minus three (3) percent to plus one (1) percent of the optimum moisture content and the required dry density for each layer of the improved subgrade material shall not be less than ninety-five (95) percent of the maximum dry density in accordance with ASTM D 698, JIS A-1210 or other approved standards.

G.8.3 Placing and Compaction

The Specifications for the placing and compaction of the improved subgrade material, including testing, shall be the same as stipulated in Sub-paragraph G.7.3, except that the depth of each layer after compaction shall not exceed twenty (20) cm. The CBR value shall not be less than corrected CBR 12.

G.8.4 Measurement and Payment

Measurement, for payment, of the improved subgrade course will be made on the basis of actual compacted volume in cubic meters determined by the design lines and grades shown on the Drawings or as directed by the Supervision.

Payment for the improved subgrade course will be made at the unit price per cubic meter tendered therefor in the Bill of Quantities, which unit price shall constitute full compensation for the cost of all labor, equipment and materials including placing, spreading, wetting or drying as required, compacting, shaping and finishing, testing and other items necessary to complete this work.

Measurement, for payment, of the transportation of improved subgrade material will be made on the basis of volume of the material and distance of transportation in m^3.km determined by the Drawings and approved by the Supervision.

Payment for the transportation of improved subgrade material will be made at the unit price per m3.km tendered therefor in the Bill of Quantities, which unit price shall constitute full compensation for the cost of all labor, equipment and materials including loading and hauling and other items necessary to complete this work.

G.9 GRADED CRUSHED STONE SUBBASE

G.9.1 General

The graded crushed stone subbase course is the portion of the road which lies on the top of the improved subgrade course. The Contractor shall construct the graded crushed stone subbase course to the thickness shown on the Drawings or as directed by the Supervision.

G.9.2 Moisture Control and Density

The Specifications for the moisture control of the graded crushed stone subbase course material shall be the same as stipulated in Sub-paragraph G.7.2, except that it will be within the range of minus three (3) percent to plus one (1) percent of the optimum moisture content. The material for the graded crushed stone subbase course shall be compacted to at least sixty (60) % of the CBR value as determined in accordance with ASTM D 1883, JIS A-1211 or equivalent standards.

G.9.3 Processed Material

All graded crushed stone subbase course material shall consist of material excavated from the Picoazá quarry or other approved areas which has been processed through the crushing/classifying plant so as to meet the required gradation specifications. Such material shall be approved before being incorporated in the work and may be inspected by the Supervision at any time during the progress of their processing and use. Questionable materials which are pending laboratory testing and subsequent approval shall not be unloaded and incorporated with materials previously approved and accepted. If, the grading and quality of the materials do not conform to the grading or quality as previously inspected or tested, or do not comply with the Specifications, the Supervision reserves the right to reject such materials.

Samples must meet all tests required under these Specifications to the satisfaction of the Supervision. The Contractor shall permit any designated representative of the Supervision to inspect and/or test any material being used or desired to be used, at any time during or after its preparation, or while being used during the progress of the work or after the work has been competed. All such materials not complying with these Specifications, whether in place or not, shall be rejected and shall be promptly removed from the work. The Contractor shall supply all necessary materials, labor, tools, and equipment necessary to perform the testing.

Materials shall be stored so as to ensure preservation of their specified quality and fitness for the work. They shall be placed on a hard and clean ground surface approved by the Supervision and located so as to facilitate prompt inspection. The center of the storage area shall be raised and sloped to the sides as required so as to provide proper drainage. The materials shall be stored in such manner as to prevent segregation and to ensure proper gradation and moisture content. Storage piles shall be built up and removed in each layer of not exceeding one meter. The height of such stock piles shall be limited to five meters unless otherwise approved by the Supervision.

All processed aggregates shall consist of clean, tough, durable, sharp-angled fragments free of any excess of thin or elongated pieces, and reasonably free of soft, disintegrated or decomposed stone, dirt or other deleterious matters.

The material for the graded crushed stone subbase course shall consist of processed material conforming to the following gradation requirement.

Nominal Sieve Size (mm)	20	10	5	2.5	0.4	0.074
Percentage Passing	100	66-90	35-75	20-50	5-25	1-7

G.9.4 Placing, Mixing and Compaction

The Contractor shall deliver the graded crushed stone subbase course materials from the crushing plant and place it on the previously prepared improved subgrade. After material for each layer has been placed, the material shall be mixed, at the required moisture content, by means of motor graders or other approved equipment until the mixture is uniform throughout. The material shall be placed and compacted in layers of thickness not to exceed fifteen (15) cm, after compaction.

When hauling is done over previously placed material, hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer, to minimize rutting or uneven compaction.

Immediately following final spreading and smoothing, each layer shall be compacted to the full width by means of smooth wheel power rollers, pneumatic-tired rollers or other approved compaction equipment which is suitable and capable of compacting the material to the specified density. Full details for each specific type of compaction equipment shall be submitted to the Supervision for approval.

The loading, operation and speed of travel of the roller shall be such as required to obtain the specified compaction. The immediately preceding and adjacent roller tracks shall be lapped by at least fifty (50) cm. If more than one roller is used, all rollers so used shall be of the same type and dimensions.

Rolling shall progress gradually from the sides to the center, parallel to the centerline of the road, and shall continue until all the surface has been rolled. Any irregularities or depressions that develop shall be corrected by loosening the material at these places and adding or removing material until the surface becomes smooth and uniform. At all places not accessible to the roller, the material shall be compacted thoroughly with approved tampers or hand-held compactors. The material shall be both bladed and rolled until a smooth and even surface has been obtained.

The Contractor's operations in handling, spreading and compacting the material for the roadway embankment shall be such as those which will result in an acceptable distribution and gradation of the materials throughout the embankment. The density shall be uniform throughout each compacted layer. Rock pockets and clusters of rock which would interfere with the proper compaction of the material will not be permitted.

If, in the opinion of the Supervision, the rolled surface of any layer of the road embankment is too dry or too wet or too smooth, it shall be treated in such a manner as specified in Sub-paragraph G.7.3.

Testing of the graded crushed stone subbase course shall be done in accordance with JIS A-1214, ASTM D 1556 or equivalent standards.

The finished surface shall be true to the level shown on the Drawings, or as directed by the Supervision, with a tolerance of ± 3 cm in 5m.

G.9.5 Measurement and Payment

Measurement, for payment, of the graded crushed stone subbase course will be made on the basis of actually placed and compacted volume in cubic meters to the design lines and grades shown on the Drawings or as directed by the Supervision.

Payment for the graded crushed stone subbase course will be made at the unit price per cubic meter tendered therefor in the Bill of Quantities, which unit price shall constitute full compensation for the cost of all labor, equipment and materials, including procuring and hauling to the roadway, spreading, compacting, wetting or drying as required, finishing, testing and other items necessary to complete the work and to maintain during the Contract period.

G.10 SURFACE COURSE (NOT APPLICABLE)

G.11 CONCRETE RETAINING WALL AND WET RUBBLE MASONRY WALL

G.11.1 Concrete Retaining Wall

Concrete retaining wall for the access roads shall be constructed to the lines, dimensions and in the location shown on the Drawings or as directed by the Supervision.

Before work of the concrete retaining wall is commenced, the leveling concrete shall be placed on surface of open excavation for leveling base of the retaining wall as shown on the Drawings or as directed by the Supervision.

Placing of concrete and installing of reinforcing bars for the wall shall be fully conformed to all the Specifications provided hereinbefore in Paragraph E.10 and E.14 of Section E, Concrete Works, where applicable. Surface of concrete to be permanently exposed and to

be covered with embankment materials shall be formed for Finishs F2 and F1, respectively, as stipulated in Paragraph E.13 of Section E.

G.11.2 Wet Rubble Masonry Wall

Wet rubble masonry wall shall be built to the lines, dimensions and in the locations shown on the Drawings or as directed by the Supervision. Rock to be used for the wall shall be of selected, hard and blocky, not less than 30 centimeters in length and not less than 400 square centimeters in area. Rock shall be carefully arranged in relation to one another so as to have a pleasing appearance with a minimum of voids or empty spaces to be filled with mortar.

Mortar shall have the mix ratio of three parts of clean fine aggregate to one part of Portland cement (ordinary type) by volume. The fine aggregate, cement and water shall conform to the requirements specified in Sub-paragraphs E.2.1 and E.3.2 and Paragraph E.4 of Section E. Concrete for this wall consists of the placement of the concrete for foundation leveling and backfill shall be placed as shown on the Drawings. The Specifications in Section E which are applicable to the concrete for the foundation and backfill shall be complied with.

Free drain backfill shall be placed to the lines and dimensions shown on the Drawings. The free drain backfill shall conform to the requirements specified in Sub-paragraph C.7.2 of Section C. In the course of setting and mortaring the rocks, 50-millimeter diameter of P.V.C. drain pipe shall be installed in the wall at every four (4) square meters as shown on the Drawings or directed by the Supervision.

The wet rubble masonry wall shall be performed by experienced masons, duly qualified in their trade. The rocks shall be laid carefully so that the exposed faces form an uniform surface and are true to dimensions, lines and levels shown on the Drawings or as directed by the Supervision. Prior to setting, the rocks shall be wetted sufficiently to take up its surface absorption.

G.11.3 Measurement and Payment

(1) Measurement, for payment, of the concrete retaining wall will be made to the neat lines of wall in accordance with the measurement appropriate for concrete, formwork and reinforcing bars provided in Paragraph E.12 and Sub-paragraphs E.13.8 and E.14.3 of Section E, or established by the Supervision.

Payment for the concrete retaining wall will be made at the unit prices per cubic meter of concrete placed, per square meter of formwork finished and per metric ton of reinforcing bars installed tendered therefor in the Bill of Quantities, which unit prices shall include the costs of all labor, materials and equipment required to perform the work prescribed in this Paragraph.

(2) Measurement and payment of the wet rubble masonry wall will be made according to the provisions stipulated in Sub-paragraph C.19.2 of Section C.

G.12 GUARD RAILING

G.12.1 General

The Contractor shall furnish and install guard railing, including concrete foundations for the posts, as shown on the Drawings or as directed by the Supervision.

Material to be used for the steel guard railing shall conform to the requirements of JIS G 3101 (Structural Rolled Steel for General Use), ASTM A 36-70 a (Structural Steel), or equivalent standards. Steel pipe used for the posts shall conform to the requirement of JIS G 3452 (Steel Gas Pipes), ASTM A 53-73 (Welded and Seamless Steel Pipe), or equivalent standards. Materials for concrete shall conform to the requirements of Section E, Concrete Works of these Specifications.

The guard railing shall be constructed to the lines and grades, and at the locations shown on the Drawings. Posts shall be set plumb in the concrete footings. Rail elements shall be erected in a manner resulting in a smooth and continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the post at least 0.6 cm but not more than 1.2 cm. Painting of all components of the guard rail which has been erected shall be made in accordance with the provisions of Section H.

G.12.2 Measurement and Payment

Measurement, for payment, of furnishing and installing the guard railing and posts shall be made for the length along the centerline of the railing.

Payment for furnishing and installing the guard railing and posts will be made at the unit price per linear meter tendered therefor in the Bill of Quantities, which unit price shall include the cost of all labor, equipment and materials required for installing the guard railing and posts including excavation for post foundations, placing of concrete for post foundations, backfilling around the posts, painting and other necessary work.

G.13 WARNING SIGNS

G.13.1 General

All warning signs shall comply with the requirements of the Ecuadorian standards such as "Manual de Diseño de Carreteras, Ministerio de Obras Públicas y Comunicaciones" (Main Road Standard), "Manual de Diseño de Caminos Vecinales, MOP-1984, Ministerio de Obras Públicas y Comunicaciones" (Second Road Standard) and "Especificaciones Generales para Construcción de Caminos y Puentes" (General Specification for Construction of Roadway).

Warning signs shall be obtained from a manufacturer approved by the Supervision and before placing any order for the manufacture of the warning signs, the Contractor shall submit to the Supervision two copies of the following information;

(1) Name of the firm from which he proposes to obtain the signs together with place of manufacture or fabrication.

(2) A description of the items to be supplied with manufacturer's specifications together with a description of quality, grade, weight and strength.

(3) Manufacturer's "type" test certificates, or recent test results carried out on similar items.

(4) A sample sign, post and fittings which sample shall be stored on site for the Supervision.

All colors on the warning signs, with the exception of black and grey, shall be reflectorized, unless otherwise specified or instructed by the Supervision. The reflective sheeling shall be applied by mechanical vacuum- heat application method to the approval of the Supervision. The sign plate shall be covered by clear lacquer of a make recommended by the manufacturer of the reflective material.

Unless directed otherwise posts, frames, fittings and the backs of signs shall be painted with a finish coat of grey. Bolts and nuts shall be spot welded after erection to prevent theft, and a grey epoxy paint shall be applied to all areas so treated.

The Contractor shall excavate in any material for the foundation of the warning signs, provide and place foundation concrete, embedded all round and under the posts and backfill the remaining excavations as directed by the Supervision.

The Contractor shall cut back trees and vegetation to permit visibility and shall not permit material to be dumped so as to obscure the signs.

All signs shall be maintained in a clear and legible conditions and shall be washed down when necessary.

G.13.2 Measurement and Payment

Measurement, for payment, of constructing the warning signs shall be made on the basis of number of signs actually constructed.

Payment for constructing the warning signs will be made at the unit price per number of signs tendered therefor in the Bill of Quantities, which unit price shall include the cost of all labor, equipment and materials required for constructing the warning signs including excavation, concreting, backfilling, painting, and other necessary work required for the maintenance by the end of the Contract period.

G.14 BEARINGS AND ANCHOR ROD

G.14.1 General

The Contractor shall furnish and install bearings (fixed and movable types) and anchor rods with steel pipes for supporting the bridge as shown on the Drawings or as directed by the Supervision.

The materials to be used for bearings shall be the elastomeric bearing pads as stipulated in Paragraph E.23 of Section E, Concrete Works.

The anchor rods to be embedded in the bridge abutment concrete shall be D. 32 mm and those to be inserted into the concrete beams of bridge shall be capped with D. 60 mm steel pipes as shown on the Drawings or as directed by the Supervision. The materials of steel rods and pipes shall conform to the applicable requirements of Paragraph H. 2 of Section H, Miscellaneous Metal Works.

G.14.2 Measurement and Payment

(1) Measurement, for payment, of furnishing and installing bearings, fixed type and movable type, will be made of the number of the bearing in place as shown on the Drawings or directed by the Supervision.

Payment for furnishing and installing fixed type and movable type of bearing will be made at the respective unit prices per number tendered therefor in the Bill of Quantities, which unit prices shall include the cost of all labor, materials and equipment required by these Specifications.

(2) Measurement, for payment, for furnishing and installing anchor rods with steel pipes shall be made on the basis of weight in kilograms of steel rods and pipes installed as shown on the Drawings or directed by the Supervision.

Payment for furnishing and installing anchor rods with steel pipes will be made at the unit price per kilogram tendered therefor in the Bill of Quantities, which unit price shall include the cost of all labour, materials and equipment required for complete this work.

G.15 CONTRACTOR'S TEMPORARY CONSTRUCTION ROADS

G.15.1 General

The Contractor shall be responsible for designing, constructing and maintaining various temporary construction roads which he will have to use basically as "haul roads" during the time the Project work is in process. The exact route and location of these temporary construction roads shall be determined based on the Contractor's design and layout drawings as approved by the Supervision.

The temporary construction roads include but not limited to;

(1) Contractor's temporary construction road to borrow areas, if any.

(2) Contractor's temporary construction road to crushing and concrete plants.

(3) Contractor's temporary construction roads in the construction areas and to the Contractor's camp sites.

The Contractor's design of his temporary construction roads shall be based on generally acceptable standards and shall be submitted to the Supervision for approval at least forty-five (45) days prior to starting the work on the roads.

The method of construction for the Contractor's temporary construction roads including but not limited to alignment, excavation, embankment, surfacing (if any), drainage, guard rails, etc. shall be submitted in writing to the Supervision for approval at least twenty-eight (28) days prior to starting the construction of such roads.

The Contractor shall be responsible to maintain all his temporary construction roads throughout the time they are in use, to the satisfaction of the Supervision.

G.15.2 Measurement and Payment

Measurement and payment for the Contractor's temporary construction roads will be made in accordance with the provisions stipulated in Section A, General Items.

CONSTRUCTION OF CIVIL WORKS

PACKAGE 1

DAULE-PERIPA~LA ESPERANZA TRANSBASIN

VOLUME III - GENERAL AND TECHNICAL SPECIFICATIONS

SECTION H

MISCELLANEOUS METAL WORKS

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SECTION H MISCELLANEOUS METAL WORKS

H.1 GENERAL

The works for the following items shall comprise the supply of all labor, materials and equipment, and performance of all work necessary for the supplying and installation of the following works, as shown on the Drawings or as directed by the Supervision and as specified herein:

(1) Furnishing and installing steel pipe handrails;
(2) Furnishing and installing steel ladders with safety cage;
(3) Furnishing and installing steel steps (round bar);
(4) Furnishing and installing checkered steel covers and gratings;
(5) Furnishing and installing embedded steel pipes;
(6) Furnishing and installing wire net fence with gate;
(7) Furnishing and installing embedded and non-embedded metals other than above items (1) to (6);
(8) Furnishing and installing steel lifting hooks, if any; and
(9) Installation of metal items supplied by other contractor, if any.

All welding shall conform to the requirements of Paragraph H.4. Metalwork shall be erected as specified in Paragraph H.3. All joints in metalwork which are to be galvanized after fabrication shall be seal welded, if not already welded.

Painting shall be performed as prescribed in Paragraph H.5. For galvanized metalwork, red lead prime painting will not be required except for welded joints, and one coat of approved epoxy resin paint shall be applied. When galvanizing has been damaged, the area affected shall be cleaned and coated with approved zinc-rich paint or zinc metalling.

Metalwork to be embedded in concrete shall be so embedded when the concrete is being placed, as shown on the Drawings, or as directed by the Supervision, recesses or blockouts shall be made in the concrete and the metalwork shall be grouted in place or embedded in concrete. The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of scale, rust, dirt, oil, paint, and any objectionable materials which will reduce the bond between embedded metalwork and grout or concrete immediately before the grout or concrete is placed. Metalwork shall be accurately positioned and aligned in accordance with the tolerances as directed by the Supervision or as shown on the Drawings and shall be held securely in the correct position during placing and setting of the concrete.

Grout for metalwork shall be mixed in the proportions and to the consistency prescribed by the Supervision. The Contractor shall furnish cement and fine aggregate complying with the requirements of Paragraph D.2 for all grout. The cost of materials for and the mixing and placing of grout shall be included in the unit prices tendered in the Bill of Quantities for furnishing and installing the various items of metalwork for which the grout is required. Before placing grout, the surfaces of existing concrete on which the grout will be placed shall be roughened and shall be cleared of all laitance, loose or defective concrete coating and

other foreign material by effective means followed by thorough washing. Such surfaces shall be kept moist for at least 24 hours immediately prior to the placing of the grout.

II.2 MATERIALS

All materials shall be new, and materials of metalwork shall comply with following standards or approved equivalent:

Steel	JIS G 3101-76
Steel bar	JIS G 3112-75
Steel plate	JIS G 3194-66
Shaped steel	JIS G 3192-71
Steel pipe	JIS G 3444-74 and JIS G 3452-76 as appropriate
Steel square pipe	JIS G 3466-75
Steel forging	JIS G 3201-64
Steel bolt, nut and washer	JIS G 3123-75

II.3 ERECTION MANUALS FOR METAL WORKS

The erection manuals shall be submitted to the Supervision for approval, and when they are finally approved, seven (7) copies and three (3) copies shall be prepared and forwarded to the CRM and the Supervision, respectively.

The manuals shall describe in detail the procedure for assembling and erecting of each components and the use of all erection equipment, tools and measuring devices.

II.4 STANDARD AND WORKMANSHIP FOR METAL WORKS

(1) General

All materials shall be new, of a first-class nature, and of such as are usual and suitable for work of like character. All materials shall comply with the latest Japanese Industrial Standard (JIS) or the equivalent unless otherwise specified or permitted by the Supervision.

All workmanship shall be of the highest class throughout to ensure smooth and vibration free operation under all possible operating conditions, and the design, dimensions and materials of all parts shall be such that the stress to which they may be subjected shall not render them liable to distortion, undue wear, or damage under the most severe conditions encountered in service.

All parts shall conform to the dimensions shown on the approved Drawings. All joints, datum surfaces, and matching components shall be machined and all castings shall be spot faced for nuts. All machined finishes shall be shown on the approved Drawings. All screws, bolts, studs and nuts and threads for pipe shall conform to the latest JIS or standards of the International Organization for Standardization covering these components and shall all conform to the standard for metric sizes.

(2) Standard Specifications

Japanese standards issued by the Japanese Industrial Standards Association have been used throughout the Specifications. Other national or international standards may be accepted, provided that the requirements therein are, in the opinion of the Supervision, equivalent to the current issue of the Japanese standards.

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.

All electrical equipment, material and details of installation shall comply with the requirements and latest revisions of the following codes and standards where applicable:

(A) Japanese Industrial Standards (JIS)
(B) Japanese Electro-Technical Committee's Standard (JEC)
(C) Japanese Engineering Standards (JES)
(D) Japanese Electric Machine Industry Association's Standards (JEM)
(E) Japanese Cable-makers Association Standards (JCS)
(F) International Electrotechnical Commission (IEC)
(G) Local regulatory bodies having jurisdiction over installation
(H) Local codes

(3) Shop Assembly

All items of equipment shall be assembled in the shop prior to shipment, and tests shall be performed by the Contractor as may be required to demonstrate to the satisfaction of the Supervision the adequacy of the equipment and its component parts. All tests shall simulate normal operating conditions as closely as possible. All dismantled parts shall be properly match-marked and dowelled as required to ensure correct assembly in the field.

(4) Castings

All casting shall be dense, sound and true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage defects, cracks or other injurious defects and shall be satisfactorily cleaned for their intended purpose. All castings shall be checked for defects before final machining.

Castings shall not be repaired, plugged, or welded without permission of the Supervision. Such permission will be given only when the defects are small and do not adversely affect the strength, use, or machinability of the casting. Excessive segregation of impurities or alloys at critical points in a casting will result in its rejection. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs.

Surfaces which do not undergo machining and are exposed in the final installation shall be dressed to provide a satisfactory appearance so that they will not require surface smoothing at the Site prior to painting. Casting shall be in accordance with the following standards:

(A) Iron Castings

Iron castings shall be in accordance with JIS G 5501, FC 25 or approved equivalent.

(B) Steel Castlings

Steel castings shall be fully annealed and shall be in accordance with JIS G 5101, SC 42 or approved equivalent.

(C) Bronze Castings

Bronze castings shall be in accordance with JIS H 5111, BC 2 or approved equivalent.

(D) Phosphor Bronze Castings

Phosphor bronze castings shall be in accordance with JIS H 5113, PBC 2 or approved equivalent.

(5) Forgings

Forgings shall be made in accordance with JIS G 3201, SF 50 or approved equivalent. The ingots from which the forgings are made shall be cast in metal moulds, the workmanship shall be first-class in every respect and the forgings shall be free from all defects affecting their strength and durability, including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive nonmetallic inclusions and segregations.

The largest fillets compatiable with the design shall be incorporated wherever a change in section occurs. All finished surfaces of forgings shall be smooth and free from tool marks.

(6) Steel Plates and Bars

(A) Steel plates for steel conduits shall be in accordance with JIS G 3106, SM 41 or approved equivalent.

(B) Steel plates for general structure shall be in accordance with JIS G 3101 SS 41, or approved equivalent.

(C) Steel bolts, nuts and washers shall be in accordance with JIS G 3123 or approved equivalent.

(D) Corrosion-resisting steel plates and bars shall be in accordance with JIS G 4303, G 4304, G 4305, G 4306, G 4307 or approved equivalent.

(7) Checkered Plate

Checkered plate shall be of an approved raised pattern. All edges of plate and joints shall be planned and cut so as to maintain continuity of pattern.

(8) Machine Work

(A) General

All tolerance, allowances and gauges for metal fits between plain cylindrical parts shall conform to Japanese Industrial Standards or other approved equivalent standard for the class of fit as shown or otherwise required. Sufficient machining stock shall be allowed on locating pads to ensure true surfaces of solid material. Bearing surfaces shall be true and exact to secure full contact. Journal and sliding surfaces shall be polished, and all surfaces shall be finished with sufficient smoothness and accuracy to ensure proper operation when assembled. Parts entering any machine shall be carefully and accurately machined. All drilled holes for bolts shall be accurately located and drilled from templates.

(B) Finished Surfaces

Finished surfaces shall be indicated on the Contractor's drawings and shall be in accordance with Japanese Industrial Standards or equivalent. Compliance with specified surface will be determined by sense or feel and by visual inspection of the work compared to the standard roughness specimens, in accordance with the provision of the above stated standards.

(C) Unfinished Surfaces

So far as is practicable, all work shall be arranged to obtain proper matching of adjoining unfinished surface. When there is a large discrepancy between adjoining unfinished surfaces, they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the Drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner.

(D) Keys and Keyways

Keys and keyways shall conform to the requirements of Japanese Industrial Standards or other approved equivalent standard, unless otherwise specified or required.

(E) Pins and Pin Holes

Pin holes shall be bored to gauge, smooth and straight, and at right angles to the axis of the member. The boring shall be done after the member is securely fastened in position. Pins shall be of hardened and ground steel and positively held in position.

Wheels or rollers for gates shall be mounted on removable pins and have self-lubricating bushings and brass washers.

(F) Lubrication

Before assembly, all bearing surfaces, journals and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. Before operation, each lubricating system shall be checked. Self-lubricating metal bearings shall be cleaned with clean rags, and greased with an approved lubricant before assembly. Solvents shall not be used on self-lubricating metal bearings. The specification of all approved lubricants must be mentioned in the operating and maintenance instruction.

(G) Balancing

All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds and at any load up to the maximum, there shall be no vibration due to lack of such balance and the mechanical equipment shall operate with the least possible amount of noise.

(9) Miscellaneous Materials

(A) Self-lubricating metal bearings shall be in accordance with ASTM B 22, Alloy E, with L-Lubricant.

(B) Stranded wire ropes shall be in accordance with JIS G 3525, galvanized or approved equivalent.

(C) Wire rope fittings shall be manufacturer's standard fittings for the type of wire rope used.

(D) Conduit shall be in accordance with JIS C 8305 or approved equivalent.

(E) Sealing rubbers shall be moulded from a high-grade, tread type compound. The basic polymer shall be natural rubber, a co-polymer of butadiene and styrene, or a blend of both. The compound shall contain not less than 70 per cent by volume of the basic polymer, and the remainder shall consist of reinforcing carbon black, zinc-oxide accelerators, antioxidants, vulcanizing agent and/or plasticizers. The compound shall have the following physical properties:

Property	Limits
Tensile strength	210 kgf/cm^2 minimum
Ultimate Elongation	450 per cent minimum
Duramater Hardness (Shore, Type A)	50 to 70
Specific Gravity	1.1 to 1.3

Property	Limits
Water Absorption (70°C for 48 hours)	5 per cent maximum by weight
Compression Set (as a per cent of total original deflection)	30 per cent maximum
Tensile Strength (after oxygen bomb aging for 48 hours at 70°C)	80 per cent minimum of tensile strength before aging

(10) Welding

All welding shall be done either manually by the shielded metallic arc welding or automatically by the submerged arc welding.

The Contractor shall develop a welding procedure for the approval of the Supervision. After the welding procedure has been approve, the Contractor shall record it on a special Drawing which shall thereupon become one of the Drawings of the Contract. Welding symbols shall be shown on all Contractor's drawings where welding is required.

Radiographic inspection shall be carried out by the Contractor when required by the standards, these Specifications or the design criteria employed. All important welds which, in the opinion of the Supervision, may be subject to the full stress induced in the adjacent plate, or which in the opinion of the Supervision, do not appear to conform to the welding standards, shall be radiographer when required by the Supervision.

Suitable meters shall be provided to show the welding current and the arc voltage at all time during the welding operations.

Unless otherwise specifically stated, welded parts requiring machine finish shall be completely welded before being finished.

All welds shall be made continuous and watertight. The minimum throat dimension of fillet welds shall be 4.5 millimeters.

All defects in welds shall be chipped out to sound metal and such areas shall be magnafluxed or ultrasonically tested to ensure that the defect has been completely removed before repair welding.

Plates to be joined by welding shall be accurately cut to meet size. The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration and the edges of plates shall be properly formed to accommodate the various welding conditions. The surfaces of the plates for a distance of 25 millimeters from the edge to be welded shall be thoroughly cleaned of all rust, grease and scale, to bright metal.

(11) Qualification of Welding Procedure

The technique of welding employed, the appearance and quality of the welds made and the methods used in correcting defective work, shall conform to the American Welding Society (AWS) Standard D 1.1, or other approved equivalent standard.

(12) Qualification of Welders and Welding Operators

All welders and welding operators assigned to the work shall be able to perform flat and vertical welding positions in a qualification test, within the preceding six months, for welders and welding operators in accordance with JIS Z 3801 or other approved equivalent standard. The Contractor shall furnish the Supervision with certified copies of report of the results of physical tests of specimens welded in the qualifications tests. If, in the opinion of the Supervision, the work of any welder at any time appears questionable, he shall be required to pass the appropriate requalification test. All costs of qualification tests shall be borne by the Contractor.

(13) Welding Electrodes

The welding electrodes shall conform to JIS Z 3211 or 3212, low hydrogen type or approved equivalent standards.

Stainless type weld metal, where used in the water passes for protection against pitting, shall be of chromium nickel steel. The type, chemical composition and JIS number of welding rods used for this purpose shall be subject to the approval of the Supervision.

(14) Material Inspection and Testing

Materials, parts and assemblies thereof entering into the Work shall be tested, unless otherwise directed, according to the best commercial method for the particular type and class of work. When the manufacturer desires to use stock material not manufactured specifically for the equipment furnished, satisfactory evidence that such material conforms to the requirements herein stated, shall be furnished, in which case tests on these materials may be waived. Certified mill test reports of plates and sections will be acceptable. In addition to the mechanical tests required by the Specifications, all materials shall be examined in the shop for laminations and imperfections before incorporating them into the work and any defective material shall be rejected.

Witness tests and inspection of materials may be made at the place of manufacture by the Supervision, unless otherwise specified. Such witnessing and inspecting will be conducted so as to interfere as tittle as possible with manufacturing operation. The Contractor shall however comply with any reasonably request made by the inspector concerning the method of test or correction of defective workmanship.

All casting weighting 226.8 kilograms (500 pounds) or more shall have test coupons attached from which test specimens may be prepared.

The number, size and location of the test coupons shall be subject to the approval of the Supervision. Faulty material or materials found to be inferior to that specified shall be rejected and removed at once, and shall not be used in any part of the work.

Test pieces of other structural materials shall be provided as required by the Supervision.

The ultimate strength, limit of elasticity, ductility, hardness, etc. will be determined from such test pieces.

The Contractor shall furnish, free of charge, all such test pieces, blankets, etc., cut and machined to the sizes, shapes and dimensions as directed by the Supervision. The testing of the specimens will be carried out by the Contractor at his own expense, and shall be performed as directed by the Supervision.

Test pieces which represent rejected materials shall be preserved and become the property of the CRM. Copies of all test reports shall be submitted to the Supervision.

The Contractor shall supply to the Supervision, as requested, certified test reports giving the chemical analysis and physical properties of materials used.

Waiving of inspection by the Supervision shall not relieve the Contractor of the responsibility for supplying material and workmanship acceptable to the Supervision.

H.5 PROTECTION, CLEANING AND PAINTING FOR METAL WORKS

(1) General

All parts which will ultimately be embedded in concrete shall be cleaned and protected by a cement wash or other approved method before forwarding from the manufacturer's shop. Before being installed, they shall be thoroughly descaled and cleaned of all rust and adherent matter. Such cleaning shall not detrimentally affect the strength or final operation and function of the equipment.

All machined parts or bearing surface shall be cleaned and protected from corrosion by the application of an approved rust preventive lacquer, or an adhesive plastic film before forwarding from the manufacturer's shop. Where the latter is impracticable such parts shall be heavily covered with high melting point grease. After erection, such parts shall be cleaned with solvent and wiped or polished.

The final colour of all equipment shall be approved by the Supervision under the confirmation of the CRM, therefore the Contractor shall propose a colour scheme for the equipment and shall submit colour chips or paint samples. A colour chip shall be included with the approved colour schedule, for each type of finish to be applied at the site.

All equipment shall be painted as specified herein. The painting of equipment shall include the preparation of the metal surfaces, paint application, protection and drying of the paint

coatings, as well as the supplying of all tools, labour and material necessary for the entire painting work.

Sufficient paint shall be provided for field painting and touch-up of shop painting by the Contractor.

Paint shall be the product of reputable manufacturer and its selection shall be approved by the Supervision.

(2) Surface Preparation

All oil, paraffin, grease and dirt shall be removed from the surfaces to be painted using solvents. All weld spatters, slags, burrs, loose rusted mill, scale and other foreign substances shall be removed by shot or sandblasting to "white" metal. The interior surface of the steel pipe shall be mechanically cleaned or sandblasted to a commercial standard. Special attention shall be given to cleaning of corners and converging angles. If rust forms or the surfaces become contaminated in the interval between cleaning and painting, recleaning to the same degree shall be required. Surfaces not to be painted shall be protected by appropriate and adequate masking during the cleaning and painting of adjacent metalwork. Effective means shall be provided for removing all free oil and moisture from the air supply lines of blasting equipment. All surface preparation shall be subject to approval of the Supervision before any paint is applied.

(3) Application Procedure

All paint, when applied, shall provide a satisfactory film and a smooth and even surface. Paint shall be thoroughly stirred, strained, and kept at the uniform consistency during application. Paint shall not be applied when the temperature of the metal or of the surrounding air is below 10∞C. Surfaces which will be coated shall be free from moisture at the time of painting. Painting shall be performed by brushing or spraying. The first coat shall be applied immediately after surface preparation. Each coat shall be allowed to dry or harden thoroughly before the succeeding coat is applied.

(4) Surfaces not to be Painted

Bronze, brass, surfaces of gear teeth, finished ferrous surfaces, surfaces in rolling or sliding contact after field assembly and wire ropes shall not be painted.

All corrosion-resisting steel surfaces for bearings and machinery parts shall not be painted.

On completion of cleaning, such surfaces shall be coated with an adhesive plastic film to protect the surfaces from minor mechanical damage and corrosion during shipment and storage at the site. The film shall be stripped of immediately prior to field erection of the equipment.

(5) Paint Schedule

The painting shall be performed as follows:

(i) Tar-epoxy paint, total thickness of 0.45 - 0.60 millimeters, shall be applied to the following items.

(A) Exposed surface of all frames and pipes,
(B) Interior surface of steel conduits, and
(C) Items directed by the Supervision.

(ii) Epoxy resin paint, total thickness of 0.15 - 0.25 millimeters, shall be applied to the followings items.

(A) External surface of steel conduits,
(B) Stoplog, and
(C) Items directed by the Supervision.

(iii) All furnished surfaces of ferrous metal except those specified in the above be given phthalic acid resin paint or alkyed resin enamel or other approved paints. Total thickness of these paints including primer coat shall be 0.12 - 0.15 millimeters.

Comercial equipment shall be painted in accordance with the manufacturer's standard practice.

All finished surfaces of ferrous metals including screw threads that will be exposed during transportation or while awaiting installation shall be cleaned and given a heavy uniform coating of gasoline soluble, rust-preventive compound.

H.6 PACKING FOR METAL WORKS

Each item shall be packed properly or protected for transportation from the place of manufacture to the Site.

Each crate or package shall contain a packing list in a waterproof envelope and copies in triplicate shall be forwarded to the Supervision prior to dispatch. All items of package shall be clearly marked for easy identification against the packing list.

All cases, packages, etc. shall be clearly marked on the outside to indicate the total weight, to show where the weight is bearing and the correct position of the slings and shall bear an identification mark relating them to the appropriate shipping documents.

The Supervision shall reserve the right to inspect and approve the equipment and the packing before the items are dispatched. The Contractor shall be entirely responsible for ensuring that the packing is suitable for transit and such inspection will not relieve the Contractor of responsibility for any loss or damage due to faulty packing.

All packing materials shall remain the property of the Contractor and shall be removed from the Site at the earliest opportunity and disposed to the satisfaction of the Supervision.

H.7 STEEL PIPE HANDRAIL

H.7.1 General

Steel pipe handrails, movable and fixed types, shall be installed as shown on the Drawings. The Contractor shall furnish all pipes, fittings, bolts, flanges and other accessories required for the steel pipe handrails.

Handrails to be set in concrete shall be completely assembled and installed when concrete is placed, or recesses shall be left or holes shall be drilled in the concrete for anchorage, and the handrails shall be assembled and grouted in position at some later time.

H.7.2 Measurement and Payment

Measurement for payment of steel pipe handrails shall be made on the basis of installed weight of the handrails in kilograms determined by the approved Drawings or directed by the Supervision.

Payment will be made for the number of kilograms measured as provided above at the unit price per kilogram tendered therefor in the Bill of Quantities, which unit price shall constitute full compensation for the cost of all labor, tools, equipment and materials including furnishing, fabricating, transporting, installing and painting the handrail, preparing and submitting manufacturing drawings and other items necessary to complete the work.

H.8 STEEL LADDERS WITH SAFETY CAGE

H.8.1 General

Steel ladders with safety cage shall be installed as shown on the Drawings or as directed by the Supervision.

Steel ladders and safety cage shall be completely fabricated in sections convenient for handling and transporting. Field anchors and anchor bolts shall be assembled by bolting or welding. Anchors and anchor bolts shall be embedded in the concrete at the proper positions while the concrete is placed, or recesses shall be left in the concrete and the anchors and anchor bolts shall be thoroughly grouted or concrete in place.

H.8.2 Measurement and Payment

Measurement and payment for furnishing and installing the steel ladders with safety cage will be made, as same manner as stipulated in Sub-paragraph H.7.2, at the unit price per kilogram tendered therefor in the Bill of Quantities, which unit prices shall include the cost of all labour, equipment, materials and painting required.

H.9 STEEL STEPS (ROUND BAR)

H.9.1 General

The Contractor shall furnish and install steel steps as shown on the Drawings or as directed by the Supervision. The steel steps shall be installed at the positions designated when concrete is placed.

H.9.2 Measurement and Payment

Measurement and payment for furnishing and installing steel steps will be made at the unit prices per kilogram tendered therefor in the Bill of Quantities, which unit prices shall include the cost of all labour, equipment and materials required.

H.10 CHECKERED STEEL COVERS AND GRATING

H.10.1 General

Hatches including checkered steel covers, grating, frames and embedded frames, and anchorages shall be procured and installed by the Contractor as shown on the Drawings or as directed by the Supervision. Cover plates shall be made of checkered steel plate with welded reinforcing steel angles or channels as shown on the Drawings, and shall be provided with lifting slots. When cover plates are being laid in proper position, the clearance between the cover plate and the frame shall not exceed 5 mm at each side. The frame shall be composed of steel shaped sections and shall be anchored to the concrete with steel bolts or straps spaced at the maximum length of 60 cm. Steel gratings with frames of an approved type shall be provided as shown on the Drawings or as directed by the Supervision.

H.10.2 Measurement and Payment

Measurement and payment, for furnishing and installing checkered steel plate or grating will be made, as same manner as stipulated in Sub-paragraph H.7.2, at the respective unit prices per kilogram tendered therefor in the Bill of Quantities, where unit prices shall include the cost of all work and materials required.

H.11 EMBEDDED STEEL PIPES

H.11.1 General

The Contractor shall furnish and install miscellaneous embedded steel pipes for air vent, drainage of water, cable conduits or water level gauge wells and inlet pipes with screens as shown on the Drawings or as directed by the Supervision.

H.11.2 Measurement and Payment

Measurement, for payment, of embedded steel pipes will be made on the basis of installed weight of embedded steel pipes in kilograms actually installed in accordance with the approved drawings or as directed by the Supervision.

Payment will be made at the unit prices per kilogram tendered therefor in the Bill of Quantities, which unit prices shall include the cost of all labor, tools, equipment and materials including furnishing, fabricating, transporting and installing the embedded steel pipes, and the relevant work to comple the work.

H.12 WIRE NET FENCE WITH GATES

H.12.1 General

Wire net fence shall consist of steel wire fabric, steel framing, concrete foundation and gates as shown on the Drawings or as directed by the Supervision. The steel wire fabric shall be of 50 mm mesh woven with 3.2 mm dia. galvanized steel wire . The fence posts shall be L-100 x 100 x 7 steel section galvanized, set 40 cm in concrete foundations, and at a maximum spacing of 2.0 m.

At the top of the fence, three stands of galvanized braved wire B.W.G. No. 14 which is inclined and upward sloping shall be provided. Sub-posts, tension wires, barbed wire and accessories shall be as approved. All miscellaneous ferrous metalwork shall be galvanized. Guard gates shall be of steel, complete with all necessary fittings for hanging and fastening. The Contractor shall submit shop drawings of gates and posts to the Supervision for approval before starting fabrication. Gates and fittings shall be galvanized after manufacture or given two coats of zinc-rich paint.

The concrete entrance walls shall be constructed to the dimensions shown on the Drawings. The respective work for concrete walls and finishing works shall be performed in accordance with the Specifications for such work.

H.12.2 Measurement and Payment

Measurement, for payment, of wire net fence with gates shall be made on the basis of weight in kilograms actually installed in accordance with the Drawings and Specifications and/or as directed by the Supervision.

Payment for wire net fence with gates will be made at the unit price per kilogram tendered therefor in the Bill of Quantities, which unit price shall include the costs of all labour, equipment and materials including wires, steel frames, posts, gates, and painting if required, and other relevant work necessary to complete the wire net fence with gates.

Payment for trench excavation, backilling and concrete works for posts will be made separately under the appropriate work items in the Bill of Quantities.

H.13 EMBEDDED AND NON-EMBEDDED METALS

H.13.1 General

The Contractor shall furnish and install miscellaneous embedded and non-embedded metal work as shown on the Drawings or as directed by the Supervision.

H.13.2 Measurement and Payment

Measurement for payment of embedded metal work and non-embedded metal work shall be made on the basis of installed weight of embedded metal or non-embedded metal in kilograms determined by the approved Drawings or directed by the Supervision.

Payment will be made for the number of kilograms measured as provided above at the respective unit prices per kilogram tendered therefor in the Bill of Quantities, which unit price for embedded metal work or non-embedded metal work shall constitute full compensation for the cost of all labor, tools, equipment and materials including furnishing, fabricating, transporting, and installing the embedded metal work or non-embedded metal work, preparing and submitting manufacturing drawings and other necessary documents, and other items necessary to complete the work.

Unless otherwise specified or directed by the Supervision, the cost of painting for embedded metal work and non-embedded metal work shall be included in the respective unit prices as specified above.

H.14 STEEL LIFTING HOOK, IF ANY

H.14.1 General

The Contractor shall furnish and embed the steel lifting hooks on the ceiling of the inlet valve house if required or as directed by the Supervision. The lifting hooks shall be round steel bar or steel plate which shall conform to the applicable JIS standards or equivalent.

H.14.2 Measurement and Payment

Measurement, for payment, of furnishing and installing the lifting hooks will be made on the basis of installed weight in kilograms actually used for the work. Payment for the lifting hooks will be made at the unit price per kilogram tendered therefor in the Bill of Quantities, which unit price shall include the cost of all labour, equipment and materials required to complete the work.

H.15 INSTALLATION OF METAL ITEMS SUPPLIED BY OTHER CONTRACTOR, IF ANY

H.15.1 General

The Contractor shall embed all metal items such as anchor plates, hooks, bolts, etc. supplied by the other contractor and so specified on the Drawings to be installed by the Contractor at the locations, lines and grades shown on the Drawings.

H.15.2 Measurement and Payment

Measurement, for payment, of embedding metal items supplied by the other contractor will be made on the basis of installed weight of embedded metal items in kilograms actually embedded, and payment for these items will be made at the unit prices per kilogram tendered therefor in the Bill of Quantities, which unit price shall include all the costs to complete the work.

CONSTRUCTION OF CIVIL WORKS

PACKAGE 1

DAULE-PERIPA-LA ESPERANZA TRANSBASIN

VOLUME III - GENERAL AND TECHNICAL SPECIFICATIONS

SECTION I

BUILDING WORKS

Table of Contents

SECTION I BUILDING WORKS

I.1 GENERAL

I.1.1 Scope of Works

The works in this Section shall cover the complete construction of a building for the Conguillo inlet superstructure including ventilation facilities.

Electrical facilities shall be provided under Section J Electrical Works in these Specifications.

Building construction shall include structural works such as earth works and concrete works with all architectural finishing works.

Storm water from the building roof and surface runoff shall be conducted to nearby open ditches or streams.

The work shall be complete in every respect including supply of all labor, materials, tools and equipment and testing. The work shall be constructed and completed in accordance with the Drawings and Specifications and as directed by the Supervision.

I.1.2 Relevant Provisions

All relevant provisions in other Section of these Specifications shall be applied here where applicable, provided that they do not conflict those specified hereafter.

I.2 WALL, ROOFING, CEILING AND FLOOR WORKS

I.2.1 Concrete Works

Except as otherwise provided herein or directed by the Supervision, the concrete, reinforcing steel bars and formworks shall be performed in accordance with the provisions of concrete works as stipulated in Section E of these Specifications.

The class of concrete to be used for the building and other structures shall be of class C, and levelling concrete shall be of class H. All concrete shall be made with ordinary Portland cement specified hereto.

I.2.2 Masonry Works

(1) Concrete Hollow Block Masonry

(a) Materials

(i) Concrete Hollow Block Units

Concrete blocks shall consist of three (3) core units with nominal face 190 mm x 390 mm x either 100 mm or 150 mm thick conforming to the requirements of JIS A 5406 TYPE B, ASTM C 67 and C 126 or approved equivalent.

All units shall have the minimum compressive strength of not less than sixty (60) kgf/cm2. The Contractor shall furnish such stretcher, corner, jamb and bond beams required to complete the work as indicated. All units shall be true to size, without cracks, chips, splits, or other defects which may impair their strength and/or durability.

(ii) Mortar

Mortar to be used for laying hollow block units shall be proportional by volume of one (1) part Portland cement and three (3) parts of well graded, clean coarse sand, and with addition of hydrated lime not to exceed one- tenth (1/10) the combined volume of cement and sand for interior walls. Add 0.912 liters of water-proofing admixture per sack of cement for mortar in cavity walls. The water for mortar shall be clean and free from injurious amount of acid, alkali or organic matters. Only sufficient water to make a workable mixture will be permitted.

(iii) Grout

Grout for filling cells in masonry units shall be one (1) part of Portland cement, three (3) parts sand, two (2) parts pea gravel, and one- tenth (1/10) lime putty. Add admixture as specified in item (ii) above for grout in cavity walls only.

(b) Laying

Concrete surface to receive the concrete hollow block shall be cleaned and thoroughly wetted prior to laying the masonry units. All masonry units shall be cleaned and all dust or dirt removed from the surface before laying and shall be laid dry. Fractional parts of units will not be permitted as long as complete units can be used. All masonry shall be laid true to plumb and to a plane surface.

Joints shall be 10 mm thick, with full mortar coverage on the face shells and on the webs surrounding the cells. Joint shall be as uniform as possible.

I.2.3 Plastering Works

(1) Cement Mortar

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 matters or other objectionable matter. The sand shall be well graded within the following limits:

For first and second coat	Max. granule size: 5 mm
For finish coat	Max. granule size: 2.5 mm
For tile bed	Max. granule size: 5 mm

The mix proportion of the cement mortar by volume shall be as follows:

For first and second coat	Cement : Sand = 1 : 3
For finish coat	Cement : Sand = 1 : 3
For tile bed	Cement : Sand = 1 : 4 or 1 : 3

Lime powder may be mixed in the mortar for finishing coat at 10% of sand by volume, excessive use shall not be allowed. Lime shall be sufficiently hydrated before use.

(2) Waterproof Cement Mortar

Waterproof cement mortar shall be made by mixing a waterproof agent into ordinary cement mortar. The Contractor shall be responsible for selection and quality of the waterproof agent and obtain approval of the Supervision. The mixing and application shall be in accordance with the manufacturer's instructions.

(3) Expanding Grout

An expanding grout shall be used around any pipe or embedded metals passing through a concrete wall where water may stand on one or both sides of the wall and where the pipe or embedded metals are not embedded in the initially constructed structure. The grout shall expand upon setting to effect bonding of the grout to the main concrete and the pipe or embedded metals. An approved expanding agent shall be mixed in cement mortar conforming to the manufacturer's instructions.

(4) Metal Wire Lath

Metal wire lath shall be of galvanized expanded metal with diamond mesh having a metal sheet thickness of not less than 0.3 mm.

(5) Application

The surfaces which are to receive scratch coat shall be free from all laitance, scum, loose carbonate scale, loose aggregate, dirt and other foreign matters. In case of cement mortar or

concrete block surface, they shall be sufficiently and uniformly dampened immediately before the application of mortar. Concrete surfaces shall be kept wet for 24 hours prior to the application of mortar.

Where shown on the Drawings or directed by the Supervision, metal wire lath shall be fixed to the brick, concrete block or concrete walls before applying cement mortar plaster. The metal wire lath shall be fixed to the structure with staples.

Cement mortar shall be used within 90 minutes from the time of mixing. Retempering shall not be permitted.

The rendering for tile works shall be made in 2 coats to 18 mm thick and its surface shall be cross scratched. In case of cement mortar finish, mortar shall be applied in 3 coats making the total thickness of 30 mm for floors and 20 mm for other areas. Concrete floors may be plastered in one coat if the surface are smooth and level upon approval of the Supervision. Reduction of number of coats and total thickness in other areas if proposed by the Contractor shall be subject to approval of the Supervision. Cement mortar finish shall be metal trowel finished unless otherwise specified. When the finish coat is applied, the entire surface or a bay of floor, 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 metal expansion beads within the coating thickness in a manner approved by the Supervision.

The finished surface shall be perfectly plumb or level as the case may be except otherwise specified without any bulging, runs, bruises or stains.

Scratch coat shall be applied as soon as possible after construction of the base structure to allow at least 1 week drying time until the finish coat.

After application of each 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 not to cause displacement or damage.

(6) Colored Cement Mortar Spray

The sand to be used shall have the same quality and grading as specified in this Sub-paragraph. The mix proportion of the colored cement mortar shall be 1:2:6:9 in ratios by volume of white cement, ordinary Portland cement, slaked lime and sand. Water proofing admixture and pigment of an approved brand shall be added to the above mix proportions to be approved by the Supervision. Colored cement mortar spray shall be applied in two coats. The first coat shall be applied thinly and the second coat in sufficient thickness to produce a uniform appearance in color and texture. The second coat shall be applied 24 hours after the first coat.

I.2.4 Bituminous Waterproofing Works

(1) General

Waterproofing for roof, and toilet and shower room floor shall be of 3-ply and 2-ply built-up asphalt waterproofing respectively consisting of the following from the bottom in order to the top:

3-Ply built-up roofing	2-Ply built-up roofing
- Asphalt primer	- Asphalt primer
- Asphalt compound	- Asphalt compound
- Asphalt felt (1st layer)	- Asphalt felt (1 st layer)
- Asphalt compound	- Asphalt compound
- Special asphalt felt (2nd layer)	- Asphalt felt (2nd layer)
- Asphalt compound	- Asphalt compound
- Asphalt felt (3rd layer)	
- Asphalt compound	

(2) Material

Asphalt primer shall be of factory mixed primer composed of blown asphalt, solvent naphtha and benzine 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 specification sheets and sample of the roofing materials to the Supervision for approval.

(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 kg/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 damp or rainy day or at any time considered unsuitable by the Supervision.

(4) Protection Concrete on Built-up Roofing

Materials such as cement, aggregate and sand, mixing, casting and curing of concrete shall comply with applicable provisions in Section E Concrete Works hereto.

The concrete shall cover the entire faces of the roofing in a thickness of 10 cm.

The concrete shall be provided with expansion joints to the full depth in a grid pattern of not larger than 3 m. Top of the joint shall be filled up with asphalt compound to a thickness of 25 mm on top of bituminous or foamed plastic board.

(5) Alternative Waterproofing

The Contractor may use an alternative waterproofing upon approval of the Supervision submitting him required data and information. Total unit weight of the alternative roofing system shall not be heavier than the one specified.

(6) Guarantee

The Contractor shall guarantee that if any leakage should develop in the areas treated by him within two (2) years from the date of completion of construction due to defective materials or workmanship, the Contractor shall promptly make repairs thereto including the protection concrete at his own expense.

I.3 DOOR, WINDOW AND LOUVER

I.3.1 Metal Doors, Windows and Louvers

(1) Materials

Materials for all doors, windows, louvers and frames shall be free from defects impairing their strength, durability or appearance and shall be the best of their respective kinds. They shall be made to sustain safely strains or stresses to which they may normally be subjected.

(2) Shop Drawings

The Contractor shall submit shop drawings of all work for approval of the Supervision. He shall carefully verify all dimensions at the Site so that proper adjustments can be made. Shop drawings shall show in large scale the details of the various parts indicating the methods of anchoring and securing the work, its reinforcement, and the schedule listing the quantities of each kind of door, window and louver and its location.

(3) Priming

All steel work shall be thoroughly cleaned of rust, oil, grease and other impurities and then given one shop coat of a primer. Parts inaccessible after assembly shall be primed in the shop before assembly.

All shop primed surfaces damaged in the field shall be cleaned and reprimed with the same paint.

(4) Steel Door Leaves and Frames

Hollow steel door leaves shall be fabricated from cold rolled sheet steel. The minimum metal thickness shall be as follows:

Panel : 1.6 mm
Stiffener plates and anchor plates : 2.3 mm

The door leaves shall be full flushed seamless panel, 40 mm thick unless otherwise specified.

Doors shall be mortised and reinforced for hinges and locks. Doors shall be reinforced for closures and other surfaces supplied hardware where required.

Door frames shall be formed of cold rolled sheet steel. The minimum metal thickness shall be as follows:

Frame : 2.3 mm
Architrave : 1.6 mm
Threshold : 2.3 mm

The frames shall be blanked, reinforced, drilled and tapped to receive template hinges and locust strikes. They shall be reinforced for surface mounted closures where required. All frames shall be prepared with rubber bumpers.

All frames shall be fixed to the structure with welded or snap-in anchors. The frames shall be furnished with a spreader bar attached to the bottom of the jamps; where no floor finish occur to conceal these spread bars, stainless steel channel shall be used, welded to the back of the jamps.

Frames shall be securely caulked with approved caulking material on exterior walls. The frames shall be extended to accommodate transom where they occur.

(5) Aluminium Doors, Windows, Louvers and Frames

The aluminium doors, windows, louvers and frames shall comply with the requirements JIS A 4702 and A 4706, or approved equivalent industrial standard. Catalogue of the products shall be submitted for approval of the Supervision.

Aluminium doors, windows, louvers and frames shall be fabricated of extruded aluminium sections and aluminium plates.

Fastening devices such as screws, bolts nuts, rivets etc. shall be of aluminium or stainless steel.

Washers shall be neoprene rubber, aluminium or stainless steel.

Sealing materials shall be polysulfide rubber.

All external faces of aluminium shall be applied with peelable protection film or the like before dispatching from the factory.

Where aluminium faces come in contact with steel, masonry, or other materials, they shall be treated with a coat of zinc chromate or alkali-resistant bituminous paint before installation.

(6) Insect Screens

Insect screen shall be fabricated of extruded aluminium frames with wire secured in frames to the inner side of windows and louvers by means of spline or galvanized screws. Screen unit shall be removable and rewirable. Screen wire shall be aluminium mesh, stainless mesh or other approved wire.

(7) Installation

Along the rims of the opening in concrete, brick and concrete block structures for the door, window and louver anchor metals shall be prembedded in a proper interval as the works progress.

Before installing the frames of door, window and louver, the rim of the opening which come in contact with them shall be cleaned of all loose and foreign matters and the prembedded anchor metals shall be exposed and extended.

The frames shall be set in place with suitable wedges plumb and true to line and then rigidly fixed to the structure through the fixing metals. The space between the frame and the structure shall be plugged with cement mortar. Exterior perimeters of the frame shall be sealed with approved caulking compound.

After glazing and painting works have been completed, all movable parts of the door and window shall be adjusted to ensure proper fitting and functioning.

(8) Finish Hardware

The Contractor shall supply and install all necessary hardware for doors and windows as shown and as specified below. Samples or catalogues of all hardware shall be submitted to the Supervision for approval.

The hardware shall comply with the following requirements:

Hinges	:	Stainless steel pivot hinges, 2 pieces for each door leaf.
Floor hinges	:	Cast iron body with stainless steel cover, oil and spring activated with 90∞ stop device.
Knobs, lever handles and fasteners	:	Stainless steel or chromium plated bronze.
Lock sets	:	Bronze, cylindrical lock, with 3 sets of key.
Door bolts	:	Chromium plated bronze or stainless steel, surface or flush type.
Door stops	:	Wall or floor mounted type with rubber bumper and holder.
Door closer	:	Die-cast aluminium body, oil or spring activated with hold-open feature.

The Contractor shall supply three (3) master key sets for groups of the key sets as directed by the Supervision.

I.4 GLAZING, CAULKING AND FINISHING WORKS

I.4.1 Glazing Works

(1) Materials

The brand and quality of glass shall conform to JIS R 3201 to R 3204 or approved equivalent and shall be subject to the approval of the Supervision. The Contractor shall, if he proposes alternative products, submit catalogue and samples to the Supervision for his approval.

The type and thickness of glass shall be determined by depending on the service and the dimensions of panes so that they may safely withstand the strains and stresses to which they may normally be subjected and still fulfill their intended purpose.

(2) Installation

All panes shall be accurately cut to fit in the places with 4 mm clearance all around. All panes shall be set in vinyl glazing beads applied on all four sides for the full length and using spacer shims and clips at intervals recommended by the glass manufacturer. Panes for aluminium sashes shall be set evenly in the rebates. All panes shall be cleaned and polished when the building work is completed.

The Contractor shall be held fully responsible for any defective glass, curing of glass and all scratched, damaged or broken glass which shall be immediately removed and replaced.

I.4.2 Caulking Works

(1) Material

Caulking compound shall be of one component polysulfide base compound. Color of the compound shall generally match the color of adjacent materials. Primer and joint filler shall be of types recommended by the manufacturer of caulking compound.

(2) Application

All caulking shall be done in a manner to completely seal the joints against wind, rain and dust.

If caulking spaces exceed 13 mm in depth, their bottoms shall be packed solidly with joint filler or backstop to within 13 mm of the face of the work and then caulked with compound. These backup materials shall not adhere to the caulking compound, otherwise bond breaking tape shall be applied.

Where caulking compound comes in contact with cement, concrete, brick or other porous material, the latter shall be primed to prevent absorption of oils from the compound.

Caulking compound shall be applied with a caulking gun. Excessive caulking materials shall be removed.

I.4.3 Painting Works

(1) Materials

The Contractor shall submit catalogues and specifications of all paints to be used to the Supervision for approval.

(2) Application

All metal surfaces shall be oil painted unless other paints are specified. All steel components other than galvanized steel shall be prepared and primed in the shop and finish painted after erection.

All metal surfaces to be painted shall, prior to application of paint, be prepared in the following manner:

- All soil or other foreign matter (other than grease and oil) shall be removed by brushing or scraping.

- Oil or grease shall be removed by wiping the surface with rags or brushes wetted with an approved solvent.

- Excessive rust scale shall be removed by hand chipping or by power impact tools.

- Rough welds and sharp steel edges shall be ground smooth, and all weld spatter shall be removed.

- The whole surface shall be cleaned by means of sand blast or combination of powered steel scrapers or steel brushes and sand papers.

Immediately after completion of the surface preparation, approved primer shall be applied; two coats for the structural steels and one coat for other steels unless otherwise specified.

Spray painting equipment 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.

Painting shall not be done in rain, fog or mist, or at any other time considered unsuitable by the Supervision. All the surrounding works shall be protected in a suitable manner from paint drops and overspray.

Color shall be later designated by the Supervision. The color of primer and each finish coat shall be contrasting in order to distinguish the work progress.

Quantities of paint applied in each coat shall not be less than 0.09 kg/m^2.

The finished surface shall show a smooth and uniform finish, free from any stains and shall be uniform in color and shade.

(3) Oil paint to Steel Surface

Painting shall comprise one or two coats of anti-corrosive paint and two coats of oil paint. Sufficient time shall be allowed for drying between each new coat.

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

(4) Vinyl Emulsion Paint

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.

I.4.4 Spray Tile Finish

Spray tile shall be of a solvent base, polyester resin system reinforced with fibers. The spray tile shall be made of emulsion type epoxy resin as a main component, and asbestos, diatomite, pigment, etc. as sub-components, each conductive to good bonding, waterproofing, malleability and insulation. The spray finished surface shall be ripple, smooth and glossy.

The Contractor shall submit catalogues and samples to the Supervision for his approval.

Concrete, cement mortar or any other surface to receive the spray tile shall be cleaned of dust, laitance, loose particles or any other foreign matters and shall be ground and puttied to a smooth surface. The surfaces shall be completely dry and the surrounding structures, fitting and fixture shall be properly protected from being smeared.

The spray tile shall be applied in strict accordance with the manufacturer's instructions.

I.4.5 Interior Finishing Works

(1) Asbestos Cement Sheet

Asbestos cement sheet shall be of hard asbestos flat sheets, 6 mm thick and shall conform to JIS A 5403 or approved equivalent. The asbestos cement sheet ceiling shall include the complete metal suspending ceiling system same as specified for the rockwool acoustic tile in this Sub-paragraph. The sheets shall be fixed securely to the ceiling joist with stainless flat head screws. Joints shall be of open joints 5 mm in width, straight and uniform. Surface of the sheet shall be finished with vinyl emulsion paint as shown on the Drawings.

I.5 MISCELLANEOUS WORKS

I.5.1 Miscellaneous Metal Works

(1) General

All materials to be used for the miscellaneous metal works shall conform to JIS G 3101, SS 41 or approved equivalent, unless otherwise specified on the Drawings.

All steel faces except where embedded in concrete shall be coated with one coat of primer and two coats of oil paint unless otherwise specified.

The work shall be fabricated in the shop as far as possible. The work shall be erected true to line and straight, accurately fitted with tight joints and intersections. All works shall be reinforced where required.

Catalogues and/or shop drawings for each item shall be submitted for the approval of the Supervision.

(2) Roof Drains and Floor Drains

The building roof and floor drains shall be of cast iron body, heat coated with asphalt. Care shall be exercised in fitting 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 removal cast iron 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 larger than 1.5 times the cross-sectional area of the drain pipe. Grates shall be fixed with non-corrosive 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 roof waterproof membrane.

(3) Door Mats

Stainless steel door mat shall be provided at the porch floor in front of the entrance door. The door mat shall be of grates fabricated of stainless steel flat bars into a depth of not less than 30 mm, set in a recess provided in the floor. The recess shall be trimmed with stainless steel flat bars and provided with a drainage pipe, 50 mm in diameter and applied with asphalt coating. Polyvinyl chloride drain pipe shall be provided under the door mat recess.

(4) Steel Hooks

Steel hooks having the 1.0 ton in suspension capacities shall be provided as shown on the Drawings or directed by the Supervision.

(5) Door Sills

Door sill for steel flush door shall be made of 2 mm thick stainless steel plate with a dimension of 40 mm wide. Door sill shall be provided for in the joint between different floor finishing and installed with steel anchor lugs the full width of each door width as shown on the Drawings.

I.5.2 Miscellaneous Works

(1) Downspout

Downspouts shall be of bell-end type PVC pipe for heavy use, solvent cement connected and provided with adaptable vent for effective water flow. Downspouts shall be strongly secured to concrete columns and walls with 3.0 mm galvanized wall brackets and 2.3 mm metal straps attached by galvanized lug screws and expansion anchors. Wall brackets shall be provided for within 1,500 mm spacing.

(2) Room Name Plates

Where shown on the Drawing or as directed by the Supervision, room name plates shall be provided on the external surfaces of entrance door of each room. The name plates shall be made of acrylic resin plates having approximately 80 mm x 350 mm x 6 mm thick in size and fixed with chromium plated screws to the doors. On the plate shall be engraved the name of the room as directed by the Supervision.

(3) Skylights

Skylight shall be of ventilator type consisting of skylight dome and louvered skylight well.

The dome shall be either double or single dome formed of opaline tinted acrylic resin or tempered glass. The dome shall be bolted to the skylight well underneath which shall be constructed of steels. The well shall be louvered to serve as a gravity ventilator.

The dome and the well shall be designed to prevent storm water from driving into the room and flashing, condensation gutter and seepage outlet shall be provided to shed water outside.

Catalogs of skylight shall be submitted to the Supervision for approval.

I.6 MEASUREMENT FOR PAYMENT FOR ARCHITECTURAL WORKS

I.6.1 General

Measurement for payment and payment method hereafter specified shall be applied to the architectural work items in the Bill of Quantities. All works shall be complete in every respect finished, installed, constructed and tested in accordance with the Drawings and the Specifications and as directed by the Supervision.

All work items shall include all costs to complete to respective items including those for related works as specified and any other incidental works which are not specifically mentioned but reasonably inferable.

I.6.2 Measurement and Payment

Measurement for payment for each work item shall be made by the following methods, and payment for these shall be made at the unit prices tendered in the Bill of Quantities so established according to the measurement, which unit prices shall include the cost for all incidental works specified and as required.

	Works Item		Basis of Measurement	Incidental Works included
(1)	Concrete Works			
	(a) Concrete	:	Volume of concrete placed in cubic meters.	/Casting, compaction and initial floating to level surface.
	(b) Formwork	:	Area of formwork measured in square meters.	/Shoring and removal.
	(c) Reinforcing bars	:	Weight of steel reinforcement measured in tons.	/Bending, lapping and securing.
(2)	Masonry Works			
	(a) Concrete block wall	:	Area of concrete block wall measured in square meters.	/Bonding and filling cement mortar.
(3)	Plastering Works			
	(a) Cement mortar plaster to floor, wall and ceiling	:	Area of plastered surface measured in square meters.	/Expanding grouting and corner beads.

	Works Item		Basis of Measurement	Incidental Works included
	(b) Cement mortar plaster to skirting	:	Length of plastered surface measured in linear meters.	
	(c) Waterproof cement mortar plaster to roof, top of eaves, parapet and roof gutter	:	Area of plastered surface measured in square meters. /Waterproofing admixture, coner beads and required wire lath.	
	(d) Colored cement spray	:	Area of surface sprayed with colored cement spray measured in square meters./ Surface preparation.	
	(e) Concrete trowel finish to floor	:	Area of concrete floor surface troweled.	
(4)	Bituminous Waterproofing Works			
	(a) 3-ply built-up asphalt roofing, 2-ply built-up asphalt roofing	:	Area of surface covered with asphalt roofing measured in square meters. /Joint filler, asphalt compound and required caulking.	
(5)	Carpentry and Joiner Works			
	(a) Wooden blind box, Wooden casing for aluminium windows, Wooden ceiling trimming	:	Length of blind box, casing and trimming measured in linear meters. /Wooden blocks and required fixing devices.	
(6)	Metal Doors, Windows and Louvers			
	(a) Steel doors	:	Area of door leaves measured in square meters. /Steel frames, hardware, cement mortar grouting and caulking	
	(b) Steel louvers	:	Area of louvers measured in square meters. /Steel frames, required insect screen, cement mortar grouting and caulking.	
	(c) Aluminium windows	:	Area of windows measured in square meters. /Aluminium frames, required insect screen, hardware, cement mortar grouting and caulking.	
	(d) Aluminium louvers	:	Area of louvers measured in square meters. /Aluminium frames, cement mortar grouting and caulking.	

	Works Item		Basis of Measurement	Incidental Works included
(7)	Glazing Works			
	(a) Float glass, Wired glass, Sheet glass, Figured glass	:	Area of surface covered with glass measured in square meters.	/Glazing beads.
(8)	Painting Works			
	(a) Vinyl emulsion paint, oil paint	:	Area of painted surface measured in square meters.	/Surface preparation.
(9)	Spray Tile			
	(a) Spray tile	:	Area of surface sprayed with spray tile measured in square meters.	/Surface preparation.
(10)	Interior Finishing Works			
	(a) Asbestos cement sheet	:	Area of ceiling finished with cement sheets measured in square meters.	/Suspension frames, ceiling inspection holes and required accessories.
(11)	Miscellaneous Metal Woks			
	(a) Steel hoist hook bar	:	Number of hook bars measured in numbers.	
	(b) Roof drain, Floor drain	:	Number of drains measured in numbers.	/Mortar grouting and caulking.
	(c) Stainless steel door mat	:	Number of door mats measured in numbers.	/Fixing border angles.
(12)	Miscellaneous Works			
	(a) Polyvinyl chloride downspout, Drainage clay pipe	:	Length of downspouts and clay pipes measured in linear meters.	/Supporters and required steel fittings.
	(b) Room name plate	:	Number of name plates measured in numbers.	/Inscriptions and fixing metals.

I.7 PLUMBING AND FIRE PROTECTION WORKS

I.7.1 General

The works under this Sub-paragraph shall cover water drainage system for the inlet superstructure.

The Contractor shall carefully investigate the structural and finish conditions in Architectural Works affecting all his work and shall arrange such work accordingly, at no additional cost to the CRM.

I.7.2 Plumbing Works

(1) Pipes

(a) PVC Pipes

Polyvinyl chloride pipes shall be used for storm drain, and drainage pipes for outdoor piping. The PVC pipes shall conform to JIS K 6741 or approved equivalent. The pipes shall be laid and jointed in accordance with the manufacturer's instructions and to the Supervision's satisfaction.

(2) Painting

All hangers, supports and other iron works shall be painted with one coat of red lead primer and with two coats of oil point. Color shall be as directed by the Supervision.

I.7.3 Waste Water

Waste water from floor drains and storm water from downspout shall be discharged to drainage ditches or disposed in a subsoil drainage system as shown on the Drawings.

I.7.4 Fire Extinguishers

Fire extinguishers shall be of dry chemical, portable, 6.0 kg in capacity, CO_2 pressure operated type.

A three meter length of 6 mm inside diameter air hose rated for a working pressure of 21 kgf/cm2 with air charging valve and threaded adaptor coupling shall be provided for pressurizing the extinguishers.

Each fire extinguishers 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 electrical fires. Suitable chrome finished hooks or hangers with attachment screws shall be supplied and installed where shown or as directed by the Supervision.

I.8 VENTILATION WORKS

I.8.1 General

The works shall comprise ventilation system by outside air supply fans and exhaust fans for the inlet superstructure.

(1) Code and Standards

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

(a) Japan 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 Supervision if he proposes to deviate from the above codes or standards.

(2) Shop Drawings and Working Drawings

The Contractor shall submit for approval of the Supervision the following working drawings:

- Layout drawings of equipment including list of equipment and materials to be incorporated,
- Fabrication details of duct and detailed layout,
- Details of sleeves and opening for ducting,
- Details of supports, hangers, attachments, anchoring,
- Details of vibration isolation,
- Details of foundation for equipment,
- Detailed layout of electric wiring and conducting,
- Complete electrical connection diagrams,
- Other drawings as required by the Supervision.

(3) Data and Samples

The Contractor shall submit for approval of the Supervision a complete list of materials and equipment which he intends to incorporate in the works under this Paragraph including sufficient descriptive materials such as catalogs, cuts, diagrams, performance curves, charts, layout drawings and other data published by the manufacturer to demonstrate conformance to the Specifications and Drawings.

I.8.2 Fans

(1) Propeller Fans

Propeller fans and motors shall be supported on heavy metal frames designed for wall opening and mounting. Motors shall have totally enclosed enclosures. Gravity dampers and rainhood shall be provided on the exterior side of wall. Remote manual switch with pilot indicating light shall be provided where indicated.

(2) Ceiling Mounted Duct Type Fans

Fans shall be of turbo type or axial flow type against static pressure and complete with totally-sealed motor. All parts shall be protected by application of high quality enamel paint.

(3) Multiblade Fans

Air supply and exhaust fans for substructure shall be floor mounted, V-belt driven, multi-blade type centrifugal fans with compete vibration isolating base and accessories having the capacities as shown on the Drawings.

I.8.3 Duct Work

(1) General

Duct work shall be constructed of galvanized steel sheets. Ducts, unless otherwise approved, shall conform to the dimension indicated and shall be straight and smooth on the inside with joints neatly finished. Ducts shall be made substantially airtight at all joints connections, grilles, register, or diffusers.

(2) Duct Construction

Curved elbows shall have a centerline radius not less than 1-1/2 times the width or diameter of the duct.

Laps at the joints shall be made in the direction of air flow. Button punch or bolt connections in standing seams shall be spaced at fixed centers not greater than 150 mm. Horizontal locks or seams of the type known as "Button Punch Snap Lock" may be used in lieu of "Pittsburgh Lock".

Transformations shall be made with side pitches not to exceed a maximum of 20 degrees, 49 degrees included angle for diverging air flow and 30 degrees, 60 degrees included angle for covering air flow, or as indicated.

Duct and stiffeners shall be constructed of steels of thickness and fabrication indicated in Table I-2 for rectangular ducts.

Air deflector shall be provided in all square elbows, duct-mounted supply outlets, takeoff or extension collars to supply outlets, and tap-in branch-takeoff connections. Air deflectors shall be factory-turning vanes or louver blades for uniform air distribution and change of direction with minimum turbulence and pressure loss.

(3) Duct Access Doors

Hinged doors shall be provided at all air control dampers, fire dampers and other apparatus requiring service and inspection in the duct system. Doors shall be 35 cm x 45 cm unless otherwise indicated. Where size of duct will not accommodate this size, the doors shall be made as large as practical.

Table I-2 Sheet Metal Thickness for Rectangular Duct Construction (Low Velocity System)

Galvanized Sheet Gage and Thickness mm	Longer Side of Duct in	Bracing
26 0.5	15-45	None
24 0.6	46-75	25 x 25 x 3 girth angle reinforcing spaced on 180 cm max. Centers
22 0.8	75-150	30 x 30 x 3 girth angle rein-forcing spaced on 90 cm max. Centers
20 1.0	151-225	40 x 40 x 3 girth angle rein-forcing spaced on 90 cm max. Centers
18	226 & over	40 x 40 x 5 girth angle rein-forcing spaced on 90 cm max. Centers

Notes: Ducts with longer sides of 500 mm and over shall have angle flanged joint.

All fittings shall be continuous weld constructions.

I.8.4 Miscellaneous Units

(1) Goosenecks and Rainhoods

Goosenecks and rainhoods shall be fabricated from galvanized steel sheets, and shall be provided with frames and steel structural shapes. Bird insect screens shall be provided where indicated. Sheet metal fabrications shall conform to Sub-paragraph I.8.3, Duct Work specified hereinbefore. Thickness of sheet metal shall be as indicated.

(2) Dampers

(a) General

All damper frames shall be constructed of 16 gage galvanized sheet metal, and shall have flanges for duct mounting. The blades shall be parallel or opposed, as required, and suitable for the air velocities to be encountered in the system. Replaceable edge seals shall be provided with the damper, installed along the top, bottom and sides of the frame and each blade.

(b) Manual Dampers and Splitters

Manual dampers with locking quadrants shall be installed where indicated or necessary for proper control and balancing of air distribution. All dampers shall have an accessible operating mechanism. Splitter dampers shall be operated by quadrant operators or steel rod brought through the side of the duct with locking set-screw and bushing. Manual volume control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be two gages heavier than duct in which installed. Unless otherwise indicted, multileaf dampers shall be opposed-blade type with maximum blade width of 300 mm. Splitter dampers shall be of sufficient length to close off either branch duct.

(3) Diffusers, Register and Grilles

(a) General

Diffusers, register, and grilles shall be the approved products of a manufacturer regularly engaged in the manufacturer of such products and shall be factory-fabricated of steel or aluminium and shall distribute the specified quantity of air evenly over space intended, without causing noticeable drafts, air movement faster than 0.5 m/sec. in occupied zone, or dead spots anywhere in the conditioned area. The Contractor shall be responsible for diffusion, spread, drop, and throw. Diffusers and registers shall be provided with opposed-blade volume controller with accessible key operator unless otherwise indicated.

(b) Diffusers

Diffusers shall be round, square, rectangular, slop strip-shape or perforated-face type with fixed or adjustable air discharge pattern as indicated. Ceiling mounted units shall minimizes ceiling smudging through design features.

(c) Register

Registers shall be four-way directional-control type except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply-register face.

(d) Grilles

Grilles shall be as specified herein for registers, without volume-control damper.

(e) Louvers

Louvers blades shall be fabricated from aluminium or steel sheets, and shall be provided with frame or structural shapes. Blades shall be accurately fitted and firmly secured to frames. Edges of louver blades shall be folded or beaded for rigidity and baffled to exclude driving rain. Louver shall be provided with bird screen where shown on the Drawing. Sheet metal thickness shall be as indicated.

(4) Apparatus Connections

Where sheet-metal connections are made to fan, plenum chamber or the like, a noncombustible flexible connection of woven asbestos or other approved noncombustible material approximately 150 mm in width, shall be installed. For rectangular ducts the flexible connections locked to metal collars shall be installed using normal duct construction methods.

(5) Duct Supports

Duct supports shall not less than two steel hangers spaced in accordance with Table I-3. Supports on the risers shall allow free vertical movement of the duct.

Table I-3 Duct Supports for Rectangular Duct

Galvanized Sheet Gage and Thickness mm	Angle Support mm	Max. Spacing cm
26 0.5	25 x 25 x 3	300
24 0.6	25 x 25 x 3	300

Table I-3 Duct Supports for Rectangular Duct

Galvanized Sheet Gage and Thickness mm	Angle Support mm	Max. Spacing cm
22 0.8	30 x 30 x 3	300
20 1.0	40 x 40 x 3	300
18 1.2	40 x 40 x 5	300

Notes: Hangers shall be steel rod 9 mm in diameter.

I.8.5 Tests

(1) General

Upon completion of the ventilation system, and at a time designated by the Supervision, the entire system shall be performance-tested as hereinafter specified. The tests shall be conducted in the presence of the Supervision. Procedures for conducting of the tests shall conform to the applicable standard. The Contractor shall furnish all instruments, test equipment, water, electricity and personnel that are required for the tests at no extra cost to the CRM.

(2) Performance

After the foregoing test have been completed, tests to demonstrate the capacity specified and general operating characteristics of all equipment shall be conducted by a competent experienced expert in the presence of the Supervision. The tests shall cover a period of not less than 3 days for each system and shall demonstrate that the entire system is functioning in accordance with the Drawings and Specifications. Corrections and adjustments shall be made as necessary to produce specified conditions.

Controls	:	Setting and performance of automatic or safety controls
Multi-blade Fans	:	Electric power output of fan motor
		Air quantity
		Air speed

I.8.6 Spare Parts

The Contractor shall furnish the following spare parts with the equipment and hand over to the CRM at the time of field instruction services.

(1) For multi-blade fans (for each) : One set of V-belt

I.9 MEASUREMENT AND PAYMENT FOR BUILDING SERVICE FACILITIES

Measurement for payment for each work item shall be made by the following methods, and payment for these shall be made at the unit prices tendered in the Bill of Quantities so established according to the measurement, which unit prices shall include the cost for all incidental works specified and as required.

	Works Item		Basis of Measurement	Incidental Works included
(1)	P.V.C. pipes	:	Length of pipe measured in linear meters.	/All fittings, supports, hangers and earth works.
(2)	Fire extinguishers	:	Number of fire extinguishers measured in numbers.	/All accessories specified.
(3)	Galvanized steel pipes for drain	:	Length of drain pipe measured in linear meters.	/All fittings, supports, hangers, insulations, painting and sleeves.
(4)	Multi-blade type air supply fan and exhaust fan	:	Number of fan measured in numbers.	/Concrete foundation, vibration isolating base and required accessories.

	Works Item		Basis of Measurement	Incidental Works included
(5)	Wall mounted propeller type air supply and exhaust fans	:	Number of fan measured in numbers. /Wooden frame, gravity shutter, rainhood and painting.	
(6)	Ceiling mounted duct type fans	:	Number of fans measured in numbers. /Hangers, supports, intake grille, air filter and required accessories.	
(7)	Galvanized steel sheets	:	Area of steel sheet measured in square meters. Seams and bends at joints shall not be counted in the measurement. Openings for air diffusers, grilles or the like shall not be deducted from the area of steel sheets. /All supports, hangers, sleeves, painting, reinforcement metals and inspection doors.	
(8)	Grilles	:	Number of grille measured in numbers.	
(9)	Volume damper, fire damper	:	Number of damper measured in numbers.	
(10)	Air filter for multi-blade type air supply fan	:	Number of air filter measured in numbers. /Aluminium casing and metal wire lath.	
(11)	Spare parts and consumables	:	Total cost measured in lump sums. /Spare parts, stand-by equipment and consumable as specified.	

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SECTION J

ELECTRICAL WORKS

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SECTION J ELECTRICAL WORKS

J.1 GENERAL

The lighting and ancillary electrical equipment shall be provided for the Conguillo inlet structure as shown on the Drawings or as directed by the Supervision. The following apparatus and materials shall be furnished and installed to complete the lighting and ancillary electrical equipment in the inlet structure;

(1) Panel Boards

(a)	Lighting Panel	:	For lighting and convenience outlet circuits as shown on the Drawings

(2) Lighting Fixtures

(a)	Type A	:	Pipe pendant fluorescent light, 40 W x 2
(b)	Type B	:	Ceiling or wall surface mounted fluorescent light, 40 W x 1
(c)	Type F	:	Wall mounted incandescent light with opal glass or plastic globe, 60 W x 1

(3) Switches and Outlet

(a)	Convenience Outlets	:	Wall mounted, duplex outlet, 127 V and 20 A
(b)	Tumbler Switches	:	127 V and 10 A

(4) Conduits

(a)	Rigid Steel Conduits	:	f 16 mm and f 22 mm (or f 1/2" and f 3/4")

(5) Wires and Cables

(a)	IV Wires	:	600 V grade, PVC insulated single core wire, 2.0 mm2 and 3.5 mm2 (or 14AWG and 12 AWG)
(b)	CV Cables	:	600 V grade, thermoplastic polyethylene insulated and PVC sheathed, multi-core cable, 4 C x 3.5 mm2 (or 4 x 12 AWG)

(6) Grounding System

The grounding system of the Conguillo inlet structure shall be installed refering to the general plan as shown on the Drawings.

The grounding system shall comprise copper conductor mesh covering the inlet structure and grounding rods/plates as required. The lead conductor to connect the equipment to the mesh shall also be provided.

The Contractor shall design and submit drawings for approval to the Supervision. The target grounding resistance shall be less than 5 ohm.

The Contractor shall supply all materials and equipment necessary to complete the electrical system of the inlet structure.

J.2 ELECTRICITY SUPPLY

The power for lighting and auxiliary power equipment shall be of 3 phase, 4 wire, 220 V or single phase, 127 V, 60 Hz. The power will be supplied from the diesel engine generator provided under the other contract.

J.3 REQUIREMENTS FOR MATERIALS AND EQUIPMENT

(1) Standard and Approval

Unless otherwise specifically provided herein, all electric materials and equipment shall comply with the requirements of the latest revisions of Japanese Standards and any other standards authorized by the Supervision. The Contractor shall obtain approval of the Supervision if he proposes to deviate from the said standards.

The equipment and materials shall be subjected to tests at the manufacturer's factory before shipment and test records shall be submitted to the Supervision as instructed to do so.

As far as practicable all similar equipment shall be interchangeable.

(2) Electric Power Source

The power source shall be A.C. 220/127 V, 3-phase, 4-wire and 60 Hz.

(3) Panel Boards

Electric circuits for panels shall conform to the Drawings. The panels shall be dead-front, no-fuse circuit breaker type, sheet steel made with locks and ventilators. Phasing marks shall be indicated.

Circuit cards shall be provided in card holders in the panel. No-fuse circuit breakers shall have sufficient interrupting capacity to protect the circuits on an electrical fault.

The lighting panel shall be furnished with the apparatus shown on the Drawings.

(4) Wires and Cables

Insulated wires shall be of 600 V, PVC insulated single-core copper wire. Insulated wires shall have a minimum size of 2.0 mm2 of 14 AWG, stranded conductor.

Low tension cables shall be 600 V cross-linked polyethylene insulated and PVC sheathed cable (CV cable) and conductors shall be stranded and larger than 2.0 mm2.

(5) Conduits

Conduits shall be of rigid steel, galvanized inside and outside and enamelled inside, or of galvanized rigid steel coated with epoxy resin inside. They shall have a minimum inside diameter of 16 mm or 1/2 inch.

(6) Outlet, Switch and Junction Boxes and Fittings

The boxes to be concealed in concrete shall be of galvanized sheet steel and shall be fitted with appropriate covers where necessary to set flush with the finished surfaces of the structures. The boxes in the exposed work shall be of galvanized, cast steel or alloy fitted with appropriate covers.

(7) Convenience Outlets

Convenience outlets shall be of duplex outlet type suitable for 2-blade plug for single-phase, 127 V, 20 A, and provided with suitable outlet box cover and stainless cover plates.

(8) Tumbler Switches

Wall switches shall be of enclosed flush or surface mounting tumbler type, single pole, 127 V, 10 A, and shall be fully recessed within the box fitted with suitable plates for covering them.

(9) Lighting Fixtures

Lighting fixtures shall be complete with lamps, and shall comply with the following:

Fluorescent lighting fixtures for A.C. 127 V shall be equipped with ballasts of high power factor and of rapid-start type for 40 W.

Mercury lighting fixtures for A.C. 127 V shall be equipped with screwed base lamp holders, ballasts of high power factor for stable operation.

Incandescent lighting fixtures shall be equipped with complete fittings for A.C. 127 V.

The lighting fixtures for the valve room shall be of water-proof type and for outdoor use shall be of weather-proof type. Special care shall be exercised on selection of fixtures to prevent accumulation of insects and dust.

(10) Lighting Supports

Lighting supports shall be steel poles galvanized outside and inside. The shape and size of poles shall be as shown on the Drawings. Ballasts, cut out switch and terminal shall be equipped in the pole and other attachments necessary for wiring and fixing of the lighting fixtures shall also be supplied.

(11) Grounding System

The Contractor shall provide and install the following materials but not limited to;

- Bare annealed copper conductor of 50 mm2 or 1/0 AWG for the ground mesh and 38 mm^2 or 2 AWG for lead wire to the low voltage equipment.

- Copper plates of 1.0 x 1.0 m with a thickness of 3 mm, provided with lead wire, copper plated steel rods of 1.5 m or over in length and with a diameter of 14 mm or over may also be used for lessening the grounding resistance.

- Connectors of compression type suitable for connecting the above conductors.

J.4 SPARE PARTS

(1)	Cables and conduits	:	5 % for each size
(2)	Lighting fixtures	:	5 % or min. 1 set for each type
(3)	Bulbs and tubes	:	300 %
(4)	Lighting supports	:	1 no. for each type
(5)	Fuses	:	300 %
(6)	Others	:	As recommended by the manufacturers

J.5 INSTALLATION WORKS

All installation works shall be carried out in accordance with the requirements of these Specifications or as directed by the Supervision.

(1) Conduits

Conduits shall be concealed within the walls, ceilings and floors where possible. Exposed runs of conduit shall have supports spaced at not more than 150 cm. Conduit shall be securely fastened to all sheet outlets, junction and pull boxes with galvanized lock nuts

bushings. Exposed conduits shall be finished with the same color of the wall or ceiling against which the conduits are placed.

(2) Wiring

Where an underground cable crosses a roadway, it shall be suitably protected against damage from heavy traffic. Suitable cable route markers shall be provided at 10 m spacing for short runs and at 20 m spacing for long runs.

(3) Switches

The height of switches above floors shall be 120 cm.

(4) Lighting Fixtures

Electric tubes and bulbs shall be installed when directed by the Supervision.

(5) Grounding System

The mesh conductors shall be directly buried in the ground at least 0.8 m below ground surface. The grounding plates shall be placed horizontally in the ground at least 1 m below ground surface. The grounding rods shall be driven into the ground a minimum of 2.5 m. Grounding lead conductor for electrical equipment and other facilities shall be provided at the location close respective equipment. Connection for electrical equipment and other facilities will be carried out by the Contractor supplying the equipment.

J.6 TEST

The following tests shall be carried out by the Contractor after completion of the installation works.

(1) Test such as specified in applicable standards
(2) Continuity test
(3) Measurement of insulation resistance
(4) Switching and operation test

J.7 MEASUREMENT AND PAYMENT

Measurement for payment for each work item shall be made by the following methods, and payment for these shall be made at the unit prices in the Bill of Quantities so established according to the measurement, which unit prices shall include the cost for all incidental works specified and tests as required.

Measurement and payment for grounding system shall be made for the length of 50 mm^2 copper conductor measured in meters at the unit price per meter stated in the Bill of Quantities, which the unit price shall constitute full compensation for the cost of all labor,

tools, equipment and materials, including those for the measurement of grounding resistance and any other items necessary to complete the works.

	Works Item		Basis of Measurement	Incidental Works Included
(1)	Panels	:	Number of panels measured in sets. /All mounting devices, support, frames, bonding, installation and connections	
(2)	Lighting fixture	:	Number of fixtures measured in sets. /All lamps, fittings, bonding, supports, hangers, penetration and repair ceiling, reinforcement of ceiling suspension and installation.	
(3)	Switches and outlets	:	Number of switches and outlets measured in sets. /All fittings, boxes, bonding, support and installation.	
(4)	Wires and cables	:	Length of wires or cables measured in linear meters. /All joint materials and installation.	
(5)	Conduit pipes	:	Length of conduit pipes measured in linear meters. /All fittings, bonding, supports, paint finish, sleeves and installation.	

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SECTION K

MEASURING APPARATUS

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SECTION K MEASURING APPARATUS

K.1 GENERAL

The Contractor shall furnish, install, maintain and take readings of instruments for the detection of ground movements and the detection of deformations in underground excavations.

The instruments to be supplied, installed and maintained shall be convergence bolts for measuring horizontal and diagonal convergence, roof settlement and invert upheaval; stress measuring anchors and strain gauges for measuring stress of rock bolts; disk load cells for measuring stress of steel supports; hydraulic pressure cells for measuring stress of shotcrete; together with all required measuring equipment, such as leveling survey equipment, steel tape, dial gauge, transducer, etc., for reading.

All readings and measurements shall be taken by the Contractor to monitor deformations of the underground excavations and surrounding ground in order to evaluate ground stability. The data shall be submitted, in an approved form, to the Supervision on a daily basis. The Supervision may direct adjustments of support elements or modifications to the excavation plan on the basis of the observed data.

Damaged or missing instruments shall be repaired or replaced by the Contractor as soon as possible at no additional cost to the CRM.

K.2 CONVERGENCE MEASUREMENTS

Convergence bolts shall be securely attached to exposed rock or shotcrete surface within the underground excavation, and located such that pairs of bolts are at directly opposite sides of the opening and as shown on the Drawings or as directed in other underground excavations. A tape extensometer with dial gauge shall be used to connect between convergence bolts in tunnels and other underground structures to monitor the change in size of the opening, if any, occurring during the period between excavation and construction of the final lining.

The Contractor shall supply and install convergence bolts in the pattern indicated above or as directed. The convergence bolts shall be installed as soon as practicable after the tunnel, shaft or underground structure has been excavated and supported, and generally within 5 m of the working face.

Convergence bolts shall be approved non-corrosive bolts compatible with the approved convergence measuring devices, and shall be installed in accordance with the manufacturer's instructions. The chainage, offset and elevation of each convergence bolt shall be established to within 25 mm by the Contractor.

The measuring device shall be an "OYO type" tape extensometer in Japan or approved equivalent. Two (2) tape type extensometers shall be provided by the Contractor.

Measuring shall be made twice daily until the heading has advanced five (5) times the tunnel width, or as directed by the Supervision, and weekly thereafter until the final underground excavation lining is constructed.

K.3 ROOF SETTLEMENT AND INVERT UPHEAVAL MEASUREMENTS

The roof settlement and invert upheaval measurements will be used to monitor the changes in size of the opening of underground structures and the effectiveness of primary support. The measurements shall be made by means of leveling.

The Contractor shall supply and install 12 mm diameter x 200 mm long grouted stainless steel bolts in crown or invert portion as shown on the Drawings or as directed by the Supervision, and take survey leveling measurement.

Measurements shall be made twice daily until the heading has advanced five (5) times the tunnel width and weekly thereafter until the final underground excavation lining is constructed.

K.4 STRESS MEASURING ANCHORS FOR ROCK BOLT LOADS

Stress measuring anchors shall be installed at specified locations and used to monitor the rock bolt loads. Readings shall be taken weekly or as directed by the Supervision.

The Contractor shall supply, install and test stress measuring anchors as shown on the Drawings or directed by the Supervision, and take readings. The anchors shall be installed and tested in accordance with the manufacturer's recommendations. Measurement of the elongation of anchors shall be done using a dial gauge or a strain gauge, and load determined from an anchor load versus dial gauge reading calibration curve.

The stress measuring anchors shall be MMA or EMA type (mechanical or electrical type) average stress measuring anchors produced by "SHINGIJUTSU KEIKAKU CO., LTD.," in Japan, or approved equivalent, and with a 14 ton design capacity.

K.5 DISK LOAD CELLS FOR STEEL SUPPORT LOADS

Disk load cells shall be installed at the crown portion of steel supports at specified locations in the underground excavations, and used to monitor the steel support loads. The Contractor shall supply, install and test disk load cells as shown on the Drawings or as directed by the Supervision. Readings shall be taken daily from installation of the steel supports until completion of the shotcrete lining, and weekly thereafter until completion of the concrete lining. Readings of the disk load cells shall be done by means of a strain/stress transducer unit. Two (2) transducer units shall be provided by the Contractor.

The disk load cells for steel support shall be ME 960 type load cells produced by "INTERFELS GMB/H", or approved equivalent, with a nominal load of 20 ton and a maximum load of 24 ton.

K.6 HYDRAULIC PRESSURE CELLS FOR MEASUREMENT OF STRESS OF SHOTCRETE

The Contractor shall supply, install, measure and test hydraulic pressure cell assemblies at the specified locations in the underground excavations, as shown on the Drawings or as directed by the Supervision. The hydraulic pressure cell assemblies shall be installed and tested in accordance with the manufacturer's recommendations, at the interface between rock and shotcrete and inside the shotcrete in order to measure radial pressure and tangential pressures.

The hydraulic pressure cells shall be of two types:

- Contact pressure cell for interface between the rock and shotcrete or concrete lining (50 kgf/cm2 capacity)

- Stress cell unit for embedment in shotcrete or concrete lining (200 kgf/cm2 capacity)

The cells to be used shall be proposed by the Contractor and approved by the Supervision.

The cells shall be installed in accordance with the manufacturer's instructions. Readings shall be taken daily initially then weekly thereafter or as directed by the Supervision.

A portable manual hydraulic readout unit shall be provided complete with a hand-operated hydraulic pump, flow controller, pressure gauge, valves, etc., all mounted in a carrying frame.

K.7 MEASUREMENT AND PAYMENT

Measurement and payment for supplying and installing instruments, and the measurement and recording of the convergences, roof settlement and invert upheaval, stress measuring anchors, disk load cells, and hydraulic pressure cells, will be made of the actual numbers of measurements as directed and approved by the Supervision at the respective unit prices per number tendered therefor in the Bill of Quantities. Provided that the actual numbers of measurements for horizontal and diagonal convergences shall mean the number of sections of which the convergence bolts are installed for measurements.

No separate payment will be made for taking measurements and reading instruments, for providing access (including staging, etc.) to obtain measurements and readings, for recording and submitting data, or for any other work required to meet the requirements of this Section.

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SECTION L

MISCELLANEOUS

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SECTION L MISCELLANEOUS

L.1 TRASH BOOMS FOR RESERVOIR

L.1.1 General

The Contractor shall furnish, install and float the trash booms on the reservoir as shown on the Drawings or as directed by the Supervision.

The trash booms shall consist of drums as floats, wire ropes, wire clips, chains, shackles, angles welded on the drums, concrete anchor blocks, and embedded steel metals in the blocks.

The drums shall conform to JIS, ASTM or approved local standard, having dimension of 58 cm in diameter, 88 cm in length and 2 mm in thickness. The drums and other steel surface shall be painted with one coat of anticorrosive primer and two coats of oil paint. Sand and gravel shall be filled in the drums as balance weight.

The wire rope shall be galvanized, flexible, improved plough steel wire type with grease impregnated fiber core.

The drums shall be connected with the drums by the clips, chains, shackles and angles welded on the drums. All materials to be incorporated in the metalwork required in this Paragraph shall be approved by the Supervision and shall conform to the JIS standards or approved equivalent.

The construction of anchor blocks shall conform to the Section E, Concrete Works.

L.1.2 Measurement and Payment

Measurement, for payment, of trash boom will be made of the length in linear meters along the centerline from end to end of trash boom in place. Payment will be made at the unit price per linear meter tendered therefor in the Bill of Quantities, which the unit price shall include all cost of labour, materials and equipment for furnishing and installing the trash boom with connecting materials and other work specified in this Paragraph. Provided that payment for trench excavation, backfilling, concrete works and embedded steel metals will be made separately under the appropriate work items in the Bill of Quantities.

L.2 WATER LEVEL STAFF GAUGE

L.2.1 Material and Installation

The Contractor shall furnish and install water level staff gauges at locations as shown on the Drawings or as directed by the Supervision. The staff gauges shall consist of steel pipes, 100 mm in diameter and 20 m in total length, and concrete foundations.

The steel pipes shall conform to JIS, ASTM or approved local standard stipulated in Section H, Miscellaneous Metal Works. The surface of steel pipes shall be painted with one coat of anticorrosive primer and two coats of oil paint as shown on the Drawings of as directed by the Supervision.

The Contractor shall set the staff gauges vertically by accurate levelling from the designated bench marks. Excavation and backfilling, and concrete foundation shall conform to the applicable provisions stipulated in Section C, Earth Works and Section E, Concrete Works.

L.2.2 Measurement and Payment

Measurement and payment of the water level staff gauges will be made on the lump sum basis.

Payment will be made upon completion of the water level gauges based on the lump sum price tendered therefor in the Bill of Quantities, which the lump sum price shall include the cost of all labor, tools, equipment and materials including supplying and setting the gauge staff pipes, painting, excavation and backfilling, and foundation concrete and other costs necessary to complete the work.

L.3 DREDGING OF THE EXISTING INLET CHANNEL

L.3.1 General

This Paragraph covers dredging, hauling and disposing the dredged materials (silt) within the limit of the construction area shown on the Drawings or directed by the Supervision.

The term "dredging" means all required underwater excavation performed by methods other than open-cut excavation and underground excavation below the water surface elevations indicated in the cross sections of inlet channel as shown on the Drawings or directed by the Supervision.

The Contractor shall submit to the Supervision for his approval not later than three (3) months before starting the dredging operations, his proposed method and sequence of dredging, details of the construction equipment, notices, etc.

The method adopted shall be such as to enable the completion of the Works on time and to the satisfaction of the Supervision.

L.3.2 Study of Site Conditions

The Contractor shall be deemed to have examined the information to him critically and to have satisfied himself as to the nature and amount of material to be dredged and other local conditions such as removal of water hyacinths from the existing reservoir surface, current laws and regulations which may affect his dredging operations and any other matter or thing which may affect the Works.

L.3.3 Method of Survey

The Contractor shall execute the surveys from time to time jointly with the Supervision using a boat fitted with an approved type of echo sounder (minimum accuracy of 0.10 m), staff, sounding lead and positioning, for which purpose the Contractor shall provide operators who have been trained for the equipment.

Cross section survey in the inlet channel shall be made at specified cross lines as shown on the Drawings or directed by the Supervision.

Bar calibration of the echo sounding equipment shall be carried out prior to the commencement of each day's surveying and at such other times as the Supervision may direct and the corrections shall be agreed between the Contractor and the Supervision.

L.3.4 Initial Survey

Before dredging commences the Contractor in the presence of the Supervision shall jointly survey, including taking soundings, the whole area to be dredged including spoil bank areas. Sounding shall be taken at 20 m intervals for spoil banks and inlet channel and, if during the progress of the works the Supervision or the Contractor shall so desire, additional soundings shall be taken at the intermediate section of between cross lines initially designated. The results shall be recorded on a drawing which shall be prepared by the Contractor and shall, together with similar surveys to be prepared on completion of the work, from the basis for ascertaining the measured quantities of the materials dredged and employed for spoil banking.

L.3.5 Method of Dredging

The Contractor shall dredge the inlet channel to the lines and grades as shown on the Drawings or directed by the Supervision. For the purpose of positioning of dredges the Contractor shall provide and maintain a sufficient number of reference points and bench marks on site. The Contractor shall set up such points and marks in suitable positions and, he shall protect the points and marks to prevent access from unauthorized persons or from destructions, all to the approval of the Supervision.

Any obstacles encountered by the Contractor during dredging operations shall be removed by the Contractor and the time taken in clearing such obstacles or by moving the dredge to other area will not be acceptable as a reason for delay in completion of the works.

The Contractor shall dredge the inlet channel to the full depth and width required and shall finish uniformly within the tolerance for dredging limit as specified hereinafter. On the flat and sloping faces as shown on the Drawings, tolerance of dredging shall be attained to + 0.1 m ~ - 0.2 m measured vertically.

The Contractor shall dredge and keep the cross sectional areas of the inlet channel as indicated on the Drawings or directed by the Supervision. No material shall remain

undredged above the upper tolerance limit and no material shall be dredged below the lower tolerance limit.

L.3.6 Disposal of Dredged Material

Dredged spoil shall not be deposited in any area other than the spoil banks indicated on the Drawings or such other spoil ground as may subsequently be directed by the Supervision. The method of transporting the dredged material shall be such as to obviate any deposition of material in the reservoir.

On slopes of the spoil banks, the Contractor shall place fascines so as to prevent the spillage of the spoiled materials as approved by the Supervision. Fascines shall be fastened or fixed with stakes not less than 2.0 m into the ground or filled materials. Height and stay wire of the fascines shall be approved by the Supervision.

L.3.7 Measurement and Payment

Measurement, for payment, of dredging of the existing inlet channel will be made to the prescribed dimensions and to the depth of excavation, as shown on the Drawings or as directed by the Supervision, in accordance with the provisions of this Paragraph.

Payment will be made upon completion of the dredging and against approved volume by the Supervision at the unit price per cubic meter tendered therefor in the Bill of Quantities, which the unit price shall constitute full compensation for the cost of all labour, tools, equipment and materials including surveying, removal of water hyacinths, dredging, transporting and disposal of the material, provision of facines and other items necessary to complete the work.