SUPPLEMENTAL SPECIFICATIONS TO:

DPWH STANDARD SPECIFICATIONS FOR HIGHWAYS, BRIDGES AND AIRPORTS, VOLUME II, 2013 EDITION

CONTRACTORS SHALL PURCHASE THE DPWH STANDARD SPECIFICATIONS STATED ABOVE. THIS STANDARD SPECIFICATIONS SHALL FORM PART OF THE CONTRACT DOCUMENTS AND SHALL BE READ IN CONJUNCTION WITH THIS SUPPLEMENTAL SPECIFICATIONS AND THE SPECIAL PROVISIONS OF THE STANDARD SPECIFICATIONS.

INTRODUCTION

The Specifications describe in detail the work to be executed, the character and quality of materials, workmanship and the specific responsibilities of the Contractor that are not covered by the Conditions of Contract. It includes the Technical Specifications, the DPWH Standard Specifications and Supplemental Notices or Addenda, if any, and shall be read in conjunction with the Plans and all the other Contract Documents.

The **Specifications** comprise of the DPWH Standard Specifications, the Supplemental Specifications and the Special Provisions. Conformity to standardized Pay Items of Works has been adapted in reference to **DPWH Department Order No. 5, series of 2017.**

Pertinent notes appearing in the **Contract Plans** or **Drawings** shall also be considered as part and parcel of the technical specifications. Such notes shall take precedence over the General Specifications and the Special Provisions. Further amendments to the Specifications, if necessary, shall be furnished by means of **Supplemental Notice(s)**.

The Technical Specifications comprise of the following parts:

- DPWH STANDARD SPECIFICATIONS FOR HIGHWAYS, BRIDGES AND AIRPORTS, VOLUME II, 2013 EDITION

- DPWH STANDARD SPECIFICATIONS FOR PUBLIC WORKS STRUCTURES, VOLUME III, 1995 AND SPECIAL PROVISIONS

Pertinent notes appearing in the Contract Plans or Drawings shall also be considered as part and parcel of the Technical Specifications.

Any further amendments to the Specifications and to any other Document, if necessary, will be furnished to the Contractors by means of Supplemental Notice or Addendum.

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VOLUME II STANDARD SPECIFICATIONS

A. GENERAL REQUIREMENTS

The following subsections on Offices and Laboratories for the Engineer of the DPWH Standard Specifications (2013 edition) is replaced and revised as follows:

A.1.1 Offices, Laboratories and Living Quarters for the Engineer

Modify this Sub-Section to read as follows:

A.1.1 (7) Provision of Combined Field Office and Laboratory Building for the Engineer (Rental Basis)

The Contractor shall provide and maintain field offices and testing laboratories, including all the necessary electricity, water drainage and telephone services for the use of the Engineer and his staff. The offices and laboratories shall have at least the floor area prescribed by the Engineer and shall contain the equipment, supplies and furnishing that will be needed in all types of testing particularly for soil density, concrete sampling and testing, cement testing, aggregates, etc. However, the contractor may have an option to test their samples on accredited testing laboratory by DPWH. The Contractor shall submit the list of laboratory equipment to the Engineer or DPWH Materials Testing Equipment for approval and shall be placed in testing laboratory. All offices and laboratories shall be ready for occupancy and use by the Engineer within two (2) months of the commencement of the Works. The location and final plan of the Offices and Laboratory shall require the approval of the Engineer prior to the start of construction. It is the intent of this Specification to locate the field offices and laboratories in government owned lots so that the use by the government of these facilities can be maximized even after the completion of the project. However, if no government lot is available, and these structures are to be erected on private property, it is the responsibility of the Contractor to make the necessary arrangements with the landowner(s) regarding the use of the lot for the Engineer's office and laboratories and to remove and/or transfer, if so required under the Contract, the improvements thereon, including all appurtenances upon completion of the Works.

All facilities provided by the Contractor shall be near the job site, where necessary and shall conform to the best standard for the required types. On completion of the Contract, the facilities provided by the Contractor including office equipment, apparatus, pieces of furniture, laboratory equipment, etc, unless otherwise specified in the Contract documents.

The Contractor shall be responsible for raising the ground (if necessary), grading and drainage in the vicinity of each facility with suitable access walkways, seeding and sodding of the ground around as directed and approved by the Engineer. Also, the Contractor shall construct a parking area for the compound near the buildings and a satisfactory access road to the parking areas.

A.1.1 (16) Operation and Maintenance of Field Office for the Engineer

The Contractor shall be responsible for the maintenance and protection of all facilities to be provided during the duration of the Contract, including providing adequate stock of all expendable items, such as light bulbs, light tubes,

laboratory equipment and supplies at all times to ensure proper and continuous functioning of all the Engineer's facilities.

The whole area of the Engineer's compound shall be fenced with barbed wire (or equivalent) with necessary gates as directed by the Engineer.

The Contractor shall provide suitable utilities and services, such as potable water, electricity, sewerage and security on a 24-hour basis.

A.1.3(4) The Contractor shall provide qualified and experienced laboratory staff to carry out all the materials quality control and all the tests specified in the Contract and required by the Engineer. The person so appointed by the Contractor to manage the laboratory shall be well experienced in the type of work to be undertaken and shall be subject to the approval of the Engineer. He shall work full time and shall be responsible to the Engineer for all works carried out.

The telephone service, if required in the Contract shall have a separate connection direct to the telephone company's telephone exchange single line for the exclusive use of the Engineer and his staff.

The Contractor shall provide, if required in the Contract, a two-way radio communication service.

Any portable offices required in the Contract shall be dismantled, moved and erected from time to time as directed by the Engineer.

All offices, stores and testing laboratories shall be proficiently guarded at all times of the day and night, regularly and properly cleaned, adequately supplied and maintained for the duration of the Contract.

A.1.2(2) Provision of 4x4 Pick Up Type Service Vehicles for the Engineer (on Bare Rental Basis)

The Contractor shall provide within thirty (30) calendar days after notice to commence work, the vehicles listed in the Schedule D (Transport Equipment) for the exclusive use of the Engineer. The vehicles to be provided by the Contractor shall be to the satisfaction of the Engineer. The vehicle shall comply in all respects with all relevant Philippine national or local laws statutes and regulations. The vehicle shall carry or be fitted with the accessories as may be prescribed by laws and have comprehensive insurance. The vehicle on delivery shall be new and shall be driven by a competent qualified and experienced driver who shall be under the direct order of the Engineer.

A.1.2(5) Operation and Maintenance of Vehicles for Engineer

The contractor shall maintain the vehicle in first class condition and shall be supplied with appropriate fuel and lubricants at all times.

He shall provide equivalent substitute vehicles during any period when the specified vehicles are taken out of service for maintenance, repair or any other reason. The vehicle shall be turned over to the Procuring Entity at the end of the Contract.

A.1.3(2) Provision of Survey Equipment for the Assistance to the Engineer

The Contractor shall at all times during the duration of the Contract provide for the use of the Engineer all equipment, instrument and apparatus, all information and records and qualified chainmen and laborers required by the Engineer for inspecting and measuring the Works. Such equipment, instruments and apparatus shall include those listed in the Special Provisions.

A.1.4 (1) Provision of Progress Photographs

The Contractor shall provide record photographs taken as, when and where directed by the Engineer at intervals of not more than one month. The photographs shall be sufficient in number and location to record the exact progress of the Works. The Contractor shall provide one proof print of each photograph taken, and the negative and ten copies, not less that 254 mm x 203 mm and printed on glossy paper, of any of the photographs by the Engineer. The photographs retained by the Engineer will become the property of the Government and the Contractor shall supply approved albums to accommodate them. Two copies are to be signed by the Contractor, one of which will be signed by the Engineer and returned to the Contractor.

As-Built Drawings-The Contractor Shall Produce And Supply To The Engineer One (1) Reproducible And Two (2) Good Hard Copies Of A Full Set Of "As-Built" Drawings At A1 Size. The Engineer May Allow Up To 30 Days After Target Completion Date For Delivery Of Some Of These Drawings, But Otherwise They Shall Be Due On The Completion Date. These Shall Include Correctly Amended Version Of All Contract Drawings To Freely And Accurately Describe The As-Built Condition Of All Elements Of The Project Within The Contractor's Scope Of Work, To The Approval Of The Engineer. All Drawings Shall Be Clearly Marked "As-Built". Cost For As-Built Drawings Shall Not Be Paid Separately As This Shall Be Subsidiary In All Other Pay-Items.

A.1.1(11) Provision of Furnitures/ Fixtures, Equipment and Appliances for the Field Office for the Engineer

All equipment, furniture, instrument, apparatus, fixtures, fittings and items for the use of the Engineer specified under ***Schedule A*** and ***Schedule B*** to be provided shall be new and shall conform with the specifications as to kinds, grades, types and sizes or as determined by the Engineer. These will become the property of the Implementing Agency the moment they are handed-over and accepted by the Engineer. ***Schedule C*** are items to be considered consumables to be provided by the Contractor to the Engineer on a monthly basis until the completion of the project. ***Schedule D*** list of transport equipment and maintenance of the service vehicle to be provided to the Engineer until the duration of the project.

The Engineer may require the Contractor to provide supplementary provision in addition to existing fixtures, fitting and accessories as well as required repair work. In the absence of any detail or Specification or Provisions for the purpose of making alteration or amendment to the pay item, the Contractor shall seek the approval of the Engineer.

It shall be understood that if the Contractor cannot provide the articles as described or intends to supply equivalent substitutes, he should secure the approval of the Engineer and if such approval is granted it will be on the condition that adjustments

in prices shall be effected based on the submitted receipted invoices of the Contractor.

If the Contractor cannot provide the articles as described on time, the Engineer shall secure the items and the Contractor shall immediately reimburse the Engineer for the cost thereof.

All Equipment, Furniture, Apparatus, Appliances, Service Vehicles, and Consumables are the minimum requirements to be submitted by the contractor during the execution of the project.

SCHEDULE A - FURNITURE

Qty	Description
4 sets	Office desks, dark brown non-gloss varnished, 700 mm x 1200 mm with 3-drawers on each side and center drawer provided with locks and keys
8 sets	Standard chairs, padded seat and back rest of dark brown, non-gloss varnish (including chairs for visitors and Conference Room)
1 each	Steel filing cabinet, 4-drawers, Standard, with locks and keys, dark green paint
1 each	Steel horizontal plan file cabinet, 5-drawers with dark green paint
1 each	Bookshelf, dark brown non-gloss varnish, 3-shelves, 1400 mm long x 320 mm deep
1 set	Typist table, dark brown non-gloss varnish, 600 mm x 1000 mm and chair with padded seat of dark brown synthetic leather upholstery
1 set	Standard computer table and computer chair
1 set	Conference table for eight persons, dark brown non-gloss varnish, 900 mm x 2400 mm

NOTE:

Wall shelves shall be constructed when required by the Engineer.
Height of the furniture shall be determined by the Engineer.

SCHEDULE B - EQUIPMENT, APPARATUS AND APPLIANCES

Qty	Description
2 units	Room air-conditioners, window type, 1.0 Hp and 1.5 Hp.
3 units	Electronic and battery-operated calculators with adaptors, type CASIO, 10 digits, FX 3800 P model or approved equal
1 each	12 Megapixel Camera, Canon / Sony or equivalent
unit	Core i3 – 2.5 GHz desk top computer, DVD-RW drive, 320 GB Hard Drive, 4 GB RAM, 2 speakers, 16”-18” LCD Monitor, mouse and keyboard including standard computer software packages such as Windows, Microsoft Office, Time Line, etc.
1 unit	Automatic Voltage Regulator
2 each	Fire Extinguisher (not less than 5 kg)
3 each	Electric Fan (stand type), 300 mm Blade
1 set	First Aid Kit
1 each	Air pot, 3.5 Li
1 each	Serving Tray
1 each	Janitor’s Cleaning Tools
1 each	Coffee Set
1 each	White Board (1.2m x 2.4m)
1 each	Waste Basket
1 unit	Wall Clock (300mmØ)
1 unit	Pencil Sharpener
1 each	Stapler No. 35
1 each	Stapler No. 10
1 each	Staple Remover
1 unit	Puncher, heavy duty
1 unit	Puncher, regular
1 pair	Scissors
1 each	Metric Scales
4 each	File Tray
1 each	Tape Dispenser
1 each	Rubber Stamp
1 each	Stamp Pad
4 each	Electrical Extension Cord (5m long)
2 each	Cutter

NOTE:

All electrical appliances and equipment shall be provided with transformer / voltage regulator for adapting appliances.

SCHEDULE C - CONSUMABLE ITEMS

The Contractor shall provide regular supply of expendable items required for office, laboratory, field and drafting use such as computer printer Ink (Cartridge), bond papers, yellow pad paper, cross-section paper, pencil (Mongol), ball pen, correction fluid 15ml, scotch tape (¾), masking tape (¾), batteries, staple wire #35, paper clip, brown envelope (short and long), fastener, folder (long and short), tracing paper (20"x42"), Mylar Drafting Film, ink eraser, field book, expanding envelop, copy paper (A-3 and A-4 sizes), marker (Stabilo), paper glue, cutter blade, calcium carbide reagent (0.2 bottle), distilled water (1500ml), plastic bag (8"x14"), soap, carbon paper, waste cans, drinking cups, and other similar articles, items and materials.

It shall be understood that if the Contractor cannot provide on time the articles as described, the Engineer has the right to secure equivalent substitutes on condition that the amount spent, supported by the receipted invoices, shall be refundable from the Contractor.

The Contractor shall provide not later than thirty (30) days after the date of the Notice to Proceed *three (3) units of cellular phones*(Brand New) of good quality, ready for use and for the exclusive use of the Engineer. Each unit of the cellular phone shall include but not limited to the following:

- Cigarette lighter adaptor
- User Manual

The cellular phones must have features such as calculator, alarm clock and automatic redial. It must have the following services to offer: 1) messaging services, 2) call transfer, 3) call forwarding, 4) call barring, 5) call waiting/call hold, 6) teleconferencing, 7) emergency call, and 8) other link services. Preferably medium grade or not even expensive than P10,000 or equal.

The Contractor shall provide supply of prepaid cards, maintenance and needed repairs necessary to insure continuous operation of the cellular phones during the duration of the Project.

The above cellular phones will, at the end of the project, become the property of the Implementing Agency."

SCHEDULE D - TRANSPORT EQUIPMENT (PURCHASE)

SERVICE VEHICLE

Qty	Unit	Description
1	Unit	Service Vehicle, 2 x 4 pickup, 4-door, diesel engine with air-con, stereo and brand new. This service vehicle is on rental basis.

BASIS OF PAYMENT

NO.	Description	Unit of Measurement
A.1.1(7)	Provision of Combined Field Office and Laboratory Building for the Engineer (Rental Basis)	Month
A.1.1(11)	Provision of Furniture's, Fixtures and Appliances	Lump Sum
A.1.1(16)	Operation & Maintenance of Field Office	Month
A.1.5(1)	Provision of Communication Equipment / Furnishing	Lump Sum
A.1.5(2)	Maintenance of Communication Equipment / Furnishings	Lump Sum
A.1.2(2)	Provision of 4 x 4 Pick-up type, 4-door, diesel engine For the Engineer (Bare Rental Basis)	Month
A.1.2(5)	Operation & Maintenance of one (1) unit 4 x 4 pick-up, 4-door, diesel engine Service vehicle for the Engineer	Month
A.1.4(1)	Progress Photographs	Month

A.2.1 Method of Measurement

1. Lump-sum items shall be provided for the provision of:

   - Office building for the Engineer including pieces of furniture, appliances and equipment.
   - Laboratory building for the Engineer including furniture, appliances and equipment.
   - Survey equipment for the Engineer. This provision is subsidiary to work items prescribed in the bill of quantities.
   - Site clean-up including restoration of the vegetation, repair of roadways and concrete walks .This is subsidiary to Demobilization work item.

2. The quantities for the maintenance of the office and the laboratory for the Engineer shall be for the time the Engineer occupies the office and the laboratory respectively. The unit of the measure is "month"

3. No separate payment shall be made in respect of consumable materials as this is deemed to be included in the pay item for maintenance of the Engineer's facilities.

4. The quantities for the provision of vehicles for the Engineer shall be the number of each type of vehicle supplied. The unit of measure is “each”. The provision of the vehicle shall be turned over to the government after completion of the project.
5. The quantities for the operation of vehicle for the Engineer shall be for the time the Engineer is supplied with each vehicle prior to returning back to the Contractor. The unit of measure is “month” .

6. The quantities for progress photographs shall be the number of photographs selected and provided as progress photographs. The unit of measure is “month”.

A.2.2 Basis of Payment

The quantities determined as provided above shall be paid for at the appropriate contract unit price, for each of the particular pay items shown in the Bill of Quantities which price and payment shall constitute full compensation for furnishing and maintaining such items.

B.1 Offices, shops, stores, and workmen's accommodation for Contractor

The contractor shall provide and maintain such offices, stores, workshops latrines, housing and missing accommodations as are necessary. These shall be located in the Contractor's compound, distinct and separate from the Engineer's compound. The location, dimensions and layout of such buildings and places shall be subject to the approval of the Engineer. The Contractor shall not be permitted to erect temporary buildings or structures on the site without the specific permission in writing of the Engineer including approval of the dimensions of such buildings or structures. Before the commencement of the period of Warranty, the Contractor shall fence off the Contractor's store area from the rest of the Site. By the end of the Period of Warranty, the Contractor shall fence off the Contractor's area from the rest of the Site. By the end of the Period of Warranty, the Contractor shall remove this fence, clear all the buildings and grade the area as required by the Engineer.

B.2 Medical Room and First Aid Facilities

1. The Contractor shall provide and maintain throughout the duration of the Contract a medical room together with all necessary supplies to be sited in the main Contractor's area. The medical room shall be waterproof; it could be a building or room designated and use exclusively for the purpose. It shall have a floor area of at least 15 square meters and a glazed window area of at least 2 square meters.

2. The Contractor shall employ permanently on the site a fully trained Medical Aide, who shall be engaged solely on medical duties.

3. The location of the medical room and any other arrangements shall be made known to all employees by posting on prominent locations suitable notices in the Site.

4. The Contractor's arrangement to comply with this Section shall be subject to the approval of the Engineer and also to the approval of ay qualified Medical Officer designated by the Government to supervise medical arrangements on the Site.

Measurement and Payment

Work prescribed in Section B.2 shall not be measured and paid separately; same shall be deemed to be included in pay items for other items for work.

B.4 Construction Survey and Staking

a) Description

This item shall consist of furnishing the necessary equipment and material to survey, stake, calculate, and record data for the control of work in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Plans or as established by the Engineer.

b) Construction Requirements

b-1) General

Staking activities shall be included in the construction schedule to be submitted by the Contractor. Dates and sequence of each staking activity shall be included.

The Engineer shall set initial reference lines, horizontal and vertical control points, and shall furnish the data for use in establishing control for the completion of each element of the work. Data relating to horizontal and vertical alignments, theoretical slope stake catch points, and other design data shall be furnished.

The Contractor shall be responsible for the true settling of the works or improvements and for correctness of positions, levels, dimensions and alignment of all parts of the works. He shall provide all necessary instruments, appliances, materials and supplies, and labor in connection therewith. The Contractor shall provide a survey crew supervisor at the project site whenever surveying/ staking activity is in progress.

Prior to construction, the Engineer shall be notified of any missing initial reference lines, controls, points, or stakes. The Engineer shall reestablish missing initial reference lines, controls, points, or stakes.

The Contractor for convenient use of Government-furnished data shall perform additional calculations. Immediate notification of apparent errors in the initial staking or in the furnished data shall be provided.

All initial reference and control points shall be preserved. At the start of construction, all destroyed or disturbed initial reference or control points necessary to the work shall be replaced.

Before surveying and staking, the Contractor shall discuss and coordinate the following with the Engineer:

1. Surveying and staking methods
2. Stake marking/ concrete monuments
3. Grade control for courses of material
4. Referencing
5. Structure control, and
6. Other procedures and controls necessary for the work.

Established controls shall be within the tolerances shown in **Table 1.**

Table 1
Construction Survey and Staking Tolerances

Staking phase	Horizontal	Vertical
Existing Government network control points	± 20 mm	± 8 mm x $\sqrt{k^2}$
Local supplemental control points set from existing Government network points	± 10 mm	± 3 mm x $\sqrt{k^2}$
Centerline points (PC), (PT), (POT) and (POC) including references	± 10 mm	± 10 mm
Other centerline points	± 50 mm	± 50 mm
Cross-section points and slope stakes	± 50 mm	± 50 mm
Slope stakes references	± 50 mm	± 50 mm
Culverts, ditches, and minor drainage structures	± 50 mm	± 20 mm
Retaining walls and curb and gutter	± 20 mm	± 10 mm
Bridge substructures	± 10 mm(6)	± 10 mm
Bridge superstructures	± 10 mm(6)	± 10 mm
Clearing and Grubbing limits	± 500 mm	± 10 mm
Roadway subgrade finish stakes (7)	± 50 mm	± 10 mm
Roadway finish grade stakes (7)	± 50 mm	± 10 mm

(1) At 95% confidence level. tolerances are relative to existing government network control points.
(2) K is the distance in kilometers
(3) N is the number of instrument setups
(4) Centerline points: PC –point of curve, PT- point of tangent, POT- point on tangent, POC- point on curve
(5) Take the cross-sections normal to the centerline + 1 degree
(6) Bridge control is established as local network and the tolerances are relative to that network
(7) Include pave ditches.

The Contractor shall prepare field notes in an approved format. All field notes and supporting documentation shall become the property of the government upon completion of the work.

Work shall only be started after staking for the affected work is accepted.

The construction survey and staking work may be spot-checked by the Engineer for accuracy, and unacceptable portions of work may be rejected. Rejected work shall be resurveyed, and work that is not within the tolerances specified in table 1 shall be corrected. Acceptance of the construction staking shall not relieve the Contractor of responsibility for correcting errors discovered during the work and for bearing all additional costs associated with the error, unless such error is based on incorrect data supplied in writing by the Engineer, in which case, the expense in rectifying the same shall be at the expense of the Government.

In the case of change or changed conditions which involve any change in stakeout, the Contractor shall coordinate with the engineer and facilitate the prompt reestablishment of the field control for the altered or adjusted work.

All flagging, lath, stakes, and other staking materials shall be removed and disposed after the project is completed.

c) Equipment

Survey instruments and supporting equipment capable of achieving the specified tolerances shall be furnished.

Acceptable tools, supplies, and stakes of the type and quality normally used in highway survey work and suitable for the intended use shall be furnished. Stakes and hubs of sufficient length to provide solid set in the ground with sufficient surface area above the ground for necessary legible markings shall also be furnished.

d) Survey and Staking Requirements

All survey, staking, recording of data, and calculations necessary to construct the project from the initial layout to final completion shall be performed. Stakes shall be reset as many times as necessary to construct the work.

B.4 (1) Construction Survey and Staking (Control Points and Roadway Cross-Section)

Control Points

Established initial horizontal and vertical control points in conflict with construction shall be relocated to areas that will not be disturbed by construction operations. The coordinates and elevations for the relocated points shall be furnished before the initial points are disturbed.

Roadway Cross-Section

Roadway cross-sections shall be taken normal or perpendicular to the centerline. When the centerline horizontal curve radius is less than or equal to 150 meters vertical parabolic curve radius is less than or equal to 100 meters, cross-sections shall be taken at a maximum centerline spacing of 10 meters. When the centerline horizontal curve radius greater than 100 meters, cross-sections shall be taken at a maximum centerline spacing of 20 meters. Additional cross-sections shall be taken at significant breaks in topography and at changes in the typical roadway section including transition change to superelavated sections. Along each cross-section, points shall be measured and recorded at breaks in topography and at changes in typical roadway section including transition change to superelevated sections and shall be no further apart than 5 meters. Points shall be measured and recorded to at least anticipated slope stake and reference

locations. All cross-section distances shall be reduced to horizontal distances from centerline.

B.4(2) Slopes Stakes and References

Slopes stakes and references shall be set on both sides of centerline at the cross-section locations. Slope stakes shall be established in the field as the actual point of intersection of the design roadway slope with the natural ground line. Slope stake references shall be set outside the clearing limits. All reference points and slope stake information shall be included on the reference stakes. When initial references are provided, slope stakes may be set from these points with verification of the slope stake location with field measurements. Slope stakes on any section that do not match with the staking report within the tolerances established in Table 1 shall be recatched. Roadway cross-section data shall be taken between centerline and the new slope stake location. Additional references shall be set even when the initial references are provided.

Clearing and Grubbing Limits

Clearing and grubbing limits shall be set on both sides of centerline at roadway cross-section locations, extending one (1) meter beyond the toe of the fill slopes or beyond rounding of cut slopes as the case maybe for the entire length of the project unless otherwise shown on the plans or as directed by the Engineer.

B.4(3) Centerline Reestablishment and Grade Finishing Stakes

Centerline shall be reestablished from instrument control points. The maximum spacing between centerline line points shall be 10 meters when the centerline horizontal curve radius is less than or equal 150 meters and vertical parabolic curve radius is less than or equal to 100 meters. When the centerline horizontal curve radius is greater than 150 meters and vertical parabolic curve radius is greater than 100 meters, the maximum distance between centerline points shall be 20 meters.

B.4(4) Culvert Survey and Staking

Culverts shall be staked to fit field conditions. The location of culverts may differ from the plan. The following shall be performed:

a. Survey and record the ground profile along the culvert centerline including inlet and outlet channel profile of at least 10 meters and as additionally directed by the Engineer so as to gather all necessary data for the preparation of pipe projection plan.
b. Determine the slope catch points at the inlet and outlet.
c. Set the reference points and record information necessary to determine culvert length and end treatments.
d. Plot into scale the profile along the culvert centerline reflecting the natural ground elevation, invert elevation, the flow line, the roadway section, and the size, length and the degree of elbow of culvert, end treatments, grade and other appurtenances.
e. Plot into scale he cross-section of inlet and outlet channel at not more than 5 meters interval.
f. Submit the plotted Pipe Projection Plan for approval of final culvert length, alignment and headwall.
g. When the Pipe Projection Plan has been approved, set drainage culvert structure survey and reference stakes, and stake inlet and outlet to make the structure functional.

B.4(5) Bridge Survey and Staking

Adequate horizontal and vertical control and reference points shall be set for all bridge structure and superstructure components. The bridge chord or the bridge tangent shall be established and referenced. The centerline of each pier, bent, and abutment shall also be established and referenced.

Set at least three (3) reference points each at downstream and upstream portion. Conduct topographic survey and plot into scale at least 100 meters upstream and downstream from centerline of bridge.

B.4(6) Retaining walls and Other Types of Slope Protection Works

Profile measurements along the face of the proposed wall and 2 meters in front of the wall face shall be surveyed and recorded. Cross-sections shall be taken within the limits designated by the Engineer at every 5 meters along the length of the wall and all major breaks in terrain. For each cross-section , points shall be measured and recorded every 5 meters and at all major breaks in terrain. Adequate references and horizontal and vertical control points shall be set.

1. Borrow and Waste Sites

The work essential for each layout and measurement of the borrow or waste site shall be performed. A referenced baseline, site limits, and clearing limits shall be established. Initial and final cross-sections shall be surveyed and recorded.

2. Permanent Monuments and Markers

All survey and staking necessary to establish permanent monuments and markers shall be performed.

3. Miscellaneous Survey and Staking

All surveying, staking, and recording of data essential for establishing the layout and control of the following:

a. Approach roads and trails
b. Road Right of Way and Construction limit in
c. Curb and gutter
d. Guardrail
e. Parking areas
f. Paved waterways and outfall structures
g. Lined canal and other ditches
h. Chutes and Spillways
i. Turf establishment
j. Utilities
k. Signs, delineators, and object markers
l. Pavement markings

B.4(7) Grade Finishing Stakes

Grade finishing stakes shall be set for grade elevations and horizontal alignment, at the centerline and at each shoulder of roadway cross-section locations. Stakes shall be set at the top of Subgrade and the top of each aggregate course.

Where turnouts are constructed, stakes shall be set at the centerline, at each normal shoulder, and at the shoulder of the turnout. In parking areas, hubs shall be set at the center and along the edges of the parking areas. Stakes shall be set at all ditches to be paved.

The maximum longitudinal spacing between stakes shall be 10 meters when the centerline horizontal curve radius is less than or equal to 150 meters and vertical parabolic curve radius is less than or equal to 100 meters . When the centerline horizontal curve radius is greater than 150 meters and vertical parabolic curve radius is greater than 100 meters, the maximum longitudinal spacing between stakes shall be 20 meters. The maximum transverse spacing between stakes shall be 5 meters. Brushes or guard stakes shall be used at each stake.

Method of Measurements

Construction survey and staking shall be measured by the *kilometer*

Bridge survey and staking, and retaining wall survey and staking shall be measured by the *lump sum.*

Slope, reference, and clearing and grubbing stakes shall be measured by the *kilometer*

Centerline establishment shall be measured by the *kilometer.*

Centerline reestablishment shall be measured only *one time.*

Culvert survey and staking shall be measured by the *each.*

Grade finishing stakes shall be measured by the *kilometer.*

Subgrade shall be measured *one time* and each aggregate course shall also be measured *one time.*

Permanent monuments and markers shall be measured by each unit priced and installed at the proper locations.

Miscellaneous survey and staking shall be measured by the hour of survey work ordered or by the lump sum. For miscellaneous survey and staking paid by the hour, the minimum survey crew size shall be 2 persons. Time spent in making preparations, travelling to and from the project site, performing calculations, plotting cross sections and other data, processing computer data, and other efforts necessary to successfully accomplish construction survey and staking shall not be measured separately but deemed included as subsidiary for each of the Pay Item.

Basis of Payments

The accepted quantities, measured as provided in Section B.4.3, shall be paid for at the contract unit price for each of the Pay Item listed below that is included in the bill of Quantities.

Payment shall constitute full compensation for surveying, staking, calculating/ processing by any means and recording data, for furnishing and placing all materials, and for furnishing all equipment, tools and incidentals necessary to complete the item.

The construction survey and staking lump sum items shall be paid as follows:

a. 25% of the lump sum, not to exceed 0.5% of the original contract amount, shall be paid following completion of 10% of the original contract amount.
b. Payment of the remaining portion of the lump sum shall be prorated based on the total work completed.

The bridge survey and staking and the retaining wall survey and staking lump sum items shall be paid on a prorated basis as the applicable work progresses.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
B.4(1)	Construction Survey and Staking	Kilometer
B.4(2)	Slope, reference, and cleaning and grubbing stakes	Kilometer
B.4(3)	Centerline reestablishment	Kilometer
B.4(4)	Culvert survey and staking	Each
B.4(5)	Bridge survey and staking	Lump sump
B.4(6)	Retaining wall survey and staking	Lump sump
B.4(7)	Grade finishing stakes	Kilometer
B.4(8)	Permanent monuments and markers	Each
B.4(9)	Miscellaneous survey and staking	Hour
B.4(10)	Miscellaneous survey and staking	Lump sump

B.5 Project Billboard/ Signboard

B.5.1 Description

This item shall consist of furnishing and installation of project billboard for all on-going projects being undertaken by the Department of Public Highways for information and guidance of the citizenry. The design of the billboard is shown on the Plans based on the Department Order 72 of the Department.

B.5.2 Material Requirements

The new billboard design layout and dimension shall be 1200mm x 2400mm using 12mm thick marine plywood or tarpaulin posted on 5 mm marine plywood.

The color shade combination for the yellow background of the new project billboard design is as follows:

Cyan 0
Magenta 7
Yellow 78
Key 0

B.5.3 Construction Requirements

Billboards shall be installed on the different types of structures such as:

a) For Building Project - the billboard shall be installed in front of the project site.
b) For Road/Bridge/Flood Control Project –two billboards shall be installed, i.e., one at the beginning and one at the end of the project.
c) For road projects with length of 10 kilometers or more, billboards shall also be installed at every 5 kilometers interval.
d) Names and/or pictures of any personages should not appear in the billboards.
e) No political billboards shall be allowed to be installed 100 meters before and 100 meters after all DPWH projects and in between the project limits or within the road right-of-way.
f) DPWH contractors shall not allowed to place names of politicians on their equipment or carry political billboard on their equipment.

B.5.4 Method of Measurement

Method of measurement for this item shall be per complete billboard including painting, letterings, and its framing and foundation that can withstand a strong wind pressure. The unit of measure shall be “EACH “.

B.5.5 Basis of Payment

The basis of payment for this item shall be based on B.5.4, Method of Measurement, shall be paid for at the contract unit price which price and payment shall be compensation for furnishing and installation of the billboard , framing and foundation , including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this item.

B.7 Occupational Safety and Health Program

B 7.1 GENERAL

All security and health controls necessary for the execution of the Works such as but not limited to, medical facilities, manpower safety gadgets, sanitary arrangements, explosives and fuel, temporary fencing, safety precautions and fire prevention, shall be established and maintained by the Contractor at his own expense. The Contractor shall make himself responsible for all security and health controls and shall submit to the Engineer for his approval the organization and the regulations for these purposes.

B 7.2 SITE SECURITY

The Contractor's warehouse and storage area shall be secured against unauthorized entry in a manner appropriate to its contents. The Contractor shall also provide watchmen as required.

B 7.3 SANITARY ARRANGEMENT

The Contractor shall keep the Site in a clean and sanitary condition and shall provide and maintain sanitary facilities for the use of persons employed in the Works to the extent and in the manner and at such places as approved by the Engineer and by any local or other authorities concerned, and all persons connected with the Works shall be obliged to use these sanitary facilities.

The Contractor shall also post notices and take such other precautions as may be necessary to keep the Site clean and well maintained.

B 7.4 MEDICAL FACILITIES

The Contractor shall make his own arrangement for treatment of casualties on the Site in conformity with the requirements of any duly constituted medical and sanitary authority. The Contractor shall provide first aid units/stations, and shall be responsible for and bear all cost in connection with the first aid services including the use of ambulance of injured or sick employees transporting to the hospital. Such first aid services shall be provided to the Employer, the Engineer, and to their employees at the site at no cost to them.

B 7.5 DANGEROUS MATERIALS

The Contractor shall convey, store and make use of all, petroleum, acetylene carbide, acetylene carbide of calcium and other similar dangerous materials provided by them for use in or on the Works in strict accordance with the provision of all Laws, Orders and Regulations that are in force at the Site or that may be issued from time to time by the Government or the Employer.

B 7.6 PRECAUTION FOR SAFETY

The Contractor shall take all necessary precautions against risks, loss of life or of injury to any person employed on the Works or to employees of the Employer and the Engineer or to visitors or to persons having good and sufficient reasons to be about the Works, and shall properly safeguard the Works to the satisfaction of the Engineer.

Where and when it is deemed necessary, the Contractor shall furnish lighting facilities, signs and sentry, and other safety facilities and services.

The Contractor shall provide their Workers, Supervisors , Engineers, and Owner's and Engineer's representatives the necessary safety gadgets at the site such as: safety shoes, safety helmets, safety belts, gloves, goggles, gas or dust mask, and Uniforms,

The Contractor shall furthermore take all necessary precautions against damage to the property of the Employer or of others located at or adjacent to the Site. The Contractor shall at all times comply with any accident prevention, regulations and any safety regulations of local or national authorities or that shall be prescribed by the Employer.

The Contractor shall appoint a Safety Officer and hold periodical safety meetings with the Engineer and with his own supervisors and foremen. The Contractor shall report in writing within twenty-four (24) hours to the Engineer all accidents involving the death of and/or injury to any person, resulting from the Contractor's operation.

B 7.7 FIRE PREVENTION

The Contractor shall take every precaution to prevent fire occurring on or about the Site and shall provide firefighting equipment suitable and adequate in the opinion of the Engineer, for ready use in all structures, buildings or the Works under construction, including his residential quarters, labor camps and ancillary buildings. The Contractor shall maintain such equipment and such additional firefighting equipment as may be required, in good working condition until the Works are accepted by the Employer.

The Contractor shall diligently fight any fire which occurs on the Site, wherever such fire may originate. In this regard, he shall employ all requisite equipment and manpower up to the limit of his equipment and manpower employed at the Site, including the equipment and manpower of his Subcontractors.

B 7.8 PAYMENT

The cost incurred by the Contractor in complying with the obligation under this Section shall be paid separately as prescribed in the priced Bill of Quantities.

B.8 (1) Traffic Management

B.8.1 GENERAL

The Contractor shall implement an approved Traffic Management Plan. At least 7 days prior to commencing work on the Site, the Contractor shall submit to the Engineer for approval a detailed plan covering all aspects of traffic management for each stage of the Works. The submission shall include documentation evidencing approval by all relevant authorities. No work shall commence on any work stage until the Engineer has approved the plan for that stage. Upon the Engineer's approval, the Contractor shall immediately implement the plan and keep it in operation for the full duration of the relevant work stage.

The Contractor shall be responsible at all times for the safety of the public on the Site and, should the Contractor fail to provide the necessary traffic management, the Engineer may arrange for others to carry out such work as he deems to be necessary. The Contractor shall be responsible for the cost of the necessary work and the Employer may recover this by deduction from any money due, or which may become due, to the Contractor under the Contract.

B.8.2 TRAFFIC ARRANGEMENTS

The Contractor shall make provision for the safe movement of all road users at all times and shall ensure that all traffic control and road closure or diversion signposting work which is required shall comply with the requirements of the relevant authorities.

The Contractor shall plan and implement the construction of the work such that public traffic may continue to pass safely along the affected roads at all times.

Where the safe movement of road users may be affected, the Contractor shall ensure that all necessary traffic control and road closure or diversion signposting work is provided to the satisfaction of the Engineer and the relevant authorities.

Where required, or where instructed, the Contractor shall furnish and station competent flagmen whose sole duties consist of directing the movement of traffic through or around the work.

All necessary traffic safety and management measures shall be fully operational before the Contractor commences any work that affects public roads.

B.8.3 Compliance with Instructions

The Contractor shall comply with any direction or instruction given by the Engineer or a relevant authority in respect of any traffic control proposal.

The Engineer or a relevant authority may at any time instruct the Contractor to re-open any traffic lane or shoulder to traffic without delay, whether or not closed by prior agreement.

The Engineer may order suspension, or cessation, of any activity that causes delay to traffic or threatens the safety of the public, notwithstanding that approval had previously been given to the traffic change.

B.8.4 Payment

The cost incurred by the Contractor in complying with the obligation under this Section shall be paid separately as prescribed in the priced Bill of Quantities.

B.9 Mobilization & Demobilization

Mobilization shall include transportation to the site of Contractor's plant, materials, equipment, employees, furnishings and temporary facilities.

Mobilization, as provided in these Specifications, means preparatory work and operations, including, but not limited to, those necessary for the movement of necessary personnel, plant and equipment to the Site.

Demobilization shall include dismantling and removal from the site of Contractor's plant, materials and equipment and all temporary facilities. It shall also include cleanup of the site after completion of the Contract Work as approved by the Engineer and transportation from the site of Contractor's employees.

The Contractor shall furnish the Engineer with a resources schedule, showing in detail the sequence of proposed delivery to the Site of plant and equipment necessary to comply with the proposed construction program.

The Contractor shall keep the Engineer informed of the arrival of plant and equipment on the Site.

In accordance with the Conditions of Contract, the Contractor shall not remove construction plant and equipment from the Site without the approval of the Engineer.

Basis of Payment

The quantities determined as provided above shall be paid for at the appropriate contract unit price, for each of the particular pay items shown in the Bill of Quantities which price and payment shall constitute full compensation for furnishing and maintaining such items.

	Description	Unit of Measurement
B.9.1	Mobilization / Demobilization	L.S.

Payment of 70% of the Lump Sum will be made monthly in the proportion that the progress of mobilization completed in a particular month bears to the total numbers of plant and equipment shown in the approved resources schedule.

The remaining 30% of the Lump Sum will be paid upon certification by the Engineer that the demobilization of plant and equipment has been completed including site clean up to his satisfaction.

B.9.2 Temporary Facilities

Measurement and Payment:

Payment will be made at the Lump Sum bid therefore in the priced Bill of Quantities under the following item:

Item No.	Description	Unit of Measurement
B.9.2	Temporary Facilities	L.S.

Payment of 70% of the Lump Sum will be made after the Engineer certifies that the Contractor has fully provided the necessary construction facilities; including office equipment, laboratory equipment, office furniture, consumables, and other necessary office supplies needed for the project. Payment will be made monthly in proportion to the progress of the works completed.

Payment of the remaining 30% of the Lump Sum will be made when the facilities have been removed from the Site and the area reinstated to the satisfaction of the Engineer.

B.10 Dayworks

Based on the provision of the Special Conditions of Contract Dayworks are allowed if the Procuring Entity's Representative issued a written instructions to execute any additional works by applying the Daywork rates included at the Contractor's Bid to be applied for small additional amounts of work.

All work to be paid for as Dayworks shall be recorded by the Contractor on forms approved by the Procuring Entity's Representative. Each completed form shall be verified and signed by the Procuring Entity's Representative within two days of the work being done.

An Extra Work Order may be issued by the Procuring Entity to cover the introduction of new work necessary for the completion, improvement or protection of the project which were not included as items of Work in the original contract, such as, where there are subsurface or latent physical conditions at the site differing materially from those indicated in the contract, or where there are duly unknown physical conditions at the site of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in the Work or character provided for in the contract.

The Contractor shall submit together with the priced BOQ a list of basic daywork rates and/or prices for various classes of labor, materials and Constructional Plant, including statement of conditions (if any) under which the Contractor will be paid for work executed.

The Daywork rate or price is deemed to include all direct and indirect costs as defined in these Preambles.

B 11 PROVISIONAL SUM

B 11.1 SCOPE OF WORK

The total amount of the following works is set out under the provisional sums.

Relocation and diversion works for public and private utilities such as power supply, sewer, water supply, gas supply, telephone, drainage, etc., will be made in accordance with Section B.11, except for items measured in other pay items.

The sum indicated in the Bill of Quantities for the above item is a pre-estimate of the cost of work to be performed by the Contractor.

These sums shall be the actual cost excluding overheads, administration costs and profit approved by the Engineer for the execution of the work in accordance with the Specification. All costs for overheads, administration costs and profit shall be included in the percentage addition nominated by the Contractor.

B 11.2 USE OF PROVISIONAL SUM

If the Engineer directs the Contractor to supply provisional sum items, the Contractor shall seek quotations by public tender or from certain suppliers or contractors nominated by the Engineer and shall submit those quotations to the Engineer who may, if he deems it necessary or desirable, revoke that direction in whole or in part at any item before acceptance of any quotation.

Following his consideration of any quotation submitted to him by the Contractor, the Engineer may direct the Contractor to, and the Contractor shall, obtain the items from the supplier or nominated subcontractors giving the quotation at the price and on the terms approved by the Engineer.

In the event that the Contractor has any difficulty with a supplier or nominated subcontractor or comprehend that the progress of the Works may be adversely affected by act of omission, or delay of the supplier or subcontractor, he shall immediately notify the Engineer.

B 12 REMOVAL, RELOCATION AND INCLUSION OF PUBLIC UTILITIES AND SITE FACILITIES

In general, the removal, relocation, and inclusion of public utilities and site facilities that are essential to the Works under the Contract are to be executed by their respective owners, the Contractor is therefore instructed to recognize the following stipulations:

(1) The Work Programme to be submitted shall be the basis that will determine any negotiations or working arrangements to be entered into by the Employer with the particular owners of water supply, sewerage, communication, electricity and gas supply utilities and Site facilities such as piers, etc. and it is therefore essential that the Contractor provides the details on the priorities and sequences of his construction activities and operations and any particulars that may be required by the Engineer on the said Programme.

(2) No work shall commence on any parts, portions or Sections on the Site of the Works that may affect or disturb the functions of the original conditions of public utilities and Site facilities unless a written permission has been secured first from the Engineer.

(3) Expense shall be borne by the Contractor in connection with the removal, relocation or inclusion of public utilities and Site facilities including payment of any claims from their owners as a result of any damages or injuries caused by Contractor or any of his Subcontractor(s) operations.

(4) However, if in the opinion of the Engineer, the Work will be unreasonably delayed, the Engineer after consultation with the Employer and owner of the utilities may instruct the Contractor to execute such removal, relocation or inclusion of public utilities. Payment for this work item shall be paid separately as prescribed in the Bill of Quantities.

B 12 PROTECTION AND RESTORATION OF PROPERTY

The Contractor shall be responsible for the preservation of all public and private property, monuments, telephone lines, other utilities, etc., along and adjacent to the Site insofar as they may be endangered by his operations; shall use every precaution necessary to prevent damage to pipes, conduits, and other underground structure; and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnesses or otherwise reference their location and shall not remove them until directed. Any utility lines damaged by the Contractor shall be repaired at once at his expense. All trails and roads adjacent to or intersecting the Works shall be protected from damage.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Works, or in consequence of the non-execution thereof on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring same or he shall make good such damage or injury in some other acceptable manner.

B 14 ENVIRONMENTAL

B 14.1 ENVIRONMENTAL MANAGEMENT and MONITORING

The Contractor shall conduct its activities so as to cause the least possible disturbance to the existing amenities, whether natural or man-made, and so as to comply with all applicable statutory requirements.

In particular, the Contractor shall comply with all relevant requirements of the Environmental Compliance Certificate issued by the Department of Environment and Natural Resources (DENR).

The Contractor shall:

- undertake all work in an environmentally sensitive manner;
- undertake no work outside the defined work site area without prior written approval from the Engineer;
- take all necessary actions to ensure that river water quality is not adversely affected;
- minimize the effects of runoff and erosion;
- minimize disturbance or disruption of the daily lives of local communities to the maximum possible extent; and
- ensure that at all times the Site is maintained in a neat and tidy condition.
- The Contractor shall comply with additional environmental restrictions that the Engineer may, at his discretion, instruct in writing.

B 14.2 ENVIRONMENTAL MANAGEMENT PLAN

Within 28 days of the Commencement Date, and before commencing work on the Site, the Contractor shall prepare and submit to the Engineer for approval an Environmental Management Plan (EMP). The EMP shall cover all environmental protection works and shall also include descriptions of environmental safeguards and emergency procedures.

After approval the EMP shall be strictly adhered to.

B 14.3 POLLUTION CONTROL - GENERAL

The Contractor shall design, construct, maintain and operate suitable temporary pollution control facilities necessary to prevent discharge of polluting matter or visible suspended materials into rivers, streams or existing drainage systems.

All diverted and pumped water shall be discharged at locations on the surface from which it cannot re-enter the Works and in a manner which does not cause erosion, pollution or nuisance to land holders, other contractors employed by the Employer or other persons within or adjacent to the Site.

Waste oil shall be disposed of in a manner that does not cause pollution of rivers and streams.

The burning of waste such as plastics and rubber will not be permitted and all such material shall be disposed of in an approved manner.

Soil contaminated by cement or other chemicals shall be removed and placed in approved disposal areas.

Before any work is carried out in any area of the Site, all specified or instructed or approved pollution control measures shall be in place and operational.

B 14.4 DUST CONTROL

The Contractor shall take appropriate measures, to the satisfaction of the Engineer, to minimize the generation of dust as a result of its operations and activities.

B 14.5 NOISE POLLUTION

1. Restrictions on Working Hours

The Contractor shall restrict all of its operations that result in undue noise disturbance to nearby communities and dwellings to between the hours of 0800 and 1700 unless otherwise approved by the Engineer.

2. Permitted Noise Levels

The Contractor shall provide all its plant and equipment with suitable silencers, or adopt other measures, such that the noise level in buildings adjacent to the work areas will not increase by more than 7 dB(A) above residual sound levels.

B 14.6 REFUSE AND WASTE CONTROL

Littering shall be avoided. All refuse shall initially be placed in bins provided by the Contractor for such purpose and subsequently disposed of in approved refuse dumps.

Hazardous wastes and materials soiled with hazardous wastes shall not be disposed of on the Site. All such waste shall be temporarily stored in an approved manner on Site and removed at regular intervals to off-Site waste disposal facilities designed to handle such hazardous waste.

B 14.7 CONTROL OF WATER

All proper precautions shall be taken by the Contractor to prevent discharge from the area of the Works of polluting matter or water containing visible suspended materials. The Contractor shall, where necessary, construct, maintain and operate suitable settling ponds, separating plants or other effective works to prevent or control such discharge.

For construction work on dry land, silt generated by the operations shall be prevented from entering the natural watercourses by the construction of canals which will direct storm water from the construction site to the nearest possible infiltration site (e.g., natural depressions or temporary retaining basins).

Water control measures shall be maintained in a continuously effective condition throughout the period of construction of the Works.

All temporary water control measures shall be removed and disposed of, or levelled to give a satisfactory appearance, to the satisfaction of the Engineer, such that there is not, and will not be, any interference with the operation of the Permanent Works.

B 14.8 REHABILITATION OF WORKS AREAS

The Contractor shall rehabilitate disturbed areas of the Site, as well as such other areas as may be specified or instructed by the Engineer. Such rehabilitation shall match adjacent undisturbed areas.

Rehabilitation measures shall be carried out concurrently with construction of the Works.

Cut and fill slopes shall be shaped in such a manner that the final profile appears as a natural extension of the adjacent undisturbed ground profiles.

Shaped surfaces shall be left slightly rough to facilitate binding with topsoil or the natural establishment of vegetation.

B 14.9 EMPLOYER'S ENVIRONMENTAL MONITORING

In order to inspect and confirm the effectiveness of the Contractor's environmental protection measures, the Employer may carry out monitoring either directly by himself or through a specialist consultant.

The Contractor shall provide all assistance, including access to relevant records that may be reasonably required.

B 14.10 MEASUREMENT AND PAYMENT

Payment for environmental management and protection and the entire cost of this work shall be deemed to be included in the various rates and prices in the priced Bill of Quantities.

B.15 Detour/ Access Road / Railroads/ Roads

The Contractor shall make all arrangements, pay all necessary costs and assume full responsibility for transportation to the Site of all plant, equipment, materials and supplies needed for the proper execution of the Works.

Without limiting any of its obligations or responsibilities under the Contract, the Contractor will be deemed to have obtained all necessary information pertaining to, and to have complied with, all regulations and procedures governing the use of facilities such as roads, railroads, harbors, airports, including the temporary construction of detour/access road, if necessary, leading to the project site. The Contractor shall be responsible for the road maintenance, traffic flow, and restoration to the original condition of the utilized area.

The Contractor shall be responsible for determining the load limits existing at the time and ensuring that its construction plant does not exceed such limits. Before moving any construction traffic unto highways, roads or bridges, the Contractor shall make suitable arrangements with the appropriate authorities and obtain their approval for the passage of such traffic.

The Contractor shall use every reasonable means to prevent any of the roads or bridges connecting, or on the routes to, the Site from being damaged or injured by any traffic of

the Contractor or any of its subcontractors and, in particular, shall select routes, choose and use vehicles and restrict and distribute loads so that any such extraordinary traffic shall be limited as far as reasonably possible and so that no unnecessary damage or injury may be caused to such roads and bridges.

Maintenance of Roads

All public and private roads, including detour which are being used by the Contractor's, sub-contractors' or suppliers' vehicles for the construction of the Works shall be kept clean and free of dirt and mud arising from the Works. All newly built access roads by the Contractor shall be removed and return back to original condition.

B17 DRAINAGE AND CARE OF WATER/ Temporary diversion of water

B17.1 WORKS TO BE KEPT CLEAR OF WATER

The Contractor shall keep the Works well drained until the Engineer certifies that the whole of the Works is substantially complete and shall ensure that so far as practicable, all works is carried out in the dry. Excavated areas shall be kept well drained and free from running water.

The Contractor shall construct, operate and maintain all temporary cofferdams, watercourses and other works of all kinds including pumping, and well-point dewatering that may be necessary to exclude water from the Works while construction (including construction or erection works by subcontractor) is in progress. Such temporary works shall not be removed without the approval of the Engineer.

Notwithstanding any approval by the Engineer of the arrangements made for the exclusion of water, the Contractor shall be responsible for the sufficiency thereof, and shall be liable for keeping the Works safe during all floods, and for making good at his own expense any damage to the Works that may be attributed to floods. Any loss of production, additional overheads, or additional costs of any kind that may result from the floods shall be at the Contractor's own risk.

B 17.2 DISCHARGE OF WATER INTO EXISTING CHANNEL

The Contractor shall make provision for the discharge or disposal from the Works and Temporary Works of all water and waste arising there from and the method of disposal shall be to the satisfaction of the Engineer and any authority or person having an interest in any land or channel over or in which water may be discharged.

B 17.3 PROTECTION OF EXISTING DRAINAGE

No existing drainage pipe encountered where the flow of run-off is affected by the execution of any part or section of the Works shall, in anyway, be decommissioned but fully safe guarded during the duration of said execution of the Works. The Contractor shall provide temporary outlets to such affected drainage pipes subject to the approval of the Engineer until the same have been reconnected to their permanent outlets in accordance with the Contract or as per instruction of the Engineer.

The furnishing of plant, labor and materials in pursuance to the provisions described in this Sub-Section shall not be paid for separately but all costs shall be deemed to have been included in the Bill of Quantities tendered.

B 17.4 MEASUREMENT AND PAYMENT

No separate payment will be made for the furnishing of plant, labor and materials in pursuance to the provisions described in this Sub-Section and the entire cost of this work shall be deemed included in the various rates and prices in the priced Bill of Quantities.

B 19 SCHEDULE AND REPORTS

B 19.1 COMMENCEMENT, EXECUTION AND COMPLETION OF WORKS

The Contractor shall commence the Works within seven (7) calendar days from the date of the receipt of the Employer's written Notice to Commence and shall complete the Works within the specified time duration.

B 19.2 CONSTRUCTION PROGRAMME

The Contractor shall submit a detailed construction programme or revision of the same to the Engineer for approval.

The Contractor shall submit a construction program, with full details of all the works to be carried out during the contract, within fifteen (15) days after receiving the Letter of Acceptance. The construction program shall include a PERT/CPM (Critical Path Method) network and Bar Chart with S-curve, which comply with the provisions stated hereinafter.

Activities shown on the PERT/CPM network and Bar Chart (with S-curve) shall also include time allowances for the preparation and approval of drawings and samples, procurement and shipping of materials and equipment, installation of special and critical items, possible delays caused by flood and/or inclement weather, legal holidays, etc. All critical paths shall be marked on the PERT/CPM network.

The Contractor shall submit detailed scheduling, mobilization and utilization of equipment needed in the Project. This shall be incorporated in the Bar Chart Schedule.

The Contractor shall describe the conditions of work shifts to execute night works and/or Sunday and holiday works if any, which is applied to the respective work of the construction programme.

Whenever the Contractor proposes to change the Construction Programme, the Contractor shall immediately notify the Engineer in writing for the approval of the revision.

If the Contractor falls behind the approved construction programme, he shall, within fourteen (14) days from the date of such default, submit for approval a revision of the Construction Programme showing proposed measures to offset the setback.

When requested by the Engineer, the Contractor shall promptly furnish details of the Construction Programme for particular sections of the Permanent Works.

B 19.3 PROGRESS AND COMPLETION REPORT

The Contractor shall, before the fifth day of each month, submit to the Engineer and the Employer, respectively, ten (10) copies of monthly progress report in a format acceptable to the Engineer detailing the progress of the work accomplished during the preceding month. The reports shall contain but are not limited to the following:

(1) A general description of the work performed during the reporting period and notable problems that have been encountered.

(2) The overall percentage of the Works completed as well as scheduled by the CPM network as of the end of a reporting period, with appropriate comments in writing to explain the differences and how to recover delay, if any.

(3) A list of local manpower by trade employed during the reporting period.

(4) An inventory of the amount of major construction materials consumed and delivered to the Site during the reporting period.

(5) An inventory of all equipment and plants, their present status, time when their repair is expected to be finished, if under repair.

(6) A general description of the weather and a list of rainfall and maximum and minimum temperatures and tide levels at the site for each day.

(7) A statement about labour relations and an explanation of actual or potential problems.

(8) A statement concerning the effectiveness of safety programme and a list of each accident involving hospitalization and/or death of any person. Also a list of any accidents in which equipment has been damaged to the extent it become inoperative, and any fire which has occurred.

(9) A statement concerning the effectiveness of security programme and a list of major thefts.

(10) A list of the amount and date of each payment received as of the end of the reporting period and the amount of any monthly invoice submitted but not yet paid.

(11) A list of claim submitted during a reporting period including claim amounts and extension of time claimed.

(12) A statement concerning foreseeable problems areas.

(13) Record and status of correspondences exchanged between the Contractor and the Engineer.

(14) Photographs explained in Sub-Section GS.6.4.

The above progress reports shall be prepared / submitted separately from the one specified in Sub-Section GS.6.5. At the end of the Work, the Contractor shall prepare and submit the Completion Report to the Engineer for approval.

Each photograph. Additional prints shall be submitted if required by the Engineer or the Employer.

The negatives of the photographs shall be the property of the Employer and no print from these negatives shall be supplied to any person unless so authorized by the Employer.

Upon completion of the Works, the Contractor shall submit all of the negatives arranged chronologically and marked for identification. The Contractor shall submit to the

Employer two (2) sets of color photographs adequately edited and filed showing the entire sequence of the Works until its completion.

B 19.4 WEEKLY WORK SCHEDULE AND DAILY WORK ACCOMPLISHMENT

Every Friday, the Contractor shall submit two (2) copies of a weekly schedule of main work items to be accomplished during the succeeding week. The schedule shall be in a form approved by the Engineer and is to contain appropriate comments with regards to major work items to be performed.

The Contractor shall likewise submit Daily Work Accomplishment to provide the Engineer the necessary data to closely and effectively monitor the progress of the Works.

B 19.5 JOINT PROGRESS MEETINGS

A regular meeting between the Engineer and the Contractor will be held once a week or fortnight at a time directed by the Engineer. The purpose of this meeting is to discuss the progress being made and the work proposed for the forthcoming activities. The Employer may attend such meetings or hold separate meetings whenever necessary. Special meetings shall be called as the need for it arises.

B 19.6 PAYMENT

Payment for preparation and submission of the progress and completion reports including construction programme and progress photos will be made in the lump sum cost as stated therefore in the Bill of Quantities. The payment will be made monthly in proportion with the monthly progress of the whole Works completed at the current month. The payment shall constitute full compensation for all labour, materials, equipment, necessary copies and other incidental cost therewith. However, if not in the tendered Pay Item, Payments for Schedule and Reports shall be deemed included in various rates and prices in the priced Bill of Quantities.

B 20 MATERIALS AND WORKMANSHIP

B 20.1 MATERIALS

B 20.1.1 General

All materials used in the Works shall be of the best quality for their respective kinds as specified herein and/or shown in the Drawings and stated in the Bill of Quantities. They shall be obtained from sources and suppliers approved by the Engineer and shall comply strictly with the current issue of the appropriate standard published by the American Society for Testing Materials (ASTM), or other equivalent national or international standard approved by the Engineer.

Reference to Japanese or American Standards in the Specifications or Bill of Quantities does not imply any bias in favor of equipment, fittings, finishing, etc., but rather to indicate only the acceptable standard.

The Contractor may relate his offer to other national standards or codes of practices but shall explain the system used and provide the Engineer with all the necessary information and comparisons in English showing that his proposed standards are equivalent to the specified standards. The Contractor shall supply to the Engineer three (3) copies of such alternative standards in English.

Any material not fully specified herein shall be the best of their kind and be specifically approved by the Engineer.

In all cases where the name of a particular type or make of material or equipment or item is referred to in the Drawings or elsewhere in this Specification, this is intended to indicate only the acceptable standard. The Contractor may offer alternative material and Plant to that specified in the Contract and in all such cases the Contractor's offer shall be at least of equal or better quality and capacity.

When alternatives are offered, the Contractor shall submit to the Engineer for approval a statement detailing the alternatives, and shall include full technical descriptions, drawings and specifications, and shall provide such full information as required to enable the Engineer to determine that the alternative is equivalent to the item specified. Any further information shall be provided by the Contractor when called for by the Engineer.

B 20.1.2 Standards and Codes of Practice

Material and workmanship for the Permanent Works and testing shall satisfy the stipulations of the Specifications and also be in compliance with the newest edition of relevant standards.

Below are lists of relevant standard to which references are made in this Specifications. In the list, the following abbreviation are used:

American Association of State Highway and Transportation Officials	AASHTO
American Institute of Steel Construction	AISC
American National Standard Institute	ANSI
American Standard Association	ASA
American Society for Testing and Materials	ASTM
American Welding Society	AWS
American Water Works Association	AWWA
American Wood Preservers Association	AWPA
British Standard	BS
International Electro Technical Commission	IEC
Institute of Electronics and Electrical Engineer	IEEE
International Standard Organization	ISO
Japan Electric Code	JEC
Japan Electric Machine Industry Association Standard	JEM
Japanese Industrial Standard	JIS
Japan Water Gate Association Standard	-
National Electrical Code	NEC
National Electrical Manufacturer's Association	NEMA
National Fire Protection Administration	NFPA
Philippine Electric Code	PEC
Philippine National Standard	PNS
Philippine Standards	PS
U.S. Federal Specifications	Fed. Specs
Underwriter's Laboratories	UL

B20.1.3 Approval for Materials

The Contractor, before placing any order for materials or manufactured articles to be incorporated in the Permanent Works, shall submit for approval a complete description of

such items and the names of the firms from whom the items shall be purchased. When so directed, the Contractor shall submit samples and certificates for approval.

B20.1.4 Alternatives and Substitutions

If during the performance of the Works, the Contractor encounters conditions other than those mentioned in the Contract, which affect the ability of the Contractor to obtain Plants, Contractor's Equipment, goods and materials and services (hereinafter referred to as "Constructional Resources") essential to the carrying out of the Works and the requirements of which are detailed or to be provided by the Contractor under the terms of the Contract, or required to be made available by the Contractor at a given time to carry out a particular work or complete a section or part of the Works and would, in his opinion, result in a delay or alteration in his Works Program or would require, or necessitate the use of alternative construction methods and/or resources, then the Contractor shall submit a written notice to the Engineer informing him of the situation and present his proposal to correct or remedy such adverse conditions.

B20.1.5 Inspection of Materials

Materials furnished under the Contract shall be subject to inspection, examination and tests at any time and in any condition both off-site and on-site. The Contractor shall furnish promptly without additional charge, all facilities, labor and materials reasonably needed for performing such inspection, examination and tests as may be required by the Engineer. Acceptance of materials or waiving of inspection thereof shall in no way relieve the Contractor of the responsibility for furnishing materials meeting the requirement of the Contract.

B20.1.6 Packaging

All materials and equipment shall be properly packed for transport to the Site so that they are protected against the climatic conditions to which they may be subjected in transit and in storage at the Site.

Each crate or package shall contain a packing list in a waterproof envelope. All cases, packages, etc., are to be marked carefully on the outside to indicate name of consignee entitled "(the Contractor's Name), c/o the Department of the Public Works and Highways and addressed to the Department Office in Port of Manila 2012, Philippines, the total weight and dimensions, and to show where the weight is bearing and the correct position of the slings.

B20.1.7 Stock of Materials

The Contractor shall be required to keep at all times sufficient stock of construction materials and equipment for his construction activities. Failure to do so shall be at the Contractor's risk. The Engineer shall not consider claims or requests for time extension of the Works due to Contractor’s inability to comply with this requirement.

B20.1.8 Quality Control

(5) Test of Material at the Site

Notwithstanding any previous inspections and tests, all materials delivered to the Site shall be subject to examinations and tests, if so requested by the Engineer. Should the Engineer or the Employer desire such test, the Contractor will be advised in sufficient time to permit such testing.

(a) All such examinations and tests shall be carried out by the Contractor at his cost in the presence of the Engineer's Representative in accordance with the normal practice in respect of such examinations and tests if the same may be carried out by the Contractor with his staff and equipment available at the Site.

(b) Otherwise, the tests shall be made at another laboratory approved by the Engineer at the cost of the Contractor.

The Engineer shall be at liberty to reject any materials that do not comply with the requirements of the Contract notwithstanding any previous approval thereof.

The Contractor shall not be entitled to any extra payment or extension of time for completion of the Works on account of the rejection of materials due to their non-compliance with the requirements of the Contract or of the waiting time reasonably required for carrying out the examinations and tests. Contractor shall furnish test samples as requested and shall provide reasonable assistance and cooperation as necessary to permit tests to be performed on materials or work in place including reasonable stoppage of work during testing.

(6) Test and Testing Laboratory

The Engineer will supervise such testing in the Contractor's laboratory as testing of concrete, aggregate, soil, etc., for the purpose of adequate and sufficient quality control of the Works during its execution. The Contractor shall provide a laboratory with necessary testing apparatus in his construction site. The Contractor shall provide sufficient number or volume of testing sample and perform the testing in accordance with the Specifications, and shall furnish one qualified staff and sufficient numbers of laboratory assistants, capable of carrying out standard tests specified in the Contract.

The Contractor shall carry out any field tests, such as field compaction test, concrete workability test, etc., in accordance with the manner and frequency prescribed in the Specifications and shall provide testing equipment and apparatus, and all testing staff, labor and consumables necessary for carrying out his field-testing. The Contractor shall prepare schedules of his field testing and supply of testing samples to the Engineer for the laboratory tests taking into account the work progress limited to the schedule.

B20.2 WORKMANSHIP

B20.2.1Standards of Workmanship

All workmanship shall be the best of its particular kind, and shall be carried out to the satisfaction of the Engineer.

B 20.2.2 Protection of Works from the Weather

The Contractor shall, at his own expense, carefully protect all works and materials from injury caused by the weather.

B 20.2.3 Orders to Foreman

Whenever the Contractor or his Site Engineer is not present on any part of the Works where the Engineer may decide to give orders or directions, such orders or directions shall be received and obeyed by the Foreman or other person who is in-charge of the particular work concerned. All foremen must be proficient in English or the Contractor must provide interpreters to the satisfaction of the Engineer as to their number and proficiency in English.

B 20.2.4 Straightedges

The Contractor shall furnish sufficient straightedges as may be specified by the Engineer to check concrete and other surfacing works.

The furnishing of straightedges will not be paid for directly, but all costs shall be deemed to have been included in the various items in the Bill of Quantities.

B 20.2.5 Contractor's Responsibility for Work

Where the approval of the Engineer is required under these Specifications, said approval should not relieve the Contractor of his duties or responsibilities under the Contract.

B 21 DRAWINGS AND DOCUMENTS

B 21.1 DOCUMENTS ISSUED TO THE CONTRACTOR

In connection with the Contract Documents furnished by the Employer, the Contractor is instructed to observe and comply with the following stipulations:

(1) The data which are obtained, recorded and given interpretation in accordance with accepted engineering principles, practices and methodology for purposes of design shall be considered as basis and reference in securing tenders and/or determining their working activities and construction operations. It is to be assumed that they may differ from those to be encountered and it is the Contractor's obligation to conduct his own field examination and investigation. The submission of tenders shall be construed as sufficient evidence that the Contractor has performed such examination and investigation.

(2) If during the execution of the Works there should exist variation from the data originally contained in the Contract Documents, it shall be the Contractor's responsibility to forthwith notify the Engineer in writing of such discrepancy, and the Engineer in turn shall in writing, issue an appropriate instruction. Unless evidenced by a written instruction, the Employer shall not entertain any claims of the Contractor arising from such a variation.

B 21.2 DRAWINGS TO BE FURNISHED BY THE ENGINEER

The Tender Drawings, which will consequently become the Contract Drawings, are for tendering purposes only. Provided that after the Contract Agreement was concluded, the Contractor may use the Contract Drawings as defined above as a basis for placing preliminary orders for materials and for preparing the working and shop drawings subject to revision based on the further issue of the Drawings as necessity arises to supplement, supersede or further set forth details shown on the Drawings during the progress of the Works.

The Contract Drawings shall not be used directly as a basis for fabrication and/or construction works.

After the issuance of the Letter of Acceptance, two (2) full size prints (76 x 102 cm) of Contract Drawings will be issued by the Engineer to the Contractor free of charge for the preparation of the working drawings required under the provision of Sub-Section GS.8.3 of this Specification.

On receipt of these Drawings, the Contractor shall check them carefully and notify the Engineer in writing of any discrepancies, errors or omissions and full instructions will be furnished to the Contractor should any discrepancies, errors or omissions be found. The Contractor will be required to perform the work in accordance with such further Drawings at the applicable unit or lump sums prices stated in the Bill of Quantities for such work or works of a similar nature.

Although the Drawings are prepared to scales, work shall be based upon dimensions shown on the Drawings and not on dimensions scaled from the Drawings.

B 21.3 DRAWINGS TO BE FURNISHED BY THE CONTRACTOR

All of the various types of drawings prepared by the Contractor shall be made in a form approved by the Engineer and shall be submitted in advance so that the Engineer can review and/or approve them without any delay to the Work.

The Contractor shall provide qualified and sufficient number of draftsmen and assistants capable of producing all drawings required.

After the Contractor's drawings have been reviewed and/or approved by the Engineer, they will become part of the Contract. Title given to a drawing is only to provide a general description and can be changed, as the Engineer deems necessary. These types of drawings include but are not following:

(1) Working Drawings

The Contractor will use the Contract Drawings as a basis for preparing the working drawings. The Contractor shall prepare the working Drawings based on the results of topographic, longitudinal and cross-section surveys. Such working drawings shall be made for all items of the permanent works and where applicable will show concrete outlines, bending/cutting schedules and layout of reinforcing steel bars, types of material to be used, grades, stations, exact dimensions and any other details which may be required. All working drawings shall be approved by the Engineer prior to the execution of the Works.

(2) Layout Drawings for the Temporary Works

Within twenty eight (28) calendar days calculated from the date of the receipt of Notice to Commence, the Contractor shall submit for the approval of the Engineer three (3) sets of drawings which show the layout of the Temporary Works. These drawings shall show the locations and other pertinent details of the principal components of the construction plant, offices, storage buildings, housing facilities, storage area, etc., which the Contractor proposes to construct at the Site or other authorized areas. In addition, the drawings shall show unloading facilities for materials and equipment which the Contractor proposes to bring to the Site, and the capacity of each major plant. If any change is made concerning the above-mentioned items during erection or after the items become operational, the Contractor shall submit revised drawings showing such changes to the Engineer for his reference.

(3) Record Drawings

The Contractor shall, during the progress of the work, keep a careful record of all changes where the actual installation differs from that shown on the Contract Drawings. Upon completion, the record drawings shall be the basis in the preparation of As-Built Drawings.

(4) As-Built Drawings

Throughout the period of construction, the Contractor shall prepare As-Built drawings for the various items of work which have been completed. Such drawings shall show any authorized change, which may have been made to the Contract Drawings, to the extent that they correctly portray the true "as-built" condition of each item of the Permanent Works. The format of the As-Built Drawings shall conform to the standard format of the Project and shall be drawn in ink on transparent tracing film (Mylar).

As-Built Drawings shall be subject to inspection at the Site by the Engineer's Representative, and if not found satisfactory and up-to-date, shall be re-checked within seven (7) working days. As each of the Permanent Works delineated on the Contract Drawings is completed, pertinent As-Built Drawings shall be prepared and submitted and, after approval by the Engineer, shall be mutually signed by the Engineer and the Contractor or their representative.

Within twenty-eight (28) days after the first day of Defects Liability Period, the Contractor shall furnish to both the Employer and the Engineer As-Built drawings which have been clearly revised and brought up to date showing the permanent construction actually made. The set of drawings and documents shall be of high quality reproducible material from which clear copies can be made. Five (5) sets of blueprinted copies of approved As-Built drawings shall be submitted to the Employer and one (1) set to the Engineer.

(5) Other Drawings

Drawings other than those mentioned above, which are of general nature such as proposed construction methods, schematic outlines of how various types of work are to be performed, etc., shall be submitted to the Engineer for his review and/or approval.

B 21.4 CATALOGS, DIAGRAMS AND SIMILAR DATA FOR EQUIPMENT AND MATERIALS

The Contractor shall submit to the Engineer for his approval three (3) sets of applicable catalogs, pamphlets, manufacturer's specifications, diagrams, drawings or other descriptive data for all materials and equipment to be furnished under the Contract. The approval by the Engineer of such descriptive data shall not relieve the Contractor of any of his responsibilities under the Contract.

B 21.5 SUBMISSION, REVIEW AND APPROVAL OF CONTRACTOR'S DRAWINGS

The Contractor shall, as required in the Contract, submit drawings and documents to the Engineer for review or approval at least twenty-eight (28) days prior to the execution of the work concerned with the said drawings and documents.

The procedure for the submission, review and/or approval of drawings and documents shall be understood to be as follows, provided that the Engineer shall reserve the right to make any changes to such procedure during the course of the works when the Engineer deems necessary.

When the Contractor is ready to have the Engineer review and/or approve certain drawings and documents, he shall submit three (3) copies of clearly readable blueprint copies of the drawings and documents, except otherwise provided in the other Section of these Specifications.

The Engineer shall approve the format of such drawings and documents. Within fourteen (14) days after receiving blue print copies of the drawings and documents from the

Contractor, the Engineer will return one copy marked with one of the following classifications, depending upon whether the drawings and documents are to be "approved" or "revised".

Classifications of Drawings and documents for Review/ Approval:

(1) "APPROVED"

(2) "APPROVED EXCEPT AS NOTED-RESUBMITTAL NOT REQUIRED"

(3) "RESUBMIT AFTER CORRECTION"

(4) "NOT APPROVED"

Upon receipt of drawings and documents which have been marked as shown in 1) or 2) above, the Contractor will be authorized to proceed with the work covered by such drawings and documents, making correction if indicated thereon by the Engineer. Copies of all approved drawings shall be maintained at the Contractor's site office.

When returned drawings and documents have been marked as shown in 3) above, the Contractor shall make necessary corrections and/or revisions to the drawings and documents in a timely manner and shall resubmit three (3) copies of revised drawings and documents to the Engineer. When returned drawings and documents have been re-submitted for approval, the Engineer will try to complete the review and/or approval, of the drawings and documents within seven (7) working days; however, this will depend on the number and complexity of the corrections/ revisions which have to be checked. This procedure will continue until drawings and documents have eventually been marked as shown in 1) or 2) above, at which time they will become a part of the Contract Documents.

None of the Permanent Works can be started until applicable drawings and documents have been approved by the Engineer. Prior to the start of the work, a joint inspection will be made by the Engineer and the Contractor to ensure that approved drawings and documents have been fully complied with. Any discrepancies or deficiencies, if discovered, shall be corrected before execution.

If it is necessary to make revisions of a drawing and/or document after it has been reviewed and/or approved, the Contractor shall resubmit it to the Engineer in the same manner specified herein before.

Any work done prior to the Engineer's approval of drawings and/or documents shall be at the Contractor's risk. Approval by the Engineer of the Contractor's drawings and/or documents shall not relieve the Contractor of his obligations under the Contract.

B 21.6 RIGHT TO CHANGE DESIGN AND DRAWINGS

When additional information regarding foundation, or other conditions becomes available as results of excavation work, further testing or otherwise, and if it may be found desirable to make changes in the alignment, cross sections, dimensions or design of the river or appurtenant structures to conform to such conditions, the Employer reserves the right to make such unavoidable changes as in the opinion of the Engineer are necessary or desirable to suit the actual field condition.

B 21.7 PAYMENT

Payment for preparation and submission of Contractor's drawings called for under this Section are deemed included in the contract prices of the items of work provided in the Bills of Quantities to which they so pertain.

B 22 SURVEY AND SOIL INVESTIGATION

B 22.1 BENCH MARKS

The Engineer will provide the Contractor the base benchmark map and reference survey as shown on the Drawings. The Contractor shall carry out a verification survey thereon before using any of these for setting out the Works and shall satisfy himself as to their accuracy. The Contractor may establish additional temporary benchmarks for his own convenience but each temporary bench so established shall be of a design and in location approved by the Engineer, and shall be accurately related to the base benchmark provided by the Engineer. The Contractor shall cooperate with the Engineer in carrying out a check survey or in performing survey and measurement for record and payment purposes.

The Contractor shall carry out all additional detailed survey necessary to extend the survey network in the Site and shall establish, maintain and preserve the permanent monuments and all bench marks, reference stations and the like.

No payment and time extension will be made for any work or delay caused by such check survey and setting out for the Works.

The Contractor shall give the Engineer not less than forty-eight (48) hour notice of his intention to stake out or establish levels for any part of the Works in order that arrangements may be made for checking. In the event that there is a discrepancy between the result of the survey of the Contractor and the pre –survey, the Engineer will, if he deems it necessary, revise the line and grade and require the Contractor to adjust the stakes accordingly. The Contractor shall measure the stake out and the Engineer will check the measurement and the approved measurements will be the basis of payment.

Any mark made by the Engineer or the Contractor shall be carefully preserved and, if disturbed or destroyed, shall be immediately replaced by the Contractor at his own expense to the satisfaction of the Engineer. No work shall be carried out in any section until the necessary setting-out in that section has been approved by the Engineer.

B 22.2 TOPOGRAPHIC, LONGITUDINAL AND CROSS SECTION SURVEYS

B 22.2.1 Scope of Work

Prior to commencing any work, the Contractor shall conduct topographic survey in plan including all planimetric features, longitudinal and cross section.

The survey program describing the scopes, methods, procedures and schedule shall be submitted by the Contractor to the Engineer for his approval at least ten (10) days before commencement of survey works.

The Contractor's survey drawings shall be drawn on transparent tracing film (Mylar) for print reproduction. When they have been finally approved, the survey drawings will be the basis for working drawing and measurement and payment. The Contractor shall give the Engineer the original tracings and three (3) prints of the approved drawings. The

drawings of surveys shall have a title block and be of the size prescribed by the Engineer.

Scale of the survey drawing shall be as follows unless directed by the Engineer:

Particular	Plan	Profile	Cross (V)	Section (H)
Dikes, Regulation Ponds	1/500	1/1000	1/100	1/200
Drainage Channels	1/200	1/1000	1/100	1/200
Other Structures	1/100	-	-	-

Contour line intervals shall as directed by the engineer.

B 22.2.2 Measurement and Payment

Measurement for` payment for this survey works including plan, longitudinal and cross sections, etc., will be made by the area actually surveyed as directed and approved by the Engineer.

Payment will be made at the rate per hectare tendered therefore in the priced Bill of Quantities. However if not in the tendered Pay Item, Payment for the survey works shall be deemed included in various rates and prices in the priced Bill of Quantities.

B 22.3 SETTING-OUT AND DEMARCATION OF RIGHT-OF-WAY

B 22.3.1 Scope of Work

The Contractor shall make any additional surveys and measurements that are required for the work such as slope stakes, temporary grade stakes, and structure layout, offset lines, etc. The Contractor shall be responsible for the accuracy of all surveys or measurements made by his staff.

In case of any alteration to the Contract Drawings, the Contractor shall submit to the Engineer three (3) copies of the setting out drawings. The Engineer will endorse one (1) copy with his approval, or his revision thereof, and return it to the Contractor. The Contractor shall resubmit to the Engineer for approval any Drawings that the Engineer may require to be revised.

B 22.3.2 Payment

All costs incurred by the Contractor in complying with the requirements of this Sub-Section shall be deemed included in the various rates and prices in the priced Bill of Quantities

B 23 WORKING SPACE, STORAGE AND STOCKPILING OF MATERIALS

Except for the construction Site described above, the Contractor shall be solely responsible for providing all other areas he may need for the construction of his temporary offices, warehouse, workshops, laboratory, storage areas, etc.

Materials shall not be stored on any roadway except where and as permitted by the Engineer. Stockpiling of construction materials shall be confined to such areas as may be approved by the Engineer. Additional space required, unless otherwise stipulated, shall be provided by the Contractor at his expense.

Where stockpiling is done outside of the right-of-way, the Contractor shall secure the permission of the property owner and the site shall be abandoned immediately when the portion of the Works for which it is required is completed, and the natural surfaces shall then be restored as nearly as possible to the original condition by the Contractor at his expense

The Contractor shall pay all costs, expenses, compensation or other disbursements, which may be incurred by him in negotiations with owner, occupier or public authority. The full costs, expenses, compensation or other disbursements shall be deemed to be included in the Contract Price. The Contractor shall be responsible for all damage, which he may do to land or property lying outside the working space as defined above.

B 24 PROTECTION AND RESTORATION OF PROPERTY

The Contractor shall be responsible for the preservation of all public and private property, monuments, telephone lines, other utilities, etc., along and adjacent to the Site insofar as they may be endangered by his operations; shall use every precaution necessary to prevent damage to pipes, conduits, and other underground structure; and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnesses or otherwise reference their location and shall not remove them until directed. Any utility lines damaged by the Contractor shall be repaired at once at his expense. All trails and roads adjacent to or intersecting the Works shall be protected from damage.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Works, or in consequence of the non-execution thereof on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring same or he shall make good such damage or injury in some other acceptable manner.

B 25 DRAINAGE AND CARE OF WATER

B 25.1 WORKS TO BE KEPT CLEAR OF WATER

The Contractor shall keep the Works well drained until the Engineer certifies that the whole of the Works is substantially complete and shall ensure that so far as practicable, all works is carried out in the dry. Excavated areas shall be kept well drained and free from running water.

The Contractor shall construct, operate and maintain all temporary cofferdams, watercourses and other works of all kinds including pumping, and well-point dewatering that may be necessary to exclude water from the Works while construction (including construction or erection works by subcontractor) is in progress. Such temporary works shall not be removed without the approval of the Engineer.

Notwithstanding any approval by the Engineer of the arrangements made for the exclusion of water, the Contractor shall be responsible for the sufficiency thereof, and shall be liable for keeping the Works safe during all floods, and for making good at his own expense any damage to the Works that may be attributed to floods. Any loss of production, additional overheads, or additional costs of any kind that may result from the floods shall be at the Contractor's own risk.

B 25.2 DISCHARGE OF WATER INTO EXISTING CHANNEL

The Contractor shall make provision for the discharge or disposal from the Works and Temporary Works of all water and waste arising there from and the method of disposal shall be to the satisfaction of the Engineer and any authority or person having an interest in any land or channel over or in which water may be discharged.

B 25.3 PROTECTION OF EXISTING DRAINAGE

No existing drainage pipe encountered where the flow of run-off is affected by the execution of any part or section of the Works shall, in anyway, be decommissioned but fully safe guarded during the duration of said execution of the Works. The Contractor shall provide temporary outlets to such affected drainage pipes subject to the approval of the Engineer until the same have been reconnected to their permanent outlets in accordance with the Contract or as per instruction of the Engineer.

The furnishing of plant, labor and materials in pursuance to the provisions described in this Sub-Section shall not be paid for separately but all costs shall be deemed to have been included in the Bill of Quantities tendered.

B 25.4 MEASUREMENT AND PAYMENT

Separate payment will not be made for the furnishing of plant, labor and materials in pursuance to the provisions described in this Sub-Section and the entire cost of this work shall be deemed included in the various rates and prices in the priced Bill of Quantities.

B 26 METRIC UNITS, CONVERSIONS AND ABBREVIATIONS

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

The following units and soft conversions from Imperial and SI to Metric measure shall be used throughout the Contract when metric units are not specified or not used in applicable standards.

Unit Name	Imperial	SI	Abbreviations
1 millimeter			mm
1 centimeter	= 0.3937 inch (")		cm
1 meter	= 3.2808 feet (ft)		
1 kilometer	= 0.621371 statute miles		km
1 hectare	= 2.47 acres (ac.)		ha
1 square millimeter			mm^2 or sq.mm
1 square centimeter			cm^2 or sq.cm
1 square meter			m^2 or sq.m
1 cubic meter			m^3or cu.m.
Mass			
1 gram			G
1 kilogram	= 2.204623 pounds	9.81 N	kg
1 tonne	= 1.1023 tons (short)	9.81 KN	t

Pressure			
1 kilogram per square centimeter	= 14.22 pounds per square inch	0.981 MPa	kg/cm^2
1 kilogram per square meter	= 0.205 pounds per square foot	98100 Pa	kg/m^2
Density			
1 tonne per cubic meter	= 62.428 pounds per cubic foot	9.81KN/m^3	t/m^3
1 kilogram per cubic centimeter			kg/m^3
Electro Mechanical			
1 "Pferdestarke"			PS
1 Kilowatt			KW
1 revolution per minute			RPM
1 gram per Pferdestarke-Hour			g/PS-hr
1 Kilovolt Ampere			KVA
1 liter per Kilowatt hours			lit/KW-hr
1 volt			V
1 number(s)			no(s)
1 Hertz			Hz
Length			L
Width			W
Height			H
1 cubic meter per second			m^3/sec or cu.m/sec
1 millimeter mercury			mm Ag
1 cubic meter per minute			m^3/min or cu.m/min
1 Kilo-calorie per hour			Kcal/hr
1 liter per minute			l/min
1 Celsius, Centigrade			C
1 liter			Li
1 Newton cubic meter per minute			Nm^3/min
1 degree			º or deg
1 tonne per hour			t/hr

B27 WATER CONTROL

B 27.1 GENERAL

The Contractor shall design, construct and maintain all temporary diversion and protective works and dewatering systems that are necessary to protect the various parts of the Works from water originating from any source in conjunction with B.13, Division I, General Specifications

At all times during construction of the Works, the Contractor shall maintain a drainage capacity at least equivalent to that of the existing system.

Diversion and protective works shall be located such that there is no encroachment on any area required for construction of the Works.

Control of water shall at all times be subject to the approval of the Engineer with regard to sufficiency of measures taken and environmental protection.

On completion of the Works all diversion and protective works and dewatering systems shall be removed and disposed of so as not to interfere in any way with the operation or usefulness of the Works, and the Site restored in a manner to give a slightly appearance.

B27.2 RESPONSIBILITY FOR WORKS

The Contractor shall be fully responsible for any damage or delay to the Works caused by failure of the diversion and protective works and/or dewatering installations, and shall indemnify the Employer against claims by landholders or other persons arising out of any such failure.

The Contractor shall be responsible for, and shall repair or reinstate at its expense, any damage to any part of the Works caused by the failure of the diversion and protective works and/or dewatering installations.

B 27.3 WATER CONTROL PLAN

At least 28 days before commencing any construction work, the Contractor shall submit to the Engineer a detailed Water Control Plan describing the proposed methods for control of water.

Diversion of, or interference with, the natural flow of rivers or drainage channels on the Site for any purpose shall be subject to approval.

B 27.4 SURFACE EXCAVATIONS

The Contractor shall take all necessary steps to ensure that any water entering any surface excavation does not endanger the stability of the surface excavation at any time.

The Contractor shall ensure that no concentration or accumulation of water occurs either within or around or above the area of any open excavation that may affect the safety of the excavation.

Where excavations are not self-draining, sufficient pumps and sumps shall be installed to keep the water level in such sumps at least 0.5 m below the lowest excavated surfaces for as long as required for construction of the Works. Standby pumps shall be readily available in case of breakdowns.

B 27.5 DEWATERING IN WET GROUND

The Contractor shall maintain all excavations free from water, from whatever source, to the extent necessary for the execution of the Works or in the interests of safety.

Trenches where the ground water is close to or above the bottom of the trench shall be dewatered to provide stable foundations for drainage structures and to enable construction in the dry.

Dewatering operations shall be kept to the minimum necessary for the execution of the Works. In designing dewatering systems, the Contractor shall mitigate the effect of such dewatering on settlement of, and possible damage to, nearby existing properties and structures. The Contractor shall monitor adjacent ground levels and properties and structures for settlement and damage during the construction period.

Dewatering shall continue until the drainage structures have been sufficiently completed so as to prevent flotation of the structure.

B 27.6 TEMPORARY DIVERSION OF EXISTING DRAINAGE

The Contractor shall construct temporary diversion structures and/or channels to manage the flow of drainage water during the construction period.

Such temporary diversion structures and/or channels shall be of sufficient capacity to cope with expected drainage flows and construction shall be of a standard that will minimize erosion and other detrimental effects.

B 27.7 WATER CONTROL DURING CONCRETING

All water which could flow into an area to be concreted shall be diverted clear of the area. Water arising within the area to be concreted shall be piped or pumped clear of the area.

Pumping shall be done in such a manner as to prevent any of the concrete materials being carried away. No pumping shall be done during the placing of concrete, or for a period of 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall.

B 27.8 COFFERDAMS

Cofferdams shall be constructed where necessary to protect concrete work against damage from a sudden rise of the river water level, to allow construction of parts of the Works that are below water level and to prevent erosion of embankment foundations.

Cofferdams shall be founded well below the bottom of the footings or embankment toes, constructed to a height sufficient to seal off all water, and shall be well braced and as watertight as practicable. Sufficient clearances shall be maintained between the outside line of footings or walls and the interior sides of cofferdams to provide space for formwork and to permit pumping outside the forms.

No shoring that will induce stress, shock, or vibration in any part of the Permanent Works will be permitted. Cross-struts or bracing shall not extend into the structure without written permission from the Engineer.

Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.
After the completion of the structure or embankment to a level where protection is no longer necessary, the cofferdams shall be removed in such manner as not to disturb or mar the finished work.

After removal of cofferdams, the area shall be cleaned of debris and other objectionable material. All temporary fills shall be excavated and disposed of as approved.

B27.9 MEASUREMENT AND PAYMENT

Separate payment will not be made for control of water and the entire cost of this work shall be deemed included in the various rates and prices in the priced Bill of Quantities.

PART C - EARTHWORKS

ITEM 100- CLEARING AND GRUBBING

100.1 Description

This item shall consist of clearing, grubbing, removing and disposing all vegetation and debris as designated in the Contract except those object that are designated to remain in place or are to be removed in consonance with other provisions of this Specification. The work shall also include the preservation from injury or defacement of all objects designated to remain.

100.2 Construction Requirements

100.2.1General

The Engineer will establish the limits of work and designate all trees, shrubs, plants and other things to remain. The Contractor shall preserve all objects designated to remain. Paint required for cut or scarred surface of trees or shrubs selected for retention shall be an approved asphaltum base paint prepared especially for tree surgery.

Clearing shall extend one (1) meter beyond the toe of the fill slopes or beyond rounding of cut slopes as the case maybe for the entire length of the project unless otherwise shown on the plans or as directed by the Engineer and provided it is within the right of way limits of the project, with the exception of trees under the jurisdiction of the Forest Management Bureau (FMB).

100.2.2 Clearing and Grubbing

All surface objects all trees, stumps, roots and other protruding obstructions, not designated to remain, shall be cleared and/or grubbed, including mowing as required, except as provided below:

(1) Removal of undisturbed stumps and roots and nonperishable solid objects or slope with a minimum depth of one (1) meter below subgrade or slope of embankment will not required.
(2) In areas outside of the grading limits of cut and embankment areas, stumps and nonperishable solid objects shall be cut off not more than 150 mm (6 inches) above the ground line or low water level.
(3) In areas to be rounded at the top of cut slopes, stumps shall be cut off flush with or below the surface of the final slope line.
(4) Grubbing of pits, channel changes and ditches will be required only to the depth necessitated by the proposed excavation within such areas.
(5) In area covered by cogon/talahib, wild grass and other vegetation, top soil shall be cut to a maximum depth of 150 mm, below the original ground surface or as designated by the Engineer, and disposed outside the clearing and grubbing limits as indicated in the typical roadway section.

    Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted to the required density.

If perishable material is burned, it shall be burned under the constant care of component watchmen at such times and in such a manner that the surrounding vegetation, other adjacent property, or anything designated to remain on the right way will not be jeopardized. If permitted, burning shall be done in accordance with applicable laws, ordinances, and regulation.

The Contractor shall use high intensity burning procedures, (i.e., incinerators, high stacking or pit and ditch burning with forced air supplements) that produce intense burning process. At the conclusion of each burning session, the fire shall be completely extinguished so that no smoldering debris remains.

In the event that the Contractor is directed by the Engineer not to start burning operations or to suspend such operations because of hazardous weather conditions, material to be burned which interferes with subsequent construction operations shall be moved by the Contractor to temporary locations clear of construction operations and later, if directed by the Engineer, shall be placed on a designated spot and burned.

Materials and debris which cannot be burned and perishable materials may be disposed off by method and at locations approved by the Engineer, on or off the project. If disposal is by burying, the debris shall be placed in layers with the material so disturbed to avoid nesting. Each layer shall be covered or mixed with earth material by the land-fill method to fill all voids. The top layer of material buried shall be covered with at least 300 mm (12inches) of earth or other approved material and shall be graded, shaped and compacted to present a pleasing appearance. If the disposal location is off the project, the Contractor shall make all necessary arrangements with property owners in writing for obtaining suitable disposal locations which are outside the limits of view from the project. The cost involved shall be included in the unit bid price. A copy of such agreement shall be furnished to the Engineer. The disposal areas shall be seeded, fertilized and mulched at the Contract's expense.

Woody material may be disposed off by chipping. The wood chips may be used for mulch, slope erosion control or may be uniformly spread over selected areas as directed by the Engineer. Wood chips used as mulch for slope erosion control shall have a maximum thickness of 12 mm (1/2 inch) and faces not exceeding 3900 mm^2 (6 square inches) on any individual surface area. Wood chips not designated for use under other sections shall be spread over the designated for use under sections shall be spread over the designated areas in layers not exceed 75 mm (3 inches) loose thickness. Diseased trees shall be buried or disposed off as directed by the Engineer.

All merchantable timber in the clearing area which has not been removed from the right of way prior to the beginning of construction shall become the property of the Contractor, unless otherwise provided.

Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be trimmed to give a clear height of 6 m (20 feet) above the roadbed surface. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

Timber cut inside the area staked for clearing shall be felled within the area to be cleared.

100.2.3 Individual Removal of Trees or Stumps

Individual trees or stumps designated by the Engineer for removal and located in areas other than those established for clearing and grubbing and roadside cleanup shall be removed and disposed off as specified under Subsection 100.2.2 except trees removed shall be cut as nearly flush with the ground practicable without removing stumps.

100.3 Method of Measurement

Measurement will be by or more the following alternate methods:

1. Area Basis. The work to be paid for shall be the number of hectares and fractions thereof acceptably cleared and grubbed within the limits indicated on the Plans or as may be adjusted n filed staking by the Engineer. Areas not within the clearing and grubbing limits shown on the Plans or not staked for clearing and grubbing will not be measured for payment.
2. Lump-Sum Basis. When the Bill of Quantities contains a Clearing and Grubbing lump-sum item, no measurement of area will be made for such item.
3. Individual Unit Basis (Selective Clearing). The diameter of trees will be measured at a height of 1.4 m (54 inches) above the ground. Trees less than 150 mm (6 inches) in diameter will not be measured for payment.

When Bill of Quantities indicated measurement of trees by individual unit basis, the units will be designated and measured in accordance with the following schedule of sizes.

Diameter at height of 1.4 m	Pay Item Designation
Over 150 mm to 900 mm Over 900 mm	Small Large

100.4 Basis of Payment

The accepted quantities, measured prescribed in Section 100.3, shall be paid for at the Contract unit price for each of the Pay Items listed below that in included in the Bill of Quantities, which price and payment shall be full compensation for furnishing all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
100 (1)	Clearing and Grubbing	Hectare
100 (2)	Clearing and Grubbing	Lump Sum
100 (3)	Individuals Removal of Trees, Small	Each
100 (4)	Individual removal of Trees, Large	Each

ITEM 100(4) BALLING AND REPLANTING OF TREES

100(4).1 Description

This item shall consist of balling and replanting of trees to places specified by the owner. These trees are taken from the area that are affected at the site of the proposed construction of viaduct as designated in the contract. The work shall also include the preservation from the damage of all the objects designated to remain.

100(4).2 Construction Requirements

100(4).2.1 General

The engineer will establish the number of designated trees to be transferred to the areas preferred by the owner without violating any city ordinances, forestry laws, and environmental laws, to ensure protection and conservation of natural resources for the benefit of the country.

100(4).2.2 Application of Balling

Earth-balling and Pruning/Trimming permits, regardless of number of trees are approved at the Community Environment and Natural Resources Office(CENRO) level. However, those who apply for cutting, earth-balling and trimming/pruning at the same time, the authority issuing office depends on the number of trees affected: For 10 trees and below, permits are issued by the CENRO; for more than 10 but less than 30 trees, permits are issued by the PENRO; for 31 to 50 trees, the regional executive director of the DENR will issue the permit. When there are more than 50 trees that will be affected by the abovementioned processes, the approving authority is the DENR Secretary.

The application shall consider the following;

a) Apply for Tree Cutting Permit based on existing laws and DENR rules and regulations;
b) List down the number of trees at the affected areas and submit necessary documentary requirements for the application of tree cutting permit;
c) Submit Earth-balling and Transplanting Plan, if applicable;
d) The applicant is allowed to cut only on the “footprints” of the Transmission towers and facilities; and
e) The applicant is allowed to only trim and prune in between tower sites.

100(4).2.3 Construction Procedure

The DENR has identified two methods to be used when earth-balling trees and vegetation — bare-root and balled-and-burlapped.

The bare-root method is usually employed when transplanting shrubs or small trees up to two inches or five centimeters in diameter.

The balled-and-burlapped method, meanwhile, is done for trees that are more than two inches in diameter that have to be moved during its growing season, and when the tree is considered difficult to transplant.
This method specifies that the balled-and-burlapped tree must have a soil ball.

The DENR has specified the corresponding size of the soil ball in proportion to the depth.
Earth-balling procedure:

1. Remove loose materials around the tree/vegetation to avoid causing surface roots injury or cut.
2. A circle of about six inches or 15 centimeters, bigger than the diameter of the soil ball, shall be marked which will be the basis for final trimming of the tree prior to transfer.
3. Use a spade in digging nine to 12 inches (21-31 cm) depth around the marked circle.
4. The soil ball is shaped by rounding off the top edge of the ball making a uniformly-tapered, nearly oval ball.
5. Smaller soil balls for small trees/vegetation can be manually transferred by sacking. However, mechanical equipment like cranes must be employed for trees with bigger diameters, especially heritage trees.
6. The earth-balled tree must be transplanted not more than 24 hours after its removal from its original location.

The Contractor shall backfill all the deeper excavation where the trees are removed with good material and compact to the required degree of compaction especially for areas where a permanent structure shall be constructed.

Replanting of trees shall be taken care off to prolong the life of the trees. Should the trees died due to Contractor's incompetence or negligence, he shall pay or replace the tree with equal or greater than the replanted tree. However, should there be a need to irrigate the newly planted trees, the Contractor shall continue to do so and take care of the trees by means of watering until the said tree regain its life before turning over to the owner in a good condition.

100(4).3 Method of Measurement

The Method of Measurement shall be made paid per number of trees balled and replanted in a growing condition.

When Bill of Quantities indicates measurement of trees by individual unit basis, the units will be designated and measured in accordance with the following schedule of sizes:

Diameter (mm)	Pay Item Designation
Below 900	Small
Above 900	Large

100(4).4 Basis of Payment

The accepted quantities, measured as prescribed in Section 100(4)-3, shall be paid for at the Contract unit price listed in the Bill of Quantities, which price and payment shall be full compensation for furnishing all labor, equipment, tools and incidentals necessary to complete the work prescribed in this item.

ITEM 101 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

101.1 Description

This item shall consist of the removal wholly or in part, and satisfactory disposal of all buildings, fences, structures, old pavements, abandoned pipe lines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed off under other items in the Contract. It shall also include the salvaging of designated and backfilling the resulting trenches, holes, and pits.

101.2 Construction Requirements

101.2.1 General

The Contractor shall perform the work described above, within and adjacent to the roadway, on Government land or easement, as shown on the Plans or as directed by the Engineer. All designated salvable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places on the project or as otherwise shown in the Special Provisions. Perishable material shall be handled as designated in Subsection 100.2.2. Nonperishable material may be disposed off outside the limits of view from the project with written permission of the property owner on whose property the material is placed. Copies of all agreement with property owners are to be furnished to the Engineer. Basements or cavities left by the structure removal shall be filled with acceptable material to the level of the surrounding ground and, if within the prism of construction, shall be compacted to the required density.

101.2.2 Removal of Existing Bridges, Culverts, and other Drainage Structures

All existing bridges, culverts and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic. The removal of existing culverts within embankment areas will be required only as necessary for the installation of new structures. Abandoned culverts shall be broken down, crushed and sealed or plugged. All retrieved culvert for future use as determined by the Engineer shall be carefully removed and all precautions shall be employed to avoid breakage or structural damage to any of its part. All sections of structures removed which are not designated for stockpiling or re-laying shall become the property of the Government and be removed from the project or disposed off in a manner approved by the Engineer.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down to at least 300 mm (12 inches) below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Steel bridges and wood bridges when specified to be salvaged shall be carefully dismantled without damaged. Steel members shall be match marked unless such match marking is waived by the Engineer. All salvaged material shall be stored as specified in Subsection 101.2.1.

Structures designated to become the property of the Contractor shall be removed from the right -of-way.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work, unless otherwise provided in the Special Provisions.

101.2.3 Removal of Pipes Other than Pipe Culverts

Unless otherwise provided, all pipes shall be carefully removed and every precaution taken to avoid breakage or damaged. Pipes to be relaid shall be removed and stored when necessary so that there will be no loss of damage before re-laying. The Contractor shall replace sections lost from storage or damage by negligence, at his own expense.

101.2.4 Removal of Existing Pavement, Sidewalks, Curbs, etc.

All concrete pavement, base course, sidewalks, curbs, gutters, etc., designated for removal, shall be :

(1) Broken into pieces and used for riprap on the project, or

(2) Broken into pieces, the size of which shall not exceed 300 mm (12 inches) in any dimension and stock piled at designated locations on the project for use by the Government, or

(3) Otherwise demolished and disposed off as directed by the Engineer. When specified, ballast, gravel, bituminous materials or other surfacing or pavement materials shall be removed and stockpiled as required in Subsection 101.2.1, otherwise such materials shall be disposed off as directed.

There will be no separate payment for excavating for removal of structures and obstructions or for backfilling and compacting the remaining cavity.

101.3 Method Measurement

When the Contract stipulates that payment will be made for removal of obstruction on lump-sum basis, the pay item will include all structures and obstructions encountered within the roadway. Where the contract stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the Contract.

Whenever the Bill of Quantities does not contain an item for any aforementioned removals, the work will not be paid for directly, but will be considered as a subsidiary obligation of the Contactor under other Contract Items.

101.4 Basis of Payment

The accepted quantities, measured as prescribed in Section 101.3, shall be paid for at the Contract unit price or lump sum price bid for each of the Pay Items listed below that is included in the Bill of Quantities which price and payment shall be full compensation for removing and disposing of obstructions, including materials, labor, equipments, tools and incidentals necessary to complete the work prescribed in this item.

The price shall also include backfilling, salvage on the right-of-way and disposal as provided herein.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
101 (1)	Removal of Existing Market Hall	Sq.m.
101 (2)	Removal of Existing structure	Sq.m.
101 (3)	Removal of existing rock bulkhead prior for pile driving	Cu. m.
101 (4)	Removal of reinforced concrete piles cut to seabed elevation	Cu.m.

ITEM 102- EXCAVATION

102.1 Description

This Item shall consist of roadway and drainage and borrow excavation and the disposal of material in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Plans or established by the Engineer.

102.1.1 Roadway Excavation

Roadway excavation will include excavation and grading for roadways, parking areas, intersections, approaches, slope rounding, benching, waterways and ditches; removal of unsuitable material from the road bed and beneath embankment areas; and excavating selected material found in the roadway as ordered by the Engineer for specific use in the improvement. Roadway excavation will be classified as “unclassified excavation”, “rock excavation”, “common excavation”, or “muck excavation” as indicated in the Bill of Quantities and hereinafter described.

(1) Unclassified Excavation. Unclassified excavation shall consist of the excavation and disposal of all materials regardless of its nature, not classified and included in the Bill of Quantities under other pay items.

(2) Rock Excavation. Rock excavation shall consist of igneous, sedimentary and metamorphic rock which cannot be excavated without blasting or the use or ripper, and all boulders or other detached stones each having a volume of 1 cubic meter or meter as determined by physical measurements or visually by the Engineer.

(3) Common Excavation. Common excavations shall consists of all excavation not included in the Bill of Quantities under” rock excavation” or other pay items.

(4) Muck Excavation. Muck excavation shall consist of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter not suitable for foundation material regardless of moisture content.

102.1.2 Borrow Excavation

Borrow excavation shall consists of the excavation and utilization of approved material required for the construction of embankments or for other portion of the work, and shall be obtained from approved sources, in accordance with Clause 61 and the following:

(1) Borrow, Case 1

Borrow Case 1 will consist of material obtained from sources designated on the Plans or in the Special Provisions.

(2) Borrow, Case 2

Borrow Case 2 will consist of material obtained from sources provided by the Contractor. The material shall meet the quality requirements determined by the Engineer unless otherwise provided in the Contractor.

The material shall meet the quality determined by the Engineer unless otherwise provided in the Contract.

102.2 Construction Requirements

102.2.1 General

When there is evidence of discrepancies on the actual elevations and that shown on the Plans a pre-construction survey referred to the datum plane used in the approved Plan shall be undertaken by the Contractor under the control of the Engineer to serve as basis for the computation of the actual volume of the excavated materials.

All excavations shall be finished to reasonably smooth and uniform surfaces. No materials shall be wasted without authority of the Engineer. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to excavation, all necessary clearing and grubbing in that area shall have been performed in accordance with Item 100, Clearing and Grubbing.

102.2.2 Conservation of Topsoil

Where provided for on the Plans or in the Special Provisions, suitable topsoil encountered in excavation and on areas where embankment is to be placed shall be removed to such extent and to such depth as the Engineer may direct. The removed topsoil shall be transported and deposited in storage piles at locations approved by the Engineer. The topsoil shall be completely removed to the required depth from any designated area prior to the beginning of regular excavation or embankment work in the area and shall be kept separate from other excavated materials for later use.

102.2.3 Utilization of Excavated Materials

All suitable material removed from the excavation shall be used in the formation of the embankment, subgrade, shoulders, slopes, bedding, and backfill for structures, and for other purposes shown on the Plans or as directed.

The Engineer will designate as unsuitable those soils that cannot be properly compacted in embankments. All unsuitable material shall be disposed off as shown on the Plans or as directed without delay to the Contractor.

Only approved materials shall be used in the construction of embankments and backfills.

All excess materials, including rock ad boulders that cannot be used in embankments shall be disposed off as directed.

Material encountered in the excavation and determined by the Engineer as suitable for topping, road finishing, slope protection, or other purposes shall be conserved and utilized as directed by the Engineer.

Borrow material shall not be placed until after the readily accessible roadway excavation has been placed in the fill, unless otherwise permitted or directed by the Engineer. If the Contractor places more borrow than is required and thereby causes a waste of excavation, the amount if such waste will be deducted from the borrow volume.

102.2.4 Prewatering

Excavation areas and borrow pits may be prewatered before excavating the material. When prewatering is used, the areas to be excavated shall be moistened to the full depth, from the surface to the bottom of the excavation. The water shall be controlled so that the excavated material will contain the proper moisture to permit compaction to the specified density with the use of standard compacting equipment. Prewatering shall be supplemented where necessary, by truck watering units, to ensure that the embankment material contains the proper moisture at the time of compaction.

The Contractor shall provide drilling equipment capable of suitably checking the moisture penetration to the full depth of the excavation.

102.2.5 Presplitting

Unless otherwise provided in the Contract, rock excavation which requires drilling and shooting shall be presplit.

Presplitting to obtain faces in the rock and shale formations shall be performed by: (1) drilling holes at uniform intervals along the slope lines, (2) loading and stemming the holes with appropriate explosives and stemming material, and (3) detonating the holes simultaneously.

Prior to starting drilling operations for presplitting, the Contractor shall furnish the Engineer a plan outlining the position of all drill holes, depth of drilling, type of explosives to be used, loading pattern and sequence of firing. The drilling and blasting plan is for record purposes only and will not absolve the Contractor of his responsibility for using proper drilling and blasting procedures. Controlled blasting shall begin with a short test section shall be presplit, production drilled and blasted and sufficient material excavated whereby the Engineer can determine if the Contractor's method are satisfactory. The Engineer may order discontinuance of the presplitting when he determines that the materials encountered have become unsuitable for being presplit.

The holes shall be charged with explosives of the size, kind strength, and at the spacing suitable for the formations being presplit, and with stemming material which passes a 9.5 mm (3/8 inch) standard sieve and which has the qualities for proper confinement of the explosives.

The finished presplit slope shall be reasonably uniform and free of loose rock. Variance from the true plane of the excavated backslope shall not exceed 300 mm (12 inches); however, localized irregularities or surface variations that do not constitute a safety hazard or an impairment to drainage courses or facilities will be permitted.

A maximum offset of 600 mm (24 inches) will be permitted for a construction working bench at the bottom of each lift for use in drilling the next lower presplitting pattern.

102.2.6 Excavation of Ditches, Gutters, etc.

All materials excavated from side ditches and gutters, channel changes, irrigation ditches, and such other ditches as may be designated on the Plans or staked by the Engineer, shall be utilized as provided in Subsection 102.2.3.

Ditches shall conform to the slope, grade, and shape of the required cross-section, with no projections of roots, stumps, rock, or similar matter. The Contractor shall maintain and keep open and free from leaves, sticks, and other debris all ditches dug by him until final acceptance of the work.

Furrow ditches shall be forms by plowing a continuous furrow along the line staked by the Engineer. Methods other than plowing may be used if acceptable to the Engineer. The ditches shall be cleaned out by hand shovel work, by ditcher, or by some other suitable method, throwing all loose materials on the downhill side so that the bottom of the finished ditch shall be approximately 450 mm (18 inches) below the crest of the loose material piled on the downhill side. Hand finish will not be required, but the flow lines shall be in satisfactory shape to provide drainage without overflow.

102.2.7 Excavation of Roadbed Level

Rock shall be excavated to a depth of 150 mm (6inches) below subgrade within the limits of the roadbed, and the excavation backfilled with material designated on the Plans or approved by the Engineer and compacted to the required density.

When excavation methods employed by the Contractor leave undrained pockets in the rock surface, the Contractor shall at his own expense, properly drain such depressions or when permitted by the Engineer fill the depressions with approved impermeable material.

Material below subgrade, other than sold rock shall be thoroughly scarified to a depth of 150 (6 inches) and the moisture content increased or reduced, as necessary, to bring the material throughout this 150 mm layer to the moisture content suitable for maximum compaction. This layer shall then be compacted in accordance with Subsection 104.3.3.

102.2.8 Borrow Areas

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross-section elevations and measurements of the ground surface after stripping may be taken, and the borrow material can be tested before being used. Sufficient time for testing the borrow material shall be allowed.

All borrow areas shall be bladed and left in such shape as to permit accurate measurements after excavation has been completed. The Contractor shall not excavated beyond the dimensions and elevations established, and no material shall be removed prior to the staking out and cross-sectioning of the site. The finished borrow areas shall be approximately true to line and grade established and specified and shall be finished, as prescribed in Clause 61, Standard Specifications for Public Works and Highways, Volume 1. When necessary to remove fencing, the fencing shall be replaced in at least as good condition as it was original. The Contractor shall be responsible for the confinement of livestock when a portion of the fence is removed.

102.2.9 Removal of Unsuitable Material

Add the following paragraph:

When any material, including excess unsuitable material from excavations, is to be disposed of outside the right-of-way the Contractor shall first obtain a written permit from the property owner of the proposed disposal site. He shall then submit to the Engineer the said permit or a certified copy thereof together with a written release by the property owner absolving the government from any and all responsibility in connection with the disposal of materials on his property. No disposal of any material shall be done on the disposal site before a permission is granted by the Engineer. The disposal of material at the site as provided above shall be made in a neat and uniform manner and to the satisfaction of the Engineer.

102.3 Methods of Measurement

The cost of excavation of material which is incorporated in the Works or in other areas of fill shall be deemed to be included in the Items of Work where the material is used.

Measurement of Unsuitable or Surplus Material shall be the net volume in its original position.

For measurement purposes, surplus suitable material shall be calculated as the difference between the net volume of suitable material required to be used in embankment corrected by applying a shrinkage factor or a swell factor in case or rock excavation, determined by laboratory tests to get its original volume measurement, and the net volume of suitable material from excavation in the original position. Separate pay items shall be provided for surplus common, unclassified and rock material.

The Contractor shall be deemed to have included in the contract unit prices all costs of obtaining land for the disposal of unsuitable or surplus material.

102.4 Basis of Payment

The paragraph under this Section is amended as follows:

The accepted quantities, measured as prescribed in Section 102.3 shall be paid for at the contract unit price for each of the Pay Items listed below that are included in the Bill of Quantities, which price and payment shall be full compensation for the removal and disposal of excavated materials including labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item, inclusive of haul and any “overhaul” described under Item 107.

Payment will be made under:

Payment Item	Description	Unit of Measurement
102 (1)	Unsuitable Excavation	cu.m
102 (2) Surplus	Common Excavation	cu.m.

ITEM 103 - STRUCTURE EXCAVATION

103.1 Description

This Item shall consist of the necessary excavation for foundation of bridge, culverts, underdrains, and other structures not otherwise provided for in the Specifications. Except as otherwise provided for pipe culverts, the backfilling of completed structures and the disposal of all excavated surplus materials, shall be in accordance with these Specifications and in reasonably close conformity with the Plans or as established by the Engineer.

This Item shall include necessary diverting of live streams, bailing, pumping, draining, sheeting, bracing, and necessary construction of cribs and cofferdams, and furnishing the materials therefore, and the subsequent removal of cribs and cofferdams and the placing of all necessary backfill.

It shall also include the furnishing and placing of approved foundation fill material to replace unsuitable material encountered below the foundation elevation of structures.

No allowances will be made for classification of different types of material encountered.

103.2 Construction Requirements

103.2.1 Clearing and Grubbing

103.2.2 Excavation

General, all structures. The Contractor shall notify the Engineer sufficiently in advance of the beginning of any excavation so that cross-sectional elevations and measurements may be taken on the undisturbed ground. The natural ground adjacent to the structure shall not be disturbed without permission of the Engineer.

Trenches or foundation pits for structures or structure footing shall be excavated to the lines and grades or elevations shown on the Plans or as staked by the Engineer. They shall be of sufficient size to permit the placing of structures or structure footing of the full width and length shown. The elevations of the bottoms of footings, as shown on the Plans, shall considered as approximate only and the Engineer may order; in writing, such changes in dimensions or elevations of footings as may be deemed necessary, to secure a satisfactory foundation.

Boulders, logs and other objectionable materials encountered in excavation shall be removed.

After each excavation is completed, the Contractor shall notify the Engineer to that effect and no footing, bedding material or pipe culvert shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

Structures other than pipe culverts. All rocks or other hard foundation materials shall be cleaned all loose materials, and cut to a firm surface, either level, stepped, or serrated as directed by the Engineer. All seams or crevices shall be cleaned and grouted. All loose and disintegrated rocks and thin strata shall be removed. When the footing is to rest on material other than rock, excavation to final grade shall not be made until just before the footing is to placed. When the foundation material is soft or mucky or otherwise unsuitable, as determined by the Engineer, the Contractor shall remove the unsuitable

material and backfill with approved granular material. This foundation fill shall be placed and compacted in 150 mm (6 inches) layers up to the foundation elevation.

When foundation piles are used, the excavation of each pit shall be completed before the piles are driven and any placing of foundation fill shall be done after the piles are driven. After the driving is completed, all loose and displaced materials shall be removed, leaving a smooth, solid bed to receive the footing.

Pipe Culverts. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe.

Where rock, harden, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 300 mm or 4 mm for each 100 mm of fill over the top of pipe, whichever is greater, but not exceed three- quarters of the vertical inside diameter of the pipe. The width of the excavation shall be at least 300 mm (12 inches) greater than the horizontal outside diameter of the pipe. The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 150 mm (6 inches) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil such unstable soil under the pipe and for a width of at lest one diameter on each side of the pipe shall be removed to the depth directed by the Engineer and replaced with approved granular foundation fill material properly compacted to provide adequate support for the pipe, unless other special construction methods are called for on the Plans.

The foundation surface shall provide a firm foundation of uniform density throughout the length of the culvert and, if directed by the Engineer, shall be cambered in the direction parallel to the pipe centerline.

Where pipe culverts are to be placed in trenches excavated in embankments, the excavation of each trench shall be performed after the embankment has been constructed to a plane parallel to the proposed profile grade and to such height above the bottom of the pipe as shown on the Plans or directed by the Engineer.

103.2.3 Utilization of Excavated Material

All excavated material, so far as suitable, shall be utilized as backfill or embankment. The surplus materials shall be disposed off in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure. No excavated materials shall be deposited at any times so as to endanger the partly finished structure.

103.2.4 Cofferdams

Suitable and practically watertight cofferdams shall be used wherever water-bearing strata are encountered above the elevation of the bottom of the excavation. If requested, the Contractor shall submit drawings showing his proposed method of cofferdam construction, as directed by the Engineer.

Cofferdams or cribs for foundation construction shall in general, be carried well below the bottoms of the footings and shall be well braced and as nearly watertight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit

pumping outside of the forms. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance.

When conditions are encountered which, as determined by the Engineer, render it impracticable to dewater the foundation before placing the footing, the Engineer may require the construction of a concrete for such a thickness as to resist any possible uplift. The concrete for such seal shall be placed as shown on the Plans or directed by the Engineer. The foundation shall then be dewatered and the footing placed. When weighted cribs are employed and the mass is utilized to overcome partially the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire mass of the crib to the foundation seal. When a foundation seal is placed under water. The cofferdams shall be vented or ported at low water level as directed.

Cofferdams shall be constructed so as to protect green concrete against damage from sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into substructure masonry, without written permission from the Engineer.

Any pumping that may be permitted from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete material being carried away. Any pumping required during the placing of concrete, or for a period of at least 24 hours thereafter, shall be done from a suitable sump located outside the concrete forms. Pumping to dewater a sealed cofferdam shall not commence forms. Pumping to dewater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

Unless otherwise provided, cofferdams or cribs, with all sheeting and bracing involved therewith, shall be removed by the Contractor after the completion of the substructure. Removal shall be effected in such manner as not to disturb or mar finished masonry.

103.2.5 Preservation of Channel

Unless otherwise permitted, no excavation shall be made outside of caissons, cribs, cofferdams, or sheet piling, and the natural stream bed adjacent to structure shall not be disturbed without permission from the Engineer. If any excavation or dredging is made at the side of the structure before caissons, cribs, or cofferdams are sunk in place, the Contractor shall, after the foundation base is in place, backfill all such excavations to the original ground surface or stream bed with material satisfactory to the Engineer.

103.2.6 Backfill and Embankment for Structures Other than Pipe Culverts

Excavated areas around structures shall be backfilled with free draining granular material approved by the Engineer and placed in horizontal layers not over 150 mm (6inches) in thickness, to the level of the original ground surface. Each layer shall be moistened or dried as required and thoroughly compacted with mechanical tampers.

In placing backfills or embankment, the material shall be placed simultaneously in so far as possible to approximately the same elevation on both sides of an abutment, pier or wall. If conditions require placing backfill or embankment appreciably higher on one side shall not be placed until masonry has been place for 14 days, or until tests made by the laboratory under the supervision of the Engineer establishes that the masonry has attained sufficient strength to withstand any pressure created by the methods used and materials placed without damage or strain beyond a safe factor.

Backfill or embankment shall not be placed behind the walls of concrete culverts or abutments or rigid frame structures until the top slab is placed and cured. Backfill and embankment behind abutments held at the top by the superstructure, and behind the sidewalls of culverts, shall be carried up simultaneously behind opposite abutments or sidewalls.

All embankments adjacent to structures shall be constructed in horizontal layers and compacted as prescribed in Subsection 104.3.3 except that mechanical tampers may be used for the required compaction. Special care shall be taken to prevent any wedging action against the structure and slopes bounding or within the areas to be filled shall be benched or serrated to prevent wedge action. The placing of embankment and the benching of slopes shall continue in such a manner that at all times there will be horizontal berm of thoroughly compacted material for a distance at least equal to the height of the abutment or wall to the backfilled against except insofar as undisturbed material obtrudes upon the area.

Broken rock or coarse sand and gravel shall be provided for a drainage filter at weepholes as shown on the Plans.

103.2.7 Bedding, Backfill, and Embankment for Pipe Culverts

Bedding, Backfill and Embankment for pipe culverts shall be done in accordance with Item 500, Pipe Culverts and Storm Drains.

103.3 Method of Measurement

103.3.1 Structure Excavation

The volume of excavation to be paid for will be the number of cubic metres measured in original position of material acceptably excavated on conformity with the Plans as directed by the Engineer, but in no case, except as noted, will any of the following volumes be included in the measurement for payment.

The volume outside of vertical planes 450 mm (18inches) outside of and parallel to the neat lines of footings and the inside walls of pipe and pipe-arch culverts at their widest horizontal dimensions.

The volume of excavation for culvert and sections outside the vertical plane for culverts stipulated in (1) above.

The volume outside of neat lines of underdrains as shown on the Plans, and outside the limits of foundation fill as ordered by the Engineer.

The volume included within the staked limits of the roadway excavation, contiguous channel changes, ditches, etc., for which payment is otherwise provided in the Specification,

Volume of water or other liquid resulting from construction operations and which can be pumped or drained away.

The volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed ground.

The volume of any material rehandled ,except that where the Plans indicate or the Engineer directs the excavation after embankment has been placed and except that

when installation of pipe culverts by the imperfect trench method specified in Item 500 is required, the volume of material re-excavated as directed will be included.

The volume of excavation for footings ordered at a depth more than 1.5m (60inches) below the lowest elevation for such footings shown on the original Contract Plans, unless the Bill of Quantities contains a pay item for excavation ordered below the elevations shown on the Plans for individual footings.

103.3.3 Free Draining Backfill

The Contractor shall supply, place and compact free-draining backfill to the lines, grades and dimensions and in the locations shown on the Drawings or instructed.

Free draining backfill shall be obtained from approved sources and shall be well graded with a maximum dimension of 150 mm, and not more than 5% smaller than 0.075 mm. Freed draining backfill placed within 1 m of concrete structures shall not contain rocks larger than 75 mm in maximum dimension and shall be placed carefully so as not to damage the structure.

The material shall be handled and placed in such a manner as to prevent segregation.

Free draining backfill shall be deposited in horizontal layers not more than 150 mm thick after being compacted, and shall be thoroughly wetted for the purpose of compaction, as determined by the Engineer, and the moisture content shall be uniform throughout the layer.

Free draining backfill shall be compacted with 2 passes of a vibratory plate compactor having a minimum static mass of 100 kg.

103.3.5 Basis of Payment

The accepted quantities, measured as prescribed in Section 103.3, shall be paid for at the contract unit price for each of the particular pay items listed below that is included in the Bill of Quantities. The payment shall constitute full compensation for the removal and disposal of excavated materials including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item, except as follows:

Any excavation for footings ordered at a depth more than 1.5m below the lowest elevation shown on the original Contract Plans will be paid for as provided in Part K, Measurement and Payment, unless a pay item for excavation ordered below Plan elevation appears in the Bill of Quantities.

Concrete will be measured and paid for as provided under Item 405, Structural Concrete. Any roadway or borrow excavation required in excess of the quantity excavated for structures will be measured and paid for as provided under Item 102.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
103 (1)	Structure Excavation	Cubic Meter
103 (2)	Backfill (from structural excavation)	Cubic Meter
103 (3)	Foundation Fill	Cubic Meter
103 (4)	Excavation ordered below Plan elevation	Cubic Meter
103 (6)	Pipe culverts and drain excavation	Cubic Meter

ITEM 104 EMBANKMENT

104.1 Description

This Item shall consist of the construction of embankment in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Plans or established by the Engineer.

104.2 Material Requirements

Embankments shall be constructed of suitable materials, in consonance with the following definitions:

1. Suitable Material – Material which is acceptable in accordance with the Contract and which can be compacted in the manner specified in this Item. It can be common material or rock.

   Selected Borrow, for topping – soil of such gradation that all particles will pass a sieve with 75 mm (3inches) square openings and not more than 15 mass percent will pass the 0.075 mm (No. 200) sieve, as determined by AASHTO T 11. The material shall have a plasticity index of not more than 6 as determined by ASSHTO T 90 and a liquid limit of not more than 30 as determined by AASHTO T 89.

2. Unsuitable Material – Material other than suitable materials such as:

Materials containing detrimental quantities of organic materials, such as grass, roots and sewerage.
Organic soils such as peat and muck.
Soils with liquid limit exceeding 80 and/or plasticity index exceeding 55.
Soils with a natural water content exceeding 100%.
Soils with very low natural density, 800 kg/m^3 or lower.
Soils that cannot be properly compacted as determined by the Engineer.

104.3 Construction Requirements

104.3.1 General

Prior to construction of embankment, all necessary clearing and grubbing in that area shall have been performed in conformity with Item 100, Clearing and Grubbing.

Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are a to be placed; the construction of dikes within or adjacent to the roadway; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and placing and compacting of embankment material in holes, pits, and other depressions within the roadway area.

Embankments and backfills shall contain no muck, peat, sod, roots, or other deleterious matter. Rocks, broken concrete or other solid, bulky materials shall not be placed in embankment areas where piling is to be placed or driven.

Where shown on the Plans or directed by the Engineer, the surface of the existing ground shall be compacted to a depth of 150 mm (6 inches) and to be specified requirements of this item.

Where provided on the Plans and Bill of Quantities the top portions of the roadbed in both cuts and embankments, as indicated, shall consist of selected borrow for topping from excavations.

104.3.2 Methods of Constructions

Where there is evidence of discrepancies on the actual elevations and that shown on the Plans, a preconstruction survey referred to the datum plane used in the approved Plan shall be undertaken by the Contractor under the control of the Engineer to serve as basis for the computation of the actual volume of the embankment materials.

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half width at a time, the existing slopes that are steeper than 3:1 when measured at right angles to the roadway shall be continuously benched over those areas as the work is brought up in layers. Benching will be subject to the Engineer's approval and shall be of sufficient width to permit operation of placement and compaction equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus excavated shall be placed and compacted along with the embankment material in accordance with the procedure described in this Section.

Unless shown described on the Plans or special Provisions, where an embankment of less than 1.2 m (4 feet) below subgrade is to be an made, all sod and vegetable matter shall be removed from the surface upon which the embankment is to placed, and the cleared surfaced shall be completely broken up by plowing, scarifying, or steeping to a minimum depth of 150 mm except as provided in Subsection 102.2.2.This area shall then be compacted as provided in Subsection 104.3.3. Sod not required to be removed shall be thoroughly disc harrowed or scarified before construction of embankment. Wherever a compacted road surface containing granular materials lies within 900 mm (36 inches) of the subgrade, such old road surface shall be scarified to a depth of at least 150 mm (6 inches) whenever directed by the Engineer. These scarified materials shall then be compacted as provided in Subsection 104.3.3.

When shoulder excavation is specified, the roadway shoulders shall be excavated to the depth and width shown on the Plans. The shoulder material shall be removed without disturbing the adjacent existing base course material, and all excess excavated materials shall be disposed off as provided in Subsection 102.2.3. If necessary, the areas shall be compacted before being backfilled.

Roadway embankment of earth material shall be placed in horizontal layers not exceeding 200 mm (8 inches), loose measurement, and shall be compacted as specified before the next layer is placed. However, thicker layer maybe placed if vibratory roller with high compactive effort is used provided that density requirements are attained and as approved by the Engineer. Trial section to this effect must be conducted and approved by the Engineer. Trial section to this effect must be conducted and approved by the Engineer. Effective spreading equipment shall be used on each lift to obtain uniform thickness as determined in the trial section prior to compaction. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Water shall be added or removed. If necessary. In order to obtain the required density. Removal of water shall be accomplished through aeration by plowing, blading, discing, or other methods satisfactory to the Engineer.

Where embankment is to be constructed across low swampy ground that will not support the mass of trucks or other hauling equipment, the lower part of the fill may be

constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers.

When excavated material contains more than 25 mass percent of rock larger than 150 mm in greatest diameter and cannot be placed in layers of the thickness prescribed without crushing, pulverizing or further breaking down the pieces resulting from excavation methods, such materials may be placed on the embankment in layers not exceeding in thickness the approximate average size of the larger rocks, but not greater than 600 mm (24 inches).

Even though the thickness of layers is limited as provided above, the placing of individual rocks and boulders greater than 600 mm in diameter will be permitted provided that when placed, they do not exceed 1200 mm (48inches) in height and provided they are carefully distributed, with the interstices filled with finer material to a form a dense and compact mass.

Each layer shall be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of earth. Lifts of material containing more than 25 mass percent of rock larger than 150 mm in greatest dimensions shall not be constructed above an elevation 300 mm (12inches) below the finished subgrade. The balance of the embankment shall be composed of suitable material smoothed and placed in layers not exceeding 200 mm (8 inches) in loose thickness and compacted as specified for embankments.

Dumping and rolling areas shall be so routed and distributed over each layer of the fill in such a manner as to make use of compaction effort afforded thereby and to minimize rutting and uneven compaction.

104.3.3 Compaction

Compaction Trials

Before commencing the formation of embankment, the Contractor shall submit in writing to the Engineer for approval his proposals for the compaction of each type of fill material to be used in the works. The proposals shall include the relationship between the types of compaction equipment, and the number of passes required and the method of adjusting moisture content. The Contractor shall carry out full scale compaction trials on areas not less than 10m wide and 50 m long as required by the Engineer and using his proposed procedures or such amendments thereto as may be found necessary to satisfy the Engineer that all the specified requirements regarding compaction can be consistently achieved. Compaction trials with the main types of fill materials to be used in the works shall be completed before work with the corresponding materials will be allowed to commence.

Throughout the periods when compaction of earthwork is in progress, the Contractor shall adhere to the compaction procedures found from compaction trials for each type of material being compacted, each type of compaction equipment employed and each degree of compaction specified.

EARTH

The Contractor shall compact the material placed in all embankment layers and the material scarified to the designated depth below subgrade in cut sections, until a uniform density of not less than 95 mass percent of the maximum dry density determined by

AASHTO T 99 Method C, is attained, at a moisture content determined by Engineer to be suitable for such density. Acceptance of compaction may be based in adherence to an approved roller pattern developed as set forth in Item 106, Compaction Equipment and Density Control Strips.

The Engineer shall during progress of the Work, make density tests of compacted material in accordance with AASHTO T 191, T 205, or other approved field density tests, including the use if properly calibrated nuclear testing devices. A correction for coarse particles may be made in accordance with AASHTO T 224. If, by such tests, the Engineer determines that the specified density and moisture conditions have not been attained, the Contractor shall perform additional work as may be necessary to attain the specified conditions.

At least one group of three in-situ density tests shall be carried out for each 500 m of each layer of compacted fill.

ROCK

Density requirements will not apply to portions of embankments constructed of materials which cannot be tested in accordance with approved methods.

Embankment materials classified as rock shall be deposited spread and leveled the full width of the fill with sufficient earth or other fine material so deposited to fill the interstices to produce a dense compact embankment. In addition, one of the rollers, vibrators, or compactors meeting the requirements set forth in subsection 106.2.1, Compaction Equipment, shall compact the embankment full width with a minimum of three complete passes for each layer of embankment.

104.3.4 Protection of roadbed during Construction

During the construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments or otherwise shall be so constructed as to avoid damage to embankments by erosion.

104.3.5 Protection of Structure

If embankment can be deposited on one side only of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overtuning of, or excessive pressure against the structure. When noted on the Plans, the fill adjacent to the end bent of a bridge shall not bet be placed higher that the bottom of the backfill of the bent until the superstructure is in place. When embankment is to be placed on both sides of a concrete wall or box type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.

104.3.6 Rounding and Warping Slopes

Rounding –Except in solid rock, the tops and bottoms of all slopes, including the slopes of drainage ditches, shall be rounded as indicated on the Plans. A layer of earth overlaying rock shall be rounded above the rock as done in earth slopes.

Warping-adjustments in slopes shall be made to avoid injury in standing trees or marring of weathered rock, or to harmonize with existing landscape features, and the transition to such adjusted slopes shall be gradual. At intersections of cuts and fills, slopes shall be

adjusted and warped to flow into each other or into the natural ground surfaces without noticeable break.

104.3.7 Finishing Roadbed and Slopes

After the roadbed has been substantially completed, the full width shall be conditioned by removing any sift or other unstable material that will not compact properly or serve the intended purpose. The resulting areas and all other low sections, holes of depressions shall be brought to grade with suitable selected material. Scarifying, blading, dragging, rolling, or other methods of work shall be performed or used as necessary to provide a thoroughly compacted roadbed shaped to the grades and cross-sections shown on the Plans or as staked by the Engineer.

All earth slopes shall be left with roughened surfaces but shall be reasonably uniform, without any noticeable break, and in reasonably close conformity with the Plans or other surfaces indicated on the Plans or as staked by the Engineer, with no variations therefrom readily discernible as viewed from the road.

104.3.8 Serrated Slopes

Cut slopes in rippable material (soft rock) having slope ratios between 0.75:1 and 2:1 shall be constructed so that the final slope line shall consist of a series of small horizontal steps. The step rise and tread dimensions shall be shown on the Plans. No scaling shall be performed on the stepped slopes except for removal of large rocks which will obviously be a safety hazard if they fall into the ditchline or roadway.

104.3.9 Earth Berms

When called for in the Contract, permanent earth berms shall be constructed of well graded materials with no rocks having a diameter greater than 0.25 the height of the berm. When local material is not acceptable, acceptable material shall be imported, as directed by the Engineer.

104.3.10 Compacted Berm

Compacted berm construction shall consist of moistening or drying and placing material as necessary in locations shown on the drawings or as established by the Engineer. Material shall contain no frozen material, roots, sod, or other deleterious material. Contractor shall take precaution to prevent material from escaping over the embankment slope. Shoulder surface beneath berm will be roughened to provide a bond between the berm and shoulder when completed. The Contractor shall compact the material placed until at least 90 mass percent of the maximum density is obtained as determined by AASHTO T 99, Method C. The cross-section of the finished compacted berm shall reasonably conform to the typical cross-section as shown on the Plans.

104.3.11 Uncompacted Berm

Uncompacted berm construction shall consist of drying, if necessary and placing material in locations shown on the Plans or as established by the Engineer. Material shall contain no frozen material, roots, sod or other deleterious materials. Contractor shall take precautions to prevent material from escaping over the embankment slope.

104.4 Method of Measurement

The quantity of embankment to be paid for shall be the volume of material compacted in place, accepted by the Engineer and formed with material obtained from any source.

Material from excavation per Item 102 which is used in embankment and accepted by the Engineer will be paid under Embankment and such payment will be deemed to include the cost of excavating, hauling, stockpiling and all other costs incidental to the work.

104.5 Basis of Payment

The accepted quantities, measured as prescribed in Section 104.4, shall be paid for at the Contract unit price for each of the Pay Items listed below that is included in the Bill of Quantities. The payment shall continue full compensation for placing and compacting all materials including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
104 (1)	Embankment	Cubic Meter
104 (2)	Selected, Borrow for topping, Case 1	Cubic Meter
104 (3)	Selected Borrow for topping, Case 2	Cubic Meter
104 (4)	Earth Berm	Meter

ITEM 105 SUBGRADE PREPARATION

105.1 Description

This Item shall consist of the preparation of the subgrade for the support of overlying structural layers. It shall extend to full width of the roadway. Unless authorized by the Engineer, subgrade preparation shall not be done unless the Contractor is able to start immediately the construction of the pavement structure.

105.2 Material Requirements

Unless otherwise stated in the Contract and except when the subgrade is in rock cut, all materials below subgrade level to a depth 150mm or to such greater depth as may be specified shall meet the requirements of Section 104.2, Selected Borrow for Topping.

105.3 Construction Requirements

105.3.1 Prior Works

Prior to commencing preparation of the subgrade, all culverts, cross drains, ducts and the like (including their fully compacted backfill), ditches, drains and drainage outlets shall be completed. Any work on the preparation of the subgrade shall not be started unless prior work herein described shall have been approved by the Engineer.

105.3.2 Subgrade Level Tolerance

The finished compacted surface of the subgrade shall conform to the allowable tolerances as specified hereunder:

Permitted variation from	+	20 mm
design LEVEL OF SURFACE	-	30 mm
Permitted SURFACE IRREGULARITY MEASURED BY 3-m STRAIGHT EDGE		30 mm
Permitted variations from design CROSSFALL OR CAMBER	+	0.5%
Permitted variation from design LONGITUDINAL GRADE over 25 m length	- + -	0.1%

105.3.3 Subgrade in Common Excavation

Unless otherwise specified, all materials below subgrade level in earth cuts to a depth 150 mm or other depth shown on the Plans or as directed by the Engineer shall be excavated. The material, if suitable, shall be set side for future use or, if suitable, shall be disposed off in accordance with the requirements of Subsection 102.2.9.

Where material has been removed from below subgrade level, the resulting surface shall be compacted to a depth of 150 mm and in accordance with the requirements of Subsection 104.3.3.

All materials immediately below subgrade level in earth cuts to a depth of 150 mm, or to such greater depth as may be specified, shall be compacted in accordance with the requirements of Subsection 104.3.3.

105.3.4 Subgrade in Rock Excavation

Surface irregularities under the subgrade level remaining after trimming of the rock excavation shall be leveled by placing specified material and compacted to the requirements of Subsection 104.3.3.

105.3.5 Subgrade on Embankment

After the embankment has been completed, the full width shall be conditioned by removing any soft or other unstable material that will not compacted properly. The resulting areas and all other low sections, holes, or depressions shall be brought to grade with suitable material. The entire roadbed shall be shaped and compacted to the requirements of Subsections 104.3.3. Scarifying, blading, dragging, rolling, or other methods of work shall be performed or used as necessary to provide a thoroughly compacted roadbed shaped to the cross-sections shown on the Plans.

105.3.6 Subgrade on Existing Pavement

Where the new pavement is to be constructed immediately over an existing Portland Cement concrete pavement and if so specified in the Contract the slab be broken into pieces with greatest dimensions of not more than 500 mm and the existing pavement material compacted as specified in Subsection 104.3.3, as directed by the Engineer. The resulting subgrade level shall, as part pavement construction be shaped to conform to the allowable tolerances if Subsection 105.3.2 by placing and compacting where necessary a leveling course comprising the material of the pavement course to be placed immediately above.

Where the new pavement I to be constructed immediately over an existing asphalt concrete pavement or gravel surface pavement and if so specified in the Contract the pavement shall be scarified, thoroughly loosened, reshaped and recompacted in

accordance with Subsection 104.3.3. The resulting subgrade level shall conform to the allowable tolerances of Subsection 105.3.2.

105.3.7 Protection of Completed Work

The Contractor shall be required to protect and maintain at his own expense the entire work within the limits of his Contract in good condition satisfactory to the Engineer from the time he first started work until all work shall have been completed. Maintenance shall include repairing and recompacting ruts, ridges. Soft spots and deteriorated sections of the subgrade caused by the traffic of the Contractor's vehicle/equipment or that of the public.

105.3.8 Templates and Straight-edges

The contractor shall provide for use of the Engineer, approved templates and straight-edges in sufficient number to check the accuracy of the work, as provided in this Specification.

105.4 Method of Measurement

105.4.1 Measurement of Items for Payment shall be provided only for:

1. The compaction of existing ground below subgrade level in cuts of common material as specified in Subsection 105.3.3.

2. The breaking up or scarifying, loosening, reshaping and recompacting of existing pavement as specified in Subsection 105.36.6. The quantity to be paid for shall be the area of the work specified to be carried out and accepted by the Engineer.

105.4.2 Payment for all work for the preparation of the subgrade, including shaping to the required levels and tolerances, other than as specified above shall be deemed to be included in the Pay Item for Embankment.

105.5 Basis of Payment

The accepted quantities, measured as prescribed in Section 105.4, shall be paid for at the appropriate contract unit price for Pay Item listed below that is included in the Bill of Quantities which price and payment shall be full compensation for the placing or removal and disposal of all material including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.
Payment will be made under:

Pay Item Number	Description	Unit of Measurement
105 (1)	Subgrade Preparation (Common Material)	Square Meter
105 (2)	Subgrade Preparation (Existing Pavement)	Square Meter
105 (3	Subgrade Preparation (Unsuitable Material)	Square Meter

ITEM 106 COMPACTION EQUIPMENT AND DENSITY CONTROL STRIPS

106.1 Description

When specified, this procedure will be used to determine density requirements of selected embankments, subgrade, bases, and bituminous concrete. The procedure will consist of control strip construction to establish target densities testing equipment to determine in-place densities obtained during the construction process.

106.2 Construction Requirements

106.2.1 Compaction Equipment

Compaction equipment shall be capable of obtaining compaction requirements without detrimentally affecting the compacted material. The equipment shall be modern, efficient compacting units approved by the Engineer. The compacting units may be of any type, provided they are capable of compacting each lift of material as specified and meet the minimum requirements as contained herein. Minimum requirements for rollers are as follows:

1. Sheepsfoot, tamping or grid rollers shall be capable of exerting a force of 45 Newton per millimeter (250 pounds per inch) if length of roller drum.
2. Steel-wheel rollers other than vibratory shall be capable of exerting a force of not less than 45 Newton per millimeter of width of the compression roll or rolls.
3. Vibratory steel-wheel rollers shall have a minimum mass of 6 tonnes. The compactor shall be equipped with amplitude and frequency controls and specifically designed to compact the material on which it is used.
4. Pneumatic-tire rollers shall have smooth tread tires of equal size that will provide a uniform compacting pressure for the full width of the roller and capable of exerting a ground pressure of at least 550 kpa (80 pounds per square inch)
5. Heavier compacting unit may be required to achieve the specified density of the embankment.

106.2.2 Construction of Control Strips and Determination of Target Density

To determine target density, a control strip shall be constructed at the beginning of work each course of material to be compacted. Each control strip, constructed to acceptable density and surface tolerances shall remain in place and become a section of the completed roadway. Unacceptable control strip shall be corrected or removed and replaced at the Contractor's expense. A control strip shall have an area or approximately 335 square meters and shall be of the same depth specified for the construction of the course which It represents.

The material used in the construction of the control strip shall conform to the specification requirements. They shall be furnished from the same source and shall be of the same type to be used on the remainder of the course represented by the control strip. The underlying grade or pavement structure upon which a control strip is to be constructed shall have the prior approval of the Engineer.

The equipment used in the construction of the control strip shall be approved by the Engineer and shall be of the same type and mass to be used on the remainder of the course represented by the control strip.

Compaction of control stripes shall commence immediately after the course has been placed to the specified thickness, and shall be continuous and uniform over the entire

surface. Compaction of the control strip shall be continued until no discernible increase in density can be obtained by additional compactive effort.

Upon completion of the compaction, the mean density of the control strip will be determined by averaging the results of ten in-place density tests taken at randomly selected sites within the control strip. The mean density of the control strips shall be the target density for the remainder of the course which it represents.

If the mean density of the control strip is less than 98 percent of the density of laboratory compacted specimens as determined by testing procedures appropriate for the material being placed, the Engineer may order the construction of another control strip.

A new control strip may also be ordered by the Engineer or requested by the Contractor when:

A change in the material or job-mix formula, is made.

Ten days of production have been accepted without construction of a new control strip. There is reason to believe that a control strip density is not representative of the material being placed.

106.3 Method of Measurement

No measurement for payment will be made for this Item.

106.4 Basis of Payment

Unless otherwise provided, the cost of constructing the control strip will be considered incidental to the cost of the work item for which a control strip is require. Payment for the work item shall be deemed to include compensation for performing the work herein specified and the furnishing of all materials. labor ,tools, equipment and incidentals necessary to construct the density control strip. No payment will be made for any material used in the construction of unacceptable control strip.

ITEM 107 OVERHAUL

107.1 Description

Overhaul shall consist of authorized hauling in excess of the free-haul distance is the specified distance that excavated material shall be hauled without additional compensation. Unless otherwise provided in the Contract, the free-haul distance shall be 600 meters.

107.2 Method of Measurement

In determining what constitutes authorized overhaul, it will be assumed that material taken from excavation will be deposited in embankment after having been haled the shortest distance.

The overhaul distance for material obtained and placed within the roadway limits will be measured along the centerline of the roadway. No allowance will be made for transverse or lateral movement to or from the centerline except materials moved to of from designated areas outside the roadway limits; such as Case 1, Borrow Pits, disposal areas, etc. In such case, measurement shall be along the shortest route determined by the Engineer to be feasible and satisfactory unless otherwise provided.

If the Contractor chooses to haul material over some other route, and such other route is longer, the computation for payment shall be based on the overhaul distance measured along the route designated by the Engineer.

The number of cubic metre-kilometres of overhaul to be paid for shall be the number of cubic meters of overhaul material multiplied by the overhaul distance in kilometers. The unit: cubic meter-kilometer" is the amount of hauling required to move one cubic meter a distance of one kilometer beyond the free-haul distance.

107.3 Basis of Payment

The accepted quantities, measured as prescribed in Section 107.2, shall be paid for the contract unit price for Overhaul, for the particular Pay Item listed below that is shown on the Bill of Quantities, which price and payment shall be full compensation for overhaul, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.

Payment will not be made for overhaul of Borrow, Case 2, Foundation Fill, bedding materials and material removed in the rounding of cut slopes when rounding is a separate pay item.

When the Bill of Quantities does not show estimated quantities for "Overhaul" from the Pay Item listed below, overhaul will not be directly paid for, but will be considered as a subsidiary obligation of the Contractor under other contract items.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
107 (1)	Overhaul	Cubic Meter-kilometer
107 (2)	Overhaul of Borrow, Case 1	Cubic Meter-kilometer

PART D - SUBBASE AND BASE COURSE

ITEM 200 AGGREGATE SUBBASE COURSE

200.1 Description

This work shall consist of furnishing, placing and compacting an aggregate subbase course on a prepared subgrade in accordance with this Specification and the lines, grades and cross-sections shown on the Plans, or as directed by the Engineer.

200.2 Material Requirements

Aggregate for subbase shall consist of hard, durable particles or fragments of crushed stone, crushed slag, or crushed or natural gravel and filler of natural or crushed sand or other finely divided mineral matter. The composite material shall be free from vegetable matter and lumps or balls of clay, and shall be of such nature that it can be compacted readily to form a firm, stable subbase. The subbase material shall conform to Table 200.1, Grading Requirements.

Table 200.1 – Grading Requirements

Sieve Designation		Mass Percent Passing
Standard, mm	Alternate US Standard	
50	2”	100
25	1”	55 – 85
9.5	3/8”	40 – 75
0.075	No. 200	0 - 12

200.3 Construction Requirements

200.3.2 Placing

The aggregate subbase material shall be placed at a uniform mixture on prepared subgrade in quantity which will provide the required compacted thickness. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer placed.

200.3.3 Spreading and Compacting

After the Subsection 200.3.3 add the following:

Except that grading shall not disturb the surface or otherwise, the compacting requirement shall be in accordance with Subsection 200.3.3 and the base shall be replaced of the finished lines, levels, thickness or tolerance are unsatisfactory.

200.4 Method of Measurement

Aggregate subbase will be measured by the cubic meter (m3). The quantity to be paid for shall be design volume compacted in-place as shown on the Plans, and accepted in the completed course. No allowance will be given for materials placed outside the design limits shown on the cross-sections.

200.5 Basis of Payment

Payment will be made under:

Pay Item No.	Description	Unit Measurement
200 (1)	Aggregate Subbase Course	Cubic Meter
200 (2)	Compacted Selected Fill	Cubic Meter

ITEM 202 CRUSHED AGGREGATE BASE COURSE

202.1 Description

Sub-clause 1 is modified to read as follows:

This work shall consist of furnishing, hauling, spreading, leveling and compacting crushed aggregate base course material of crushed stone, crushed gravel or crushed rock, constructed on a prepared sub-grade or sub-base in one or more layers, in accordance with the Specification and Drawings.

202.2 Material Requirements

Aggregate for base course shall consist of hard, durable particles or fragments of stone or gravel crushed to the size and the quality requirements of the item. It shall be clean and free from vegetable matters, lumps or balls of clay, and other deleterious substances. The material shall be of such nature that it can be compacted readily to form a firm, stable base. The base material shall conform to the grading requirements of Table 202.1, Grading Requirements

Table 202.1 – Grading Requirements

Sieve Designation		Mass Percent Passing
Standard, mm	Alternate US Standard	
50	2”	100
25	1”	55 – 85
9.5	3/8”	40 – 75
0.075	No. 200	0 - 12

202.3 Construction Requirements

202.3.2 Placing

In this Subsection add the following to Section 201.3.2:

An approved motorized grader shall be used in placing the crushed aggregate base.

202.3.3 Spreading and Compacting

After the Subsection 201.3.3 add the following:

Except that grading shall not disturb the surface or otherwise, the compacting requirement shall be in accordance with Subsection 201.3.3 and the base shall be replaced of the finished lines, levels, thickness or tolerance are unsatisfactory.

202.4 Method of Measurement

Crushed Aggregate Base Course will be measured by the cubic meter (m3). The quantity to be paid for shall be design volume compacted in-place as shown on the Plans, and accepted in the completed course. No allowance will be given for materials placed outside the design limits shown on the cross-sections.

200.5 Basis of Payment

Payment will be made under:

Pay Item No.	Description	Unit Measurement
202	Crushed Aggregate Base Course	Cubic Meter

PART E - SURFACE COURSE

ITEM 300 - AGGREGATE SURFACE COURSE

300.1 Description

In this paragraph, change "on a prepared base" with "on a prepared sub-base".

300.2 Material Requirements

The crushed aggregate surface course is part of structure constructed above the sub-base course. It consists of hard durable particles of fragments stone of crushed gravel to its size and of the quality to its requirements. It shall be clean, free from deleterious substance, vegetable matters, lumps and clays; and can be compacted readily to form firm stable base. The fraction passing the 0.075 mm (No. 200) sieve shall not be greater than 0.66 (two thirds) of the fraction passing the 0.425 mm (No. 4) sieve. The fraction passing the 0.425 mm (No. 4) sieve shall have the liquid limit shall not be greater than 35 and the plasticity index ranging from 6 ~ 11 as determined by AASHTO T89 and T90 respectively. The Los Angeles Abrasion test determined by AASHTO T96 will not exceed to 50 mass percent wear retained at 2.0 mm (No. 10) Sieve. At least one (1) fractured face and the material passing the 19 mm (3/4inc) sieve shall have a CBR value of not less than 80% when tested to AASHTO T193 and shall be compacted to at least 100% of the maximum dry density as determined by AASHTO T180 Method D. The materials and the maximum size of crushed base course shall be grading "A", 1 1/2" refer to **Table 202.1**" Grading Requirements" of 1995 DPWH Standard Specifications.

If filler, in addition to that naturally present, is necessary for meeting the grading requirements or for satisfactory bonding, it shall be uniformly blended with the base course material on the road or in a pug mill unless otherwise specified or approved by the Engineer. Filler shall be taken from the approved sources, shall be free from hard lumps and shall not contain more than 15 percent of material retained on the 0.425 mm (No. 4) sieve.

300.3 Construction Requirements

Same as Subsections 201.3.1 through 201.3.5 under Item 201: "Aggregate Base Course."

300.4 Basis of Payment

This Subsection shall conform to Section 202.5: "Basis of Payment" of the DPWH Standard Specifications, 1995 Edition.
Payment will be made under:

Pay Item No	Description	Unit of Measurement
300 (1)	Aggregate Surface Course	cu.m.

ITEM 301- BITUMINOUS PRIME COAT

301.1 Description

This item shall consist of preparing and treating an aggregate base course with material in accordance with the Plans and Specifications, preparatory to the construction of a bituminous surface course.

301.2 Material Requirements

Bituminous material shall be either Rapid Curing (RC) or Medium Curing (MC) Cut-back Asphalt, whichever is called for in the Bill of Quantities. It shall conform to the requirements if Item 702, Bituminous Materials. The type and grade shall be specified in the Special Provisions.

301.3 Construction Requirements

301.3.1 Surface Condition

Prime coat shall be applied only to surfaces which are dry or slightly moist. No prime coat shall be applied when the weather is foggy or rainy.

301.3.2 Equipment

The liquid bituminous material shall be sprayed by means of a pressure distributor of not less than 1000 liters capacity, mounted on pneumatic tires of such width and number that the load produced on the road surface will not exceed 1 kN (100 kgf) per cm width of tire.

The tank shall have a heating device able to heat a complete charge of bituminous liquid to 180^0C. The heating device shall be such that overheating will occur. Consequently, the flames must not directly touch the casing of the tank containing the bituminous liquid. The liquid shall be insulated n such a way that the drop in temperature when the tank is filled with bituminous liquid at 180^0 C and not heated will be less than 2^0 C per hour. A thermometer shall be fixed to the tank in order to be able to measure continuously the temperature of the liquid. The thermometer shall be places in such a way that the highest temperature in tank is measured. The tank shall be furnished with a calibrated dipstick to indicate the contents. The pipes for filling the tank shall be furnished with an easily changeable filter.

The distributor shall be able to vary the spray width of the bituminous liquid on maximum steps of 100mm to a total width of 4m. The spraying bar shall have nozzles from which the liquid is sprayed fan-shaped on the road surface equally distributed over the total spraying width.

For application of the liquid bituminous material. The distributor shall have a pump either driven by a separate motor, or with a device to synchronize its speed with the speed of the distributor. The pump shall be furnished with an indicator showing the rate of flow. The suction side of the pump shall have an easily changeable filter. A thermometer shall be fixed, such that it indicated the temperature of the liquid immediately before it leaves the spraying bar.

The distributor shall be furnished whit a tachometer, indicating its forward speed, which shall be visible from the driver's seat. The distributor shall be designed so that the

deviation from the prescribed rate of application does not exceed 10% and shall be equipped with a device for hand spraying of the bituminous liquid.

301.3.3 Application of Bituminous Materials

Immediately before applying the prime coat, the full width of surface to be treated shall be ensued to be free from all dirt and other objectionable materials. When required by the Engineer, immediately prior to the application of the prime coat. The surface shall be slightly sprayed with water but not saturated. Bituminous material shall be applied by means of a pressure distributor at the temperature given in Item 702, Bituminous Materials. The rate of application of the bituminous material shall be within the range of 1 to 2 liters/$m^{2.}$ The exact application rate for the type of the bituminous material to be ordered by the Engineer shall be based on the quality of the base materials and field conditions.

The prime coat shall be left undistributed for a period of at least 24 hours or until such time that it has sufficiently cured as determined by the Engineer, and shall not be opened to traffic so that it will not be picked up by the wheels of passing vehicles. The Contractor shall maintain the prime coat until the next course is applied. Care shall be taken that the application of bituminous material is not in excess of the specified amount. Any excess shall be blotted with sand or removed as directed by the Engineer. All areas inaccessible to the distributor shall be sprayed manually using the device for hand spraying. The surface of structures and trees adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred.

301.4 Method of Measurement

Bituminous Prime Coat shall be measured by the area covered in square meter (m^2).

301.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 301.4, shall be paid for at the contract unit price for Bituminous Prime Coat which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
301	Bituminous Prime Coat	
301 (1)	MC-Cut back Asphalt	Square Meters
301 (2)	RC-Cut back Asphalt	Square Meters

ITEM 303 – BITUMINOUS SEAL COAT

303.1 Description

This Item shall consist of an application of bituminous material with or without an application of aggregate on an existing bituminous surface course in accordance with the Plans and Specifications.

303.2 Material Requirements

303.2.1 Quantities of Materials

The approximate amounts of materials per square meter for seal coasts of the several types shall be as provided in Table 303.1. The exact amounts to be used shall be set by the Engineer.

Table 303.1 – Quantities of Materials for Seal Coats

	Type 1	Type 2	Type 3
Bituminous material L/m^2	0.20-0.50	0.51-1.00	1.01-1.50
Cover Aggregate, kg/m^2	None	5.00-10.00	10.01-14.00

303.2.2 Bituminous Materials

Bituminous material shall be Asphalt Cement. Penetration Grade 85-100, Rapid Curing (RC) Cut-Back Asphalt. It shall conform to the requirements of Item 702, Bituminous Materials, whichever is called for in the Bill of Quantities. The type and grade of asphalt cement or cut-back asphalt will be specified in the Special Provisions.

303.2.3 Coverage Aggregate

Cover Aggregate for Type 2 seal coat shall consist of sand and fine screenings, reasonably free from dirt or other organic matter.

Aggregate for Type 3 seal coat shall be crushed stone, crushed slag or crushed gravel. Only one type of aggregate shall be used in a project unless alternative types are approved.

Aggregate gradation shall conform with Table 303.2 when tested by AASHTO T 27.

Table 303.2 – Grading Requirements

Sieve Designation		**Mass Percent Passing**		
Standard mm	Alternate U.S Standard	Type 3		
		Type 2	Grading A	Grading B
12.50	½ in	-	-	100
9.50	3/8in.	100	100	85-100
4.75	No.4	85-100	85-100	10-30
2.36	No.8	60-100	10-40	0-10
1.18	No.16	-	0-10	0-5
0.300	No.50	-	0-5	-
0.150	No.100	0-10	-	-

The aggregate shall have a mass percent of wear not exceeding 40 when tested by AASHTO T 96.

When crushed slag is used, it shall be of uniform density and quality and shall have a density of not less than 960 kg/m^3 as determined by AASHTO 19.

303.3 Construction Requirements

303.3.1 Weather and Moisture Conditions

Seal coating shall not be undertaken during foggy or rainy weather or when the surface to be treated is wet. Wet cover coat material shall not be used on the work. No seal coating work shall be continued at night unless provided with sufficient lighting. The Engineer shall always be consulted before the commencement of the work and all work shall be terminated at once in the event of rain.

303.3.2 Preparation of Surface

Seal coating operations shall not be started until the bituminous surface is thoroughly compacted by traffic and rolling. In no event shall seal coat be place on newly constructed or reconditioned surfaces in less than ten (10) days after such surface is laid and opened to traffic unless ordered in writing by the Engineer.

Immediately prior to applying the bituminous material, the surface shall be cleaned of all dirt, sand, dust and other objectionable materials. This cleaning shall be effected by means of a rotary power broom or a power blower, unless other methods are authorized by the Engineer. Dried mud or other foreign materials which cannot be removed otherwise shall be removed by hand methods.

303.3.3 Application of Bituminous Material

Bituminous material shall be applied by means of a pressure distributor at the rate of approximately 0.9 to 1.8 liters for asphalt cement and 1.5 to 3.0 liters for cut-back asphalt per square metre of surface, in a uniform, unbroken spread over the section to be treated. The pressure distributor used for applying asphaltic materials shall be equipped with a pneumatic tires and shall be designed and operated so as to distribute the asphaltic material at the specified rate. It shall be equipped with a fifth wheel tachometer registering the speed and so located as to be visible to the truck driver. The distributor pump shall be equipped with a gauge registering liters per minute passing through the nozzles and readily visible to the operator. Other suitable measuring devices approved by the Engineer may be used. The exact quantity to be applied shall be determined by the Engineer. The temperature at the time of application shall be within the range of temperature specified under Item 702, Bituminous Materials. Care shall be taken that the application of bituminous material at the junction of spreads is not in excess of the specified quantities. Any excess shall be removed from the surface by a squeegee. If necessary, to obtain proper junction of spreads, a strip of manila paper approximately 1 meter wide and at least as long as the spray bar shall be used at the beginning and end of each spread. The paper shall be removed after use.

Any skipped areas or recognized deficiencies shall be corrected immediately by hand application and hand operated pressure devices or by other equally suitable means.

In the event that any structure becomes discolored with bituminous material, the Contractor, at his own expense, shall remove the discoloration to the satisfaction of the Engineer.

303.3.4 Application of the Cover Aggregate

Immediately after the application of asphalt, the cover aggregate shall be evenly spread over the surface at the rate of approximately 0.004 to 0.007 cubic meter per square meter. The exact quantity shall be as directed by the Engineer. Spreading shall be accomplished by aggregate spreader only so that an even and accurate distribution is obtained. The use of spreader boards attached to tail gates of trucks shall not be permitted. The tires of the aggregate trucks shall at no time come in contact with the uncovered and newly applied asphalt.

As soon as the cover aggregate has been spread, the surface shall be broomed lightly with approved push or drag broom to insure an even distribution, and shall then be rolled with an approved power roller weighing not less than 5, nor more than 6 tonnes to a uniform surface.

303.3.5 Maintenance

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Engineer. The maintenance work shall consist of keeping any excess aggregate evenly spread over the asphalt surface by approved sweeping devices. It shall also consist of keeping all potholes or failures which may occur, repaired by use of additional asphalt and necessary aggregate. All fat or bleeding surfaces shall be covered with approved cover aggregate so that the asphalt will not adhere to, or be picked up by the wheels of vehicles.

303.4 Method of Measurement

The quantities of bituminous material and cover aggregate shall be measured by the tone (t), calculated by the actual rate of application approved by the Engineer.

303.5 Basis of Payment

The accepted quantities, measured as prescribed in Section 303.4 shall be paid for at the contract unit price for Bituminous Seal Coat, which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
303	Bituminous Seal Coat	
303 (1)	Cover Aggregate, Type	Tonne
303 (2)	MC____Cut-back Asphalt	Tonne
303 (3)	RC____Cut-back Asphalt	Tonne
303 (4)	Asphalt Cement Pen. Gr.	Tonne

ITEM 310 – BITUMINOS CONCRETE SURFACE COURSE, HOT-LAID

310.1 Description

This Item shall consist of constructing a Bituminous Concrete Surface Course composed of aggregates, mineral filler and bituminous material mixed in a central plants, constructed and laid hot on the prepared based in accordance with this Specification and in conformity with lines, grades, thickness and typical cross-section shown on the Plans.

310.2 Material Requirements

310.2.1 Composition and Quality of Bituminous Mixture (Job-Mix Formula)

Same as Subsection 370.2.1

310.2.2 Bituminous Material

It shall be Penetration Grade Asphalt Cement and it shall conform to the requirements of Item 702, Bituminous Materials. The grade of the bituminous material shall be specified in the Special Provisions.

310.2.3 Aggregates

Aggregates shall conform to the requirements of Item 307, Bituminous Plant Mix Surface Course-General.

310.2.4 Mineral Filler

It shall conform to the requirements of Item 307, Bituminous Plans Mix Surface Course-General.

310.2.5 Hydrated Lime

It shall conform to the requirements of Item 307, Bituminous Plans-Mix Surface Course-General.

310.2.5 Hydrated Lime

It shall conform to the requirements of Item 307, Bituminous Plans-Mix Surface Course-General.

310.2.6 Proportioning of Mixtures

The proportion of bituminous material on the basis of total dry aggregate shall be from 5.0 to 8.0 mass percent, the exact percentage to be used shall be fixed by the Engineer in accordance with the job-mix formula and the other quality control requirements.

During the mixing operation, one-half to one (0.5 to 1.0) mass percent of hydrated line, dry aggregate basis, shall be added to the mixture. The lower percentage limit is applicable to aggregates which are predominantly calcareous.

310.3 Construction Requirements

The construction requirements shall be in accordance whenever applicable, with Section 307.3.

310.4 Method of Measurement

The area to paid for under this item shall be the numb-er of square meters (m^2) of asphalt pavement placed, compacted and accepted based on the thickness and density of the cores taken in accordance with Subsection 307.3.10 (Acceptance, Sampling and Testing)

310.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 310.4, shall be paid for at the contract unit price for Bituminous Concrete Surface Course, Hot-Laid, which price and payment shall be full compensation for furnishing all materials, handling, mixing, hauling, placing, rolling, compacting, labor, equipment, tools and incidentals necessary to complete this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
310	Bituminous Concrete Surface Course, Hot-Laid	Square Meter
310 (1)	Asphaltic Concrete with Lahar as Fine Aggregate Replacement	Square Meter
	Hot Rolled Asphalt with Lahar as Fine Aggregate Replacement	Square Meter

ITEM 311- PORTLAND CEMENT CONCRETE PAVEMENT

311.1 Description

This item shall consist of pavement of Portland Cement Concrete, with or without reinforcement, constructed on the prepared base in accordance with this Specification and in conformity with lines, grades, thickness and typical cross-section shown on the Plans.

311.2 Material Requirements

311.2.1 Portland Cement

It shall conform to the applicable requirements of item 700, Hydraulic Cement. Only Type I Portland Cement shall be used unless otherwise provided for in the Special Provisions. Different brands or the same brands from different mills shall not be mixed nor shall they be used alternately unless the mix is approved by the Engineer, However, the use of Portland Pozzolan Cement Type IP meeting the requirements of AASHTO M 240/ASTM C 695, Specification for Blended Hydraulic Cement shall be allowed, provided that trial mixes shall be done and that the mixes meet the concrete strength requirements, the AASHTO/ASTM provisions pertinent to the use of Portland Pozzolan Type IP shall ASTM provisions pertinent to the use of Portland Pozzolan Type IP shall be adopted.

Cement which for any reason, has become partially set or which contains lumps of caked cement will be rejected. Cement salvaged from discarded or used bags shall not be used.

Samples of Cement shall be obtained in accordance with AASHTO T 127.

311.2.2 Fine Aggregate

It shall consist of natural sand, stone screenings or other inert materials with similar characteristics, or combinations thereof, having hard, strong and durable particles. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of concrete without the approval of the Engineer.

It shall not contain than three (3) mass percent of material passing the 0.075mm (No. 200 sieve) by washing nor more than one (1) mass percent each of clay lumps or shale. The use of beach sand will not be allowed without the approval of the Engineer.

If the fine aggregate is subjected to five (5) cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 10 mass percent.

The fine aggregate shall be free from injurious amount of organic impurities. If subjected to the colorimatic test for organic impurities and a color darker than the standard is produced, it shall be rejected. However, when tested for the effect of organic impurities of strength of mortar by AASHTO T 71, the fine aggregate may be used if the relative strength at 7 and 28 days is not less than 98 mass percent.

The fine aggregate shall be well-graded from coarse to fine and shall conform to Table 311.1

Table 311.1 – Grading Requirements for Fine Aggregate

Sieve Designation	Mass Percent Passing
9.5mm (3/8 in)	100
4.75mm (No. 4)	95-100
2.36mm (No. 8)	-
1.18mm (No. 16)	45-80
0.600mm (No. 30)	-
0.300mm (No. 50)	5-30
0.150mm (No. 100)	0-10

311.2.3 Coarse Aggregate

It shall consist of crushed stone, gravel, blast furnace slag, or other approved inert materials of similar characteristics, or combinations thereof, having hard, strong, durable pieces and free from any adherent coatings.

It shall contain not more than one (1) mass percent of material passing the 0.075mm (No. 200) sieve, not more than 0.25 mass percent of clay lumps, nor more than 3.5 mass percent of soft fragments.

If the coarse aggregate is subjected to five (5) cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 12 mass percent.

It shall have a mass percent of wear not exceeding 40 when tested by AASHTO 96.

If slag is used, its density shall not be less than 1120 kg/m^3 (70 lb./cu.ft.). The gradation of the coarse aggregate shall conform to Table 311.2.

Only one grading specification shall be used from any one source.

Table 311.2
Grading Requirement for Coarse Aggregate

Sieve Designation		Mass Percent Passing		
Standard Mm	Alternate U.S Standard	Grading A	Grading B	Grading C
75.00	3 in.	100	-	-
63.00	2-1/2 in.	90-100	100	100
50.00	2 in.	-	90-100	95-100
37.5	1-1/2 in.	25-60	35-70	-
25.0	1 in.	-	0-15	35-70
19.0	¾ in	0-40	-	-
12.5	½ in.	0-5	0-5	10-30
4.75	No. 4	-	-	0-5

311.2.4 Water

Water used in mixing, curing or other designated application shall be reasonably clean and free of oil, salt, acid, alkali, grass or other substances injurious to the finished product. Water will be tested in accordance with and shall meet the requirements of Item 714, Water. Water which is drinkable may be used without test. Where the source of

water is shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

311.2.5 Reinforcing Steel

It shall conform to the requirements of Item 404, Reinforcing Steel. Dowel and tie bars shall conform to the requirements of AASHTO M 31 or M 42, except that rail steel shall not be used for tie bars that are to be bent and restraightened during construction. Tie bars shall be deformed bars. Dowel shall be plain round bars. Before delivery to the site of work, one-half of the length of each dowel shall be painted with one coat of approved lead or tar paint.

The sleeves for dowel bars shall be metal of approved design to cover 50 mm (2 inches), plus or minus 5 mm (1/4 inch) of the dowel, with a closed end, and with a suitable stop to hold the end of the sleeve at least 25 mm (1 inch) from the end of the dowel. Sleeves shall be of such design that they do not collapse during construction.

311.2.6 Joint Fillers

Poured joint fillers shall be mixed asphalt and mineral rubber filler conforming to the applicable requirements of Item 705, Joint Materials.

Performed joint filler shall conform to the applicable requirements of Item 705. It shall be punched to admit the dowels where called for in the Plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint.

311.2.7 Admixtures

Air-entraining admixture shall conform to the requirements of AASHTO M 154.

Chemical admixtures, if specified or permitted, shall conform to the requirement of AASHTO M 194.

Fly Ash, if specified or permitted as a mineral admixture and as 20% partial replacement of Portland Cement in concrete mix shall conform to the requirements of ASTM C 618.

Admixture should be added only to the concrete mix to produce some desired modifications to the properties of concrete where necessary, but not as partial replacement of cement.

311.2.8 Curing Materials

Curing materials shall conform to the following requirements as specified;

a) Burlap cloth - AASHTO M 182
b) Liquid membrane forming compounds - AASHTO M 148
c) Sheeting (film) materials - AASHTO M 171

Cotton mats and water-proof paper can be used.

311.2.9 Calcium Chloride/Calcium Nitrate

It shall conform to AASHTO M 144, if specified or permitted by the Engineer, as accelerator.

311.2.10 Storage of Cement and Aggregate

All cement shall be stored, immediately upon delivery at the Site, in weatherproof building which will protect the cement from dampness. The floor shall be raised from the ground. The building shall be placed in locations approved by the Engineer. Provision for storage shall be ample, and the shipments of cement as received shall be separately stored in such a manner as to allow the earliest deliveries to be used first and to provide easy access for identification and inspection be used first to provide easy access for identification and inspection of each shipment. Storage buildings shall have the capacity for storage of a sufficient quantity of cement to allow sampling at least twelve (12) days before the cement is to be used. Bulk cement, if used, shall be transferred to elevated air tight and weatherproof bins. Stored cements shall meet the test requirement at any time after storage when retest is ordered by the Engineer. At the time of use, all cement shall be free flowing and free of lumps.

The handling and storing of concrete aggregates shall be such as to prevent segregation or the inclusion of foreign materials. The Engineer may require that aggregates be stored on separate platforms at satisfactory locations.

In order to secure greater uniformity of concrete mix, the Engineer may require that the coarse aggregate be separated into two or more sizes. Different sizes of aggregate shall be stored in separate bins or in separate stockpiles sufficiently removed from each other to prevent the material at the edges of the piles from becoming intermixed.

311.2.11Proportioning, Consistency and Strength of Concrete

The Contractor shall prepare the design mix based on the absolute volume method as outlined in the American Concrete Institute (ACI) Standard 211.1, “Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete”.

It is the intent of this Specification to require at least 364 kg of cement per cubic meter of concrete to meet the minimum strength requirements. The Engineer shall determine from laboratory test of the materials to be used, the cement content and the proportions of aggregate and water that will produce workable concrete having a slump of between 40 and 75 mm (1-1/2 and 3 inches) if not vibrated or between 10 and 40 mm (1/2 and 1-1/2 inches) if vibrated, and flexural strength of not less than 3.8 MPa (550 psi) when tested by the third-point method of 4.5 MPa (650 psi) when tested by the mid-point method at fourteen (14) days in accordance with AASHTO T97 and T177, respectively; or a compressive strength of 24.1 MPa (3500 psi) for cores taken at fourteen (14) days and tested in accordance with AASHTO T24.

Slump shall be determined using AASHTO T24.

The designers shall consider the use of lean concrete (econocrete) mixtures using local materials or specifically modified conventional concrete mixes in base course and in the lower course composite, monolithic concrete pavements using a minimum of 75 mm (3 inches) of conventional concrete as the surface course.

The mix design shall be submitted to the Engineer for approval and shall be accompanied with certified test data from an approved laboratory demonstrating the adequacy of the mix design. A change in the source of materials during the progress of work may necessitate a new design mix.

311.3 Construction Requirements

311.3.1 Quality Control of Concrete

1. General
   The Contractor shall be responsible for the quality control of all materials during the handling, blending, and mixing and placement operations.

2. Quality Control Plan
   The Contractor shall furnish the Engineer a Quality Control Plan detailing his production control procedures and the type and frequency of sampling and testing to insure that the concrete produces complies with the Specifications. The Engineer shall be provided free access to recent plant production records and if requested, informational copies of mix design, materials certifications and sampling and testing reports.

3. Qualification of Workmen
   Experienced and qualified personnel shall perform all hatching or mixing operation for the concrete mix, and shall be present at the plant and job site to control the concrete productions whenever the plan is in operation. They shall be identified and duties defines as follows:

   a) Concrete Batcher. The person performing the batching or mixing operation shall be capable of accurately conducting aggregate surface moisture determination and establishing correct scale weights for concrete materials. He shall be capable of assuring that the proportioned batch weights of materials are in accordance with the mix design.

   b) Concrete Technician. The person responsible for concrete production control and sampling and testing for quality control shall be proficient in the concrete technology and shall have a sound knowledge of the Specification as they relate to concrete production. He shall be capable of conducting tests on concrete and concrete materials in accordance with these Specifications. He shall be capable of adjusting concrete mix designs for improving workability and Specification compliance and preparing trial mix designs. He shall be qualified to act as concrete batcher in the batcher's absence.

4. Quality Control Testing

The Contractor shall perform all sampling, testing and inspection necessary to assure quality control of the component materials and the concrete.

The Contractor shall be responsible for determining the gradation of fine and coarse aggregates and for testing the concrete mixture for slump, air content, water-cement ratio and temperature. He shall conduct his operations so as to produce a mix conforming to the approved mix design.

5. Documentation

The Contractor shall maintain adequate record of all inspections and test. The record shall indicate the nature and number of observation made, the number

and type of deficiencies found, the quantities approved and rejected and nature of any corrective action taken.

The Engineer may take independent assurance samples at random location for acceptance purposes as he deems necessary.

311.3.2 Equipment

Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity and mechanical condition. The equipment shall be at the jobsite sufficiently ahead of the start of construction operations to be examined thoroughly and approved.

1. Batching Plants and Equipment

    a. General. The batching shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, a hopper, and separate scale for cement shall be included. The weighing hopper shall be properly sealed and vented to preclude dusting operation. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned

    b. Bins and Hoppers. Bind with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.

    c. Scale. Scales for weighing aggregates and cement shall be of either the beam type of the springless-dial type. They shall be accurate within one-half percent (0.5%) throughout the range of use. Poises shall be designed to be locked in any position and to prevent unauthorized change.

    Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their continued accuracy.

    d. Automatic Weighing Devices. Unless otherwise allowed on the Contract, batching plants shall be equipped with automatic weighing devices of an approved type to proportion aggregated and bulk cement.

2. Mixers

    a. General. Concrete may be mixed at the Site of construction of at a central plant, or wholly or in part in truck mixers. Each mixer shall have a manufacturer's plate attached in a prominent place showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

    b. Mixer at Site of Construction. Mixing shall be done in an approved mixer capable of combining the aggregates, cement and water into a thoroughly mixed and uniform mass within the specified mixing period and discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when

the drum has been charged and released it at the end of the mixing period. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed 910 seconds. The mixer shall be equipped with a suitable nonresettable batch counter which shall correctly indicate the number of the batches mixed.

c. Truck Mixer and Truck Agitators. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete, shall conform to the requirements of AASHTO M 157.

d. Non-Agitator Truck. Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation.

3. Paving and Finishing Equipment

The concrete shall be placed with an approved paver designed to spread, consolidate, screed and float finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specification.

The finishing machine shall be equipped with at least two (2) oscillating type transverse screed.

Vibrators shall operate at a frequency of 8,300 to 9,600 impulses per minute under load at a maximum spacing of 60 cm.

4. Concrete Saw

The Contractor shall provide sawing equipment in adequate number of units and power to complete the sawing with a water-cooled diamond edge saw blade of an abrasive wheel to the required dimensions and at the required rate. He shall provide at least one (1) stand-by saw in good working condition and with an ample supply of saw blades.

5. Forms

Forms shall be of steel, of an approved section, and of depth equal to the thickness of the pavement at the edge. The base of the forms shall be of sufficient width to provide necessary stability in all direction. The flange braces must extend outward on the base to not less than 2/3 the height of the form

All forms shall be rigidly supported on the bed thoroughly compacted material during the entire operation of placing and finishing the concrete. Forms shall be provided with adequate devices for secure setting so that when in place, they will withstand, without visible spring or settlement, the impact and vibration of the consolidation and finishing or paving equipment.

311.3.3 Preparation of Grade

After the subgrade of base has been placed and compacted to the required density, the areas which will support the paving machine and the grade on which the pavement is to be constructed shall be trimmed to the proper elevation by means of a properly designed machine extending the prepared work areas compacted at least 60 cm beyond each edge of the proposed concrete pavement. If loss of density results from the trimming operations, it shall be restores by additional compaction before concrete is placed. If any traffic is allowed to use the prepared subgrade or base, the surface shall be checked and corrected immediately ahead of the placing concrete.

The subgrade of base shall be uniformly moist when the concrete is placed.

311.3.4 Setting Forms

1. Base Support.

   The foundation under the forms shall be hard and true to grade so that the form when set will be firmly in contract for its whole length and at the specified grade. (Any roadbed, which at the form line is found below established grade, shall be filled with approved granular materials to grade in lifts of three (3) cm or less, and thoroughly rerolled or ramped) Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

2. Form Setting

   Forms shall be set sufficiently in advance of the point where concrete is being placed. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. The forms shall not deviate from true line by more than one (1) cm at any point.

3. Grade and Alignment

   The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. Testing as to crown and elevation, prior to placing of concrete can be made by means holding an approved template in a vertical position and moved backward on the forms.

   When any forms has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

311.3.5 Conditioning of Subgrade or Base Course

When side forms have been securely set to grade, the subgrade or base course shall be brought to proper cross-section. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

Unless waterproof subgrade or base course cover material is specified, the subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently

becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

311.3.6 Handling, Measuring and Batching Materials

The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the work. Stockpiles shall be built up in layers of not more than one (1) meter in thickness. Each layer shall be completely in place before beginning the next which shall not be allowed to “cone” down over the next lower layer. Aggregates from different sources and of different grading shall not be stockpiled together.

All washed aggregates and aggregates produced or handled by hydraulic methods, stockpiled or binned for draining at least twelve (12) hours before being batched.

When mixing is done at the side of work. Aggregates shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers of adequate capacity and construction to properly carry the volume required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment to another while in transit or being dumped. When bulk cement is used, the contractor shall use a suitable method of handling the cement from weighting hopper to transporting container or into the batch itself for transportation to the mixer, with chute, boot or other approved device, to prevent loss of cement, and to provide positive assurance of the actual presence in each batch of the entire cement content specified.

Bulk cement shall be transported o the mixer in tight compartments carrying the full amount of cement required for the batch. However, if allowed in the Special provisions, it may be transported between the fine and coarse aggregate. When cement is placed in contact with the aggregates, batches may be rejected unless mixed within 1-1/2 hours of such contact. Cement in original shipping packages may be transported on top of the aggregates, each batch containing the number of sacks required by the job mix.

The mixer shall be charged without loss of cement. Batching shall be so conducted as to result in the weight to each material required within a tolerance of one (1) percent for the cement and two (2) for aggregates.

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over than one (1) percent. Unless the water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be equipped with an outside tap and valve to provide checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of measuring tank.

311.3.7 Mixing Concrete

The concrete may be fixed at the site of the work in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time will be measured from the time all materials, except water, are in the drum. Ready-mixed concrete shall mixed and delivered in accordance with requirements of AASHTO M 157, except that the minimum required revolutions at the mixing speed for transit-mixed concrete may be reduced to not less than that recommended by the mixer manufacturer. The number of revolutions recommended by the mixer manufacturer shall be indicated on the manufacturer’s serial plate attached to the mixer. The contractor shall furnish test data acceptable to the Engineer verifying that the make and model of the mixer will

produce uniform concrete conforming to the provision of AASHTO M 157 at the reduced number of revolutions shown on the serial plate.

When mixed at the site or in a central mixing plant, the mixing time shall not be less than fifty (50) seconds nor more than ninety (90) seconds, unless mixer performance test prove adequate mixing of the concrete is a shorter time period.

Four (4) seconds, shall be added to the specified mixing time if timing starts at the instant the skip reaches its maximum raised positions. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers in included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The mixer shall be operated at the drum speed as shown on the manufacturer's same plate attached on the mixer. Any concrete mixed less than the specified time shall be discarded and disposed off by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic metre, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to ten (10) percent above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batches shall be so charged into the drum that a portion of the mixing water shall be entered in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first fifteen (15) seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators or non-agitating truck specified in subsection 311.3.2, Equipment. The time elapsed from the time water is added to the mix until the concrete is deposited in place at the Site shall not exceed forty five (45) minutes when the concrete is hauled in non-agitating trucks, nor ninety (90) minutes when hauled in truck mixers or truck agitators, except that in hot weather or under other conditions contributing to quick hardening of the concrete, the maximum allowable time may be reduced by the engineer.

In exceptional cases and when volumetric measurements are authorized for small project requiring less than 75 cu.m. of concrete per Day of pouring, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowance shall be made for variations in the moisture condition of the aggregates, including the bulking effect in the fine aggregate. Batching and mixing shall be in accordance with ASTM C 685, Section 6 through 9.

Concrete mixing by chute is allowed provided that weighing scales for determining the batch weight will be used.

Retempering concrete by adding water or by other means shall not be permitted, except that when concrete is delivered in truck mixers, additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements, if permitted by the Engineer, provided all these operations are performed within (45) minutes after the initial mixing operation and the water-cement ratio is not exceeded. Concrete that is not within the specified slump limits at the time of placement shall not be used. Admixtures for increasing the workability or for accelerating the setting of the concrete will be permitted only when specifically approved by the Engineer.

311.3.8 Limitation of Mixing

No concrete shall be mixed, placed or finished when natural light is sufficient, unless an adequate and approved artificial lighting system is operated.

During hot weather, the Engineer shall require that steps be taken to prevent the temperature of mixed concrete from exceeding a maximum temperature of 90^0F (32^0C)

Concrete not place within ninety (90) minutes from the time the ingredients were charged into the mixing drum or that has developed initial set shall not be used. Retempering of concrete or mortar which has partially hardened, that is mixing with or without additional cement, aggregate, or water, shall not be permitted.

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete.

311.3.9 Placing Concrete

Concrete shall be deposited in such a manner to require minimal rehandling. Unless truck mixers or non-agitating hauling equipment are equipped with means to discharge concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such a manners as to prevent segregation. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly make concrete with boots or shoots coated with earth or foreign substances.

When concrete is to be placed adjoining a previously constructed lane and mechanical equipment will be operated upon the existing lane, that previously constructed lane shall have attained the strength for fourteen (14) day concrete. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after three (3) days.

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than fifteen (15) seconds in any one location.

Concrete shall be deposited as near as possible to the expansion and contraction joints without disturbing them, but shall not be dumped from the discharge bucket or hopper into a joint assembly unless the hooper is well centered on the joint assembly. Should any concrete material fall on or be worked into the surface of a complete slab, it shall be removed immediately.

311.3.10 Test Specimens

As work progresses, at least one (1) set consisting of three (3) concrete beam test specimens, 150 mm x 150 mm x 525 mm or 900 mm shall be taken from each 330 m^2 of pavement , 230 mm depth, or fraction thereof placed each day. Test specimens shall be made under the supervision of the Engineer, and the Contractor shall provide all concrete and other facilities necessary in making the test specimens and shall protect them from damage by construction operations. Cylinder samples shall not be used as substitute for determining the adequacy of the strength of concrete.

The beams shall be made, cured, and tested in accordance with AASHTO T 23 and T 97.

311.3.11 Strike-off of Concrete and Placement of Reinforcement

Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans. When reinforced concrete pavements is placed in two (2) layers, the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be placed at the mechanical or vibratory means.

Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale and loose or thick rust which could impair bond of the steel with the concrete.

311.3.12 Joints

Joints shall be constructed of the type and dimensions, and at the locations required by the Plans or Special Provisions. All joints shall be protected from the intrusion of injurious foreign material until sealed.

1. Longitudinal joint

   Deformed steel tie bars of specified length, size, spacing and materials shall be placed perpendicular to the longitudinal joints, they shall be placed by approved mechanical equipment or rigidly secured by chair or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material or enclosed in tubes or sleeves. When shown on the plans and when adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint. Tie bars, except those made of rail steel, may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or on lieu of bent tie bars, approved two-pieced connectors may be used.

   Longitudinal formed joints shall consist of a groove or cleft, extending downward from and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the Plans and while the concrete is in a plastic state. The groove or cleft shall be filled with either a premolded strip or poured material as required.

   The longitudinal joints shall be continuous; there shall be no gaps in either transverse or longitudinal joints at the intersection of the joints

   Longitudinal sawed joints shall cut by means of approved concrete saws to the depth, width and line shown on the Plans. Suitable guide lines or devices shall be used to assure cutting the longitudinal joint on the true line. The longitudinal joint shall be sawed before the end of the curing period or shortly

thereafter and before any equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned and, if required, the joint shall immediately be filled with sealer.

Longitudinal pavement insert type joints shall be formed by placing a continuous strip of plastic materials which will not react adversely with the chemical constituent of the concrete.

2. Transverse Expansion Joint

The expansion joint filler shall be continuous from form to form, shaped subgrade and to the keyway along form. Preformed joint filler shall be furnished in lengths equal to the width of one lane. Damage or repaired joint filler shall not be used.

The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device, shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and of the concrete. Finished joint shall not deviate more than 6 mm from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

3. Transverse Contraction Joint/Weakened Joint

When shown on the Plans, it shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement and shall include load transfer assemblies. The depth of the weekend plane joint should at all times not be less than 50 mm, while the width should not be more than 6 mm.

a. Transverse Strip Contraction Joint. It shall be formed formed by installing a parting strip to be left in place as shown on the Plans.

b. Formed Groove. It shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place at least until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.

c. Sawed Contraction Joint. It shall be created by sawing grooves in the surface of the pavement of the width not more than 6 mm, depth should at all times not be less than 50 mm, and at the spacing and lines shown on the Plans, with an approved concrete saw. After each joint is sawed, it shall be thoroughly cleaned including the adjacent concrete surface.

Sawing of the joint shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on during the day or night, regardless of weather conditions. The sawing of any joint shall be omitted if crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discounted when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. If extreme condition exist which make it impractical to prevent

erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above.

4. Transverse Construction Joint

It shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed 1.50 m of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has been mixed at the time of interruption to form a slab of at least 1.5 m long, the excess concrete from the last preceding joint shall be removed and disposed off as directed.

5. Load Transfer Device

Dowel, when used, shall be held in position parallel to the surface and center line of the slab by metal device that is left in the pavement.

The portion of each dowel painted with one coat of lead or tar, in conformance with the requirements of item 404, Reinforcing Steel, shall be thoroughly coated with approved bituminous materials, e.g., MC-70, or an approved lubricant, to prevent the concrete from binding to that portion of the dowel. The sleeves for dowels shall be metal designed to cover 50 mm plus or minus 5 mm (1/4 inch), of the dowel, with a watertight closed end and with a suitable stop to hold the end of the sleeves at least 25 mm (1 inch) from the end of the dowel.

In lieu of using dowel assemblies at contraction joints, dowel may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

311.3.13 Final Strike-off (Consolidation and Finishing)

1. Sequence

The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straight-edging and final surface finish. Work bridges or other devices necessary to provide access to the pavement surface for the purpose of finishing straight-edging, and make corrections as hereinafter specified, shall be provided by the Contractor.

In general, the addition of water to the surface of the concrete to assist in finishing operations will not be permitted, it shall be applied as fog spray by means of an approved spray equipment.

2. Finishing Joints

The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in Subsection 311.3.9, Placing Concrete.

After the concrete has been placed and vibrated adjacent to the joints as required in Subsection 311.3.9, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to over and beyond the joints causes segregation of

concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately 20 cm (8 inches) from the joint. Segregated concrete shall be removed from in front of and off the joint. The front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

3. Machine Finishing

   a. Non-vibratory Method. The concrete shall be distributed or spread as soon as placed. As soon as the concrete has been placed, it shall be struck off and screeded by an approved finishing machine. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and leave surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without wobbling or other variation tending to affect the precision finish.

      During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed in its entire length.

   b. Vibratory Method. When vibration is specified, vibrators for full width vibration of concrete paving slabs, shall meet the requirements in Subsection 311.3.2, Equipment. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and method which will produce pavement conforming to the Specifications. All provisions in item (a) above not in conflict with the provisions for the vibratory method shall govern.

4. Hand Finishing

Hand finishing methods may only be used under the following conditions:

   a. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade.

   b. In narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical, hand methods may be used.

      Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be provided for striking off the bottom layer of concrete if reinforced is used.

      The screed for the surface shall be at least 60 cm (2 feet) longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and constructed either of metal or other suitable material shod with metal.

Consolidation shall be attained by the use of suitable vibrator or other approved equipment.

In operation, the screed shall be moved forward on the forms with a combined longitudinal and transverse shearing motion, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

5. Floating

After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal float, either by hand or mechanical method.

a. Hand Method. The hand-operated longitudinal float shall be not less than 365 cm (12 feet) in length and 15 cm (6 inches) in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion while held in a floating position parallel to the road center line, and moving gradually from one side of the pavement to the other. Movement ahead along the center line of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or soupy material shall be wasted over the side forms on each pass.

b. Mechanical Method. The mechanical longitudinal float shall be of a design approved by the Engineer, and shall be in good working condition. The tracks from which the float operates shall be accurately adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustment of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward screed shall be adjusted so that the float will lap the distance specified by the Engineer on each transverse trip. The float shall pass over each areas of pavement at least two times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass.

c. Alternative Mechanical Method. As an alternative, the Contractor may use a machine composed of a cutting and smoothing float or floats suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels riding on, and constantly in contact with the side forms. If necessary, following one of the preceding method of floating, long handled floats having blades not less than 150 cm (5 feet) in length and 15 cm (6 inches) in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of, supplementing, one of the preceding methods of floating. When strike off and consolidation are done by the hand method and the crown of the pavement will not permit the use of longitudinal float, the surface shall be floated transversely by means of the long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by

a 3-m straight-edge or more in length. Successive drags shall be lapped one-half the length of the blade.

6. Straight-edge Testing and Surface Correction

After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness with a 300 cm long straight-edge. For this purpose, the Contractor shall furnish and use an accurate 300-cm straight-edge swung from handles 100 cm (3 feet) longer than one-half the width of the slab. The straight-edge shall be held in contact with the surface in successive positions parallel to the road center line and the whole area gone over from one side of the slab to the other as necessary. Advances along the road shall be in successive stages of not more than one-half the length of the straight- edge. Any depressions found shall be immediately filled with freshly mixed concrete, struck off, consolidated and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straight-edge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straight-edge and the slab conforms to the required grade and cross-section.

7. Final Finish

If the surface texture is broom finished, it shall applied when the water sheen has practically disappeared. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping. The brooming operation should be so executed that the corrugations produced in the surface shall be uniform in appearance and not more than 1.5 mm depth. Brooming shall be completed before the concrete is in such condition that the surface will be unduly roughened by the operation. The surface thus finished shall be free from rough and porous areas, irregularities, and depressions resulting from improper handling of the broom. Brooms shall be of the quality size and construction and be operated so as to produce a surface finish meeting the approval of the Engineer, the Contractor will be permitted to substitute mechanical brooming in lieu of the manual brooming herein described.

If the surface texture is belt finished, when straight-edging is complete and water sheen has practically disappeared and just before the concrete becomes non-plastic, the surface shall be belted with 2-ply canvass belt not less than 20 cm wide and at least 100 cm longer than the pavement width. Hand belts shall have suitable handles to permit controlled, uniform manipulation. The belt shall be operated with short strokes transverse to the center line and with a rapid advances parallel to the center line.

If the surface texture is drag finished, a drag shall be used which consists of a seamless strip of damp burlap or cotton fabric, which shall produce a uniform of gritty texture after dragging it longitudinally along the full width of pavement. For pavement 5 m or more in width, the drag shall be mounted on a bridge which travels on the forms. The dimensions of the drag shall be such that a strip of burlap or fabric at least 100 cm wide is in contact with the full width of pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 15 cm wider than the layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1.5 mm in depth. Drag shall

be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags be substituted.

Regardless of the method used for final finish, the hardened surface of pavement shall have a coefficient of friction of 0.25 or more. Completed pavement that is found to have a coefficient of friction less than 0.25 shall be grounded or scored by the Contractor at his expense to provide the required coefficient of friction.

8. Edging at Forms and Joints

After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints, shall be worked with an approved tool and rounded to the radius required by the Plans. A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting the tool during the use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

All joints shall be tested with a straight-edge before the concrete has set and correction made if one edge of the joint is higher than the other.

311.3.14 Surface Test

As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 3-m straight-edge or other specified device. Areas showing high spots of more than 3 mm but not exceeding 12 mm in 3 m shall be marked and immediately ground down with an approved grinding tool to an elevation where the area or spot will not show surface deviations in excess of 3 mm when tested with 3 m straight-edge. Where the departure from correct cross-section exceeds 12 mm, the pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be not less than 1.5 m in length and not less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 1.5 m in length, shall also be removed and replaced.

311.3.15 Curing

Immediately after the finishing operations have been completed and the concrete has sufficiently set, the entire surface of the newly placed concrete shall be cured in accordance with either one of the methods described herein. Failure to provide sufficient cover materials of whatever kind the Contractor may elect to use, or the lack of water to adequately take care of both curing and other requirements, shall be a cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than ½ hour between stages of curing or during the curing period.

In all congested places, concrete works should be designed so that the designed strength is attained.

1. Cotton of Burlap Mats
   The surface of the pavement shall be entirely covered with mats. The mats used shall be such length (or width) that as laid they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and the edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mat shall be so placed and weighted down so as to cause them to remain in intimate contact with the covered surface. The mat shall be maintained fully wetted and in position for 72 hours after the concrete has been placed unless otherwise specified.

2. Waterproof Paper

   The top surface and sides of the pavement shall be entirely covered with waterproof paper, the units shall lapped at least 45 cm. The paper shall be so placed and weighted down so as to cause it to remain in intimate contact with the surface covered. The paper shall have such dimension but each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement, or at pavement width and 60cm strops of paper for the edge. If laid longitudinally, paper not manufactured in sized which will provide this width shall be securely sewed or cemented together, the joints being securely sealed in such a manner that they do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed. The surface of the pavement shall be thoroughly wetted prior to the placing of the paper.

3. Straw Curing

   When this type of curing is used, the pavement shall be cured initially with burlap or cotton mats, until after final set of concrete or, in any case, for 12 hours after placing the concrete. As soon as the mats are removed, the surface and sides of pavement shall be thoroughly wetted and covered with at least 20 cm of straw or hay, thickness of which is to be measured after wetting. If the straw or hay covering becomes displace during the curing period, it shall be replaced to the original depth and saturated. It shall be kept thoroughly saturated with water for 72 hours and thoroughly wetted down during the morning of the fourth day, and the covered shall remain in the place until the concrete has attained the required strength.

4. Impervious Membrane Method

   The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with jute or cotton mats, it may be applied upon removal of the mass. The curing compound shall not be applied during rain.

   Curing compound shall be applied under pressure at the rate 4 L to not more than 14 m^2 by mechanical sprayers. The spraying equipment shall be equipped with a wind guard. At the time of use, the compound shall be a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by effective mechanical

means. Hand spraying of odd widths or shapes and concrete surface exposed by the removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed, but approved means shall be used to insure proper curing at least 72 hours and to prevent the intrusion of foreign material into the joint before sealing has been completed. The curing compound shall be such of character that the film will be harden within 30 minutes after application. Should the film be damaged from any cause within the 72 hours curing period, the damaged portions shall be repaired immediately with additional compound.

5. White Polyethylene Sheet

   The top surface and side of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 45 cm. The sheeting shall be so place and weighted down so as to cause it to remain intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed.

311.3.16 Removal of Forms

After forms for concrete shall remain in place undisturbed for not less than twenty four (24) hours after concrete pouring. In the removal of forms, crowbars should be used in pulling out nails and pins. Care should be taken so as not to break the edges of the pavement. In case portions of the concrete are spalled, they shall be immediately repaired with fresh mortar mixed in the proportion of one part of Portland Cement.

And two parts fine aggregates. Major honeycomb areas will be considered as defective work and shall be removed and replaced at the expense of the Contractor. Any area or section so removed shall not be less than the distance between weakened plane joint nor less than the full width of the lane involved.

311.3.17 Sealing Joint

Joints shall be sealed with asphalt sealant soon after completion of the curing period and before the pavement is opened to traffic, including the Contractor's equipment. Just prior to sealing , each joint shall be thoroughly cleaned of all foreign materials including membrane curing compound and the joint faces shall be clean and surface dry when the seal is applied.

The sealing material shall be applied to each joint opening to conform to the details shown on the Plans or as directed the by the Engineer. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur. The pouring shall be done in such manner that the material will not be spilled on the exposed surfaces of the concrete. The use of sand or similar material as a cover for the seal will not be permitted.

Preformed elastomeric gaskets for sealing joint shall be of the cross-sectional dimensions shown on the Plans. Seals shall be installed by suitable tools, without elongation and secured in placed with an approved lubricant adhesive which shall cover both sides of the concrete joints. The seals shall be installed in a compressive condition and shall at time of placement be below the level of the pavement surface by approximately 6mm.

The seals shall be in one piece for the full width of each transverse joint.

311.3.18 Protection of Pavement

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen signs, lights, pavement bridges or cross-overs, etc. The Plans or Special Provisions will indicate the location and type of device or facility required to protect the work and provide adequately for traffic.

All boreholes after thickness and/or strength determinations of newly constructed asphalt and concrete pavements shall be immediately filled/restored with the prescribed concrete/asphalt mix after completion of the drilling works.

Any damage to the pavement, occurring prior to final acceptance, shall be repaired or the pavement be replaced.

311.3.19 Concrete Pavement-Slip Form Method

If the Contract calls for the construction of pavement without the use of fixed forms, the following provisions shall apply:

1. Grade

   After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of properly designed machine. If the density of the base is disturbed by the grading operation, it shall be corrected by additional compaction before concrete is placed. The grade should be constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placing of concrete.

2. Placing Concrete

   The concrete shall be placed with an approved slip-form paver designed to spread, consolidate, screed and float-finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in conformance with the Plans and Specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accompanied with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur, and that necessary final finishing can be accomplished while the concrete is still within the forms. Any edge slump of the pavement, exclusive of edge rounding, in excess of 6mm shall be corrected before the concrete has hardened.

   The concrete shall be held at a uniform consistency, having a slump of not more than 40mm (1-12/inches). The slip form paver shall be operated with as nearly as possible a continuous forward movement and that all operations of mixing, delivering and spreading concrete shall be coordinated so as to provide uniform

progress with stopping and starting of the paver held a minimum. If, for any reason, it is necessary to the forward movement of the paver the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

3. Finishing

   The surface smoothness and texture shall meet the requirements of Subsections 311.3.13 and 311.3.14

4. Curing

   Unless otherwise specified, curing shall be done in accordance with one of the methods included in Subsection 311.3.15. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the pavement.

5. Joints

   All joints shall be constructed in accordance with Subsection 311.3.12

6. Protection Against Rain

   In order that the concrete may be properly protected against rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times, materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 50 mm (2inches) and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper or plastic sheeting materials for the protection of the surface of the pavement. When rain appears imminent. All paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

311.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 311.4, shall be paid for at the contract unit price for Portland cement Concrete Pavement, which price and pavement, which price and payment shall be full compensation for preparation of roadbed and finishing of shoulders, unless otherwise provided by the Special Provisions furnishing all materials, for mixing, placing, finishing and curing all concrete, for furnishing and placing all joint materials, for sawing weakened plane joints, for fitting the prefabricated center metal point, for facilitating and controlling traffic and for furnishing all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under

Pay Item Number	Description	Unit of Measurement
311 (1) 311 (1) f3	PCC Pavement (Plain) PCC Pavement (Reinforced) 0.3m thk for Rock Causeway	Square Meter Square Meter

PART F- BRIDGE CONSTRUCTION

ITEM 400 PILING

400.1 Description

400.1.1 SCOPE

The contractor shall supply all labor, materials, equipment and incidentals necessary to furnish, install and drive piles including testing as shown on the Drawing or as directed by the Engineer.

Prior to commencing the works, the Contractor shall submit to the Engineer for his approval full details of the proposed schedule and method of construction including the procedure and sequence of pile installation, the specification of all equipment to be used and any other information requested by the Engineer.

When cast-in-place concrete piles are specified on the Plans, the Engineer will not furnish the Contractor an itemized list showing the length and number of piles.

400.1.2 Test Pile

When cast–in-place piles are specified on the drawing and are load test area required in conformance with Sub-section 400.1.2 and 400.1.3 respectively, the data obtained from driving test piles and making test loads will be used in conjunction with other available sub-soil information to determine the number and lengths of piles to be furnished. The Contractor shall furnish and drive test piles of the dimensions and at the locations designated by the Engineer. They shall be of the material shown in the Bill of Quantities and shall be driven to refusal or to such tip elevation or approximate bearing value as the Engineer may request. Test piles shall be driven with the same hammer that is used for foundation piles.

400.1.3 Load Tests

Load test for piles shall be either Static or Pile Testing by Low-Strain Dynamic Method, High strain Dynamic Method or Cross-Hole Sonic Logging Method as required in the plans or as directed by the Engineer.

400.1.3.1 Static Testing

This test load shall consist of the application of incremental static loads to a pile and measuring the resultant settlement. The loads shall be applied by the hydraulic jack acting against suitable anchorage transmitting the load directly to the pile, or other methods designated by the Plans or by the Engineer.

400.1.3.2 Pile Testing

Pile testing shall be done by Low-Strain Dynamic Method. High-=Strain Dynamic Method or Cross-Hole Sonic Logging Method as required in the Plans or as directed by the Engineer.

400.1.3.2.1 Low- Strain Dynamic Method

Pile integrity testing by Low-Strain Dynamic Method shall conform to ASTM D 5882. It is so called Low Strain Method, since it requires the impact of only a small hand- held hammer, and also referred to as a Non-Destructive Method.

400.1.3.2.2 Integrity Testing

The driven pile shall be subjected to non-destructive testing to determine the extent of any defects that may be present in the pile. Integrity-testing method to be adopted shall be low-strain, by either the Pulse Echo Method (PEM) or Transient Response Method (TRM) in accordance with ASTM D 5882, subject to the approval of the Engineer.

The testing shall be carried out by the Contractor using an engineer with specialized experience in this field and shall be approved by the Engineer.

The test shall be performed using digital data acquisition equipment. The signal conditioning and power supply must have very high signal-to-noise ratios since the reflected signals for long piles (or piles in high friction soils) are often very weak. The analog to digital resolution shall be at least 16 bits and the sampling frequency at least 40,000 Hz. Data should be stored such that additional processing or further wave analysis is possible. The data must be displayed in the field for evaluations of preliminary data quality and interpretation.

Prior to integrity testing, all apparatus shall be calibrated to ensure that precise and reliable data be obtained. Certificate of calibration shall be submitted unless otherwise waived by the Engineer.

For cast-in-place piles, integrity testing shall not be performed until the concrete has cured for a minimum of seven (7) days unless otherwise approved by the Engineer. The pile head shall be free from water, dirt or other debris. The concrete at the pile top surface must be relatively smooth with sufficient space for both attachment of the motion sensing device and hammer impact area.

Fifty percent (50%) of all piles shall be integrity tested. The location of piles designated for integrity testing shall be specified by the Engineer prior to pile installation. If initial tests reveal major defects, additional piles may be selected for testing during or after pile installation at the discretion of the Engineer.

400.1.3.2.3 Report

The Contractor shall submit a report on the integrity testing containing vital information necessary for the pile evaluation, prescribed in ASTM D5882. Such report shall be submitted within seven days after the completion of each test. For each pile tested, the average, amplified velocity versus time record shall be included in the report, with a table summarizing results and conclusions. Additional plots and analysis can be included as required or suggested by the testing engineer.

400.1.3.2.4 Final Integrity Evaluation

Shafts with no significant reflections from locations above the pile toe and with a clear pile toe reflection may be accepted. Where no clear reflection is apparent, the experienced test engineer shall state to which shaft depth the test appears to be conclusive.

Where reflections from locations with significant reductions above the pile toe are observed, the pile has a serious defect. If the record is complex, the results may be deemed inconclusive. Construction records (concrete usage, grout pressures records, soil borings) may be valuable in result interpretations or additional numerical analysis modeling may be used to quantify the record.

The decision to reject and replace or repair any defective shaft is at the sole responsibility of the engineer-of-record for the foundation.

If and when necessary, as determined after evaluation of the integrity of the pile subjected to the test, the Engineer may require further tests (i.e. static load testing, dynamic load testing, core drilling, ultra-sonic logging, etc.) or dictate pile repair or replacement, depending on the seriousness of the defect that may be established.

For piles that need to be repaired, the Contractor shall submit for the approval of the Engineer, remedial measures he intends to implement. Remedial measure may include pressure grouting through core holes.

If the pile top appears questionable, further pile top cut-off and retesting may be advisable.

If a majority of piles are diagnosed as “inconclusive”, partial or even complete pile excavation or another test method may be necessary for pile acceptance.

For rejected piles, the Contractor shall make a proposal for review and approval of the Engineer. Such proposal shall include the necessary design calculations, the methodology he intends to implement, equipment and other items as may be necessary. Approval of these proposals however does not relieve the Contractor of contractual responsibilities for any defects as a result of the proposals. The cost of further tests required, remedial measures and replacement of rejected piles shall be borne by the Contractor.

400.1.3.2.2 High-Strain Dynamic Testing

Pile integrity testing by High-Strain Dynamic Method shall conform to ASTM D 4945. High-Strain Dynamic Method shall be applied to confirm the design parameters and capacities assumed for the piles as well as to confirm the normal integrity of testing of the piles. It is considered supplemental to the low-strain and sonic type integrity testing of the cast- in-place piles. It is a non-destructive relatively quick test and it is intended that the test shaft be left ia a condition suitable for use in production. The shaft used for the test will be instrumented and tested by the testing specialist, as approved by the Engineer, meeting requirements in accordance to ASTM D 4945.

400.3.14.1 Description

High-strain Dynamic Testing is performed by obtaining and analyzing record shaft force and velocity under weights impact for evaluation of shaft load carrying capacity, structural integrity, and load movement and shaft-soil load transfer relationships.

Testing of drilled and cast-in-place shafts closely resembles testing of driven piles during re-strike. The following are specifications and instructions for high-stain dynamic testing of drilled and cast-in-place foundation shafts.

The work shall consist of furnishing all materials, equipment, and labor necessary for conducting high strain dynamic tests on drilled and cast-in-placed shafts (hereinafter

each noted as test shaft). The Contractor shall not conduct the test himself but shall appoint an Independent Specialist to conduct all testing. The Contractor will be required to supply materials, equipment and labor as hereinafter specified including prior to, during, and after the load test. High-strain Dynamic Testing is a non-destructive quick test and it is intended that the test shaft be left in a condition suitable for use in production. Testing procedures shall conform to the ASTM D4945-89 specification unless as otherwise noted below. The shaft used for the test will be instrumented and tested by the Independent Specialist, as approved by the Engineer, meeting requirements outlined in the ASTM D4945-89 specification as well as those outlined below.

Pile dynamic analysis (PDA) test on bored piles shall be conducted on representative piles among the substructure of the same configuration, especially if the soil conditions are the same. The production pile testing shall be performed during re-strike to monitor hammer and drive system performance, assess pile installation stresses and integrity, as well as to evaluate pile capacity. Additional tests shall be required should there be any hammer or driving system modifications or if another hammer is to be used on the site.

400.3.14.2 Equipment and Material Requirements

The Contractor shall supply all labor, materials and equipment required to prepare the test shaft, dynamically load the shaft, and returns the shaft to a condition suitable for use in the finished structure. Equipment to be supplied by the Contractor required to perform the test includes but is not limited to:

1. If a permanent casing is not used to construct the shaft, then a shaft top extension consisting of a thin walled casing or equivalent shall be used to extend the shaft by length at least equal to two and a half (2 ½) pile diameters such that the extended pile head is readily accessible by the testing engineer at the time of the test. If the shaft top is below grade, then the Contractor must have equipment available to remove surrounding soil (creating a safe working environment) so as to expose the concrete.

2. Means to ensure flat, level (axial to shaft) and sound concrete shaft top. Concrete should be on level with, or above the casing. Prior to the test, four “windows” approximately size of 6 inches by 6 inches (150 mm by 150 mm) shall be provided at each quadrant of the casing.

3. A drop weight in the range of one and half to two percent (1.5% to 2%) of the anticipated pile capacity, or as determined by the Engineer.

4. A guide allowing variable drop heights typically between 2 to 3 m, or as determined by the Engineer.

5. A shaft top cushion consisting of new sheets of plywood with total thickness between 2 to 6 inches (50 to 150 mm), or as determined by the Engineer.

6. A steel striker plate with a thickness of at least 2 inches (50 mm) and an area between 70 to 90% of shaft top area and not less than the area of the impacting surface of the area of the impacting surface of the drop weight shall be placed on top of the plywood cushion.

7. If protruding reinforcing bars are present, the Contractor has the option

to incorporate the reinforcing steel in the test area. Upon successful completion of the dynamic test, the surrounding concrete can then be removed as to make the pile suitable for use in the structure. If the Contractor selects not to incorporate the steel in such a manner as described above 20% of the shaft cross sectional area shall be supplied with sufficient length such that the ram impact will not interface with the reinforcing bars. Steel striker plates and plywood cushion must also be sized so that they cover as much as the impact area as possible.

8. One (1) kw of 200 Volt AC Power

9. Surveyor's transit, laser light or equivalent for measurement of pile set under each impact.

400.3.14.3 Dynamic Testing Firm

Testing is to be performed by an accredited Independent Specialist from a firm with a minimum of four (4) year experience in dynamic load testing. The actual test shall be conducted and/or supervised by a practicing Geotechnical Engineer with at least five (5) years of dynamic testing experience or who has achieved basic or better level experience on the foundation QA examination as Provider of PDA Testing services. The firm selected by the Contractor must be approved by the Engineer.

The Independent Specialist must supply the following testing instrumentation in addition to instrumentation outlined in ASTM specification D4945-89 Section 5:

a) Pile Driving Analyzer (PDA)

b) Calibrated Strain Transducers

c) Calibrated Accelerometer

400.3.14.4 Reporting Results

The Independent Specialist appointed by the Contractor shall submit a timely report of the testing results to the Engineer for approval. The field results from at least one (CAPWAP) analysis (case Pile Wave Analysis Program) shall be submitted. The CAPWAP analysis shall be performed by an engineer that has achieved an advanced or better level on the foundation QA examination as providers of PDA Testing Services. The report must also provide the following:

a. Wave Equation analysis results obtained prior to testing
b. CAPWAP analysis result.
c. For each impact the maximum measured force, maximum calculated tension force, transferred energy to the gage location, corresponding stresses, and the Case Method bearing capacity.
d. Assessment of the test result with respect to both pile capacity and integrity.

400.1.3.2.3. Cross-Hole Sonic Logging of Bored Holes.

By sending ultrasonic pulses through concrete from one probe to another (probes located in parallel tubes) , the Cross hole Sonic Logging (CSL) procedure inspects the drilled shaft structural integrity, and extent and location of defects, if any. At the receiver

probe, pulse arrival time and signal the concrete affects strength. For equidistant tubes, uniform concrete yields consistent arrival times with reasonable pulse wave speed and signal strengths. Non-uniformities such as contamination, soft concrete, honeycombing, voids, or intrusions of foreign objects exhibit delayed arrival time with reduced signal strength.

400.1.5 Concrete and Steel Piles Bearing Values

The bearing values for concrete and steel pile will be determined by the Engineer using the following formula;

a) Modified Hiley's Formula or any formula from the brochures of the equipment used, shall be used when the ratio of weight of ram or hammer to weight of pile is greater than one fourth(¼);

$$Ru = \frac{2WH(W)}{(S+K)(W+Wp)}$$

$$Ra = \frac{Ru}{FS}$$

Where;

Ru = ultimate capacity of piles(KN)
Ra = capacity of pile(KN) shall be greater than the required
W = weight of ram or hammer(KN)
H = height of fall of ram(mm)
Wp = weight of pile(KN)
S = average penetration for the last ten blows(mm)
K = 10mm (unless otherwise observed/ computed during driving)
FS = factor of safety (min.=3)

b) Hiley's Formula shall be used when the ratio of the eight of ram or hammer to weight of pile is less than one fourth (1/4).

$$Ru = \frac{efWH\ 9W)}{S+^{1/2}\ (C1+C2+C3)} \times \frac{(W+n2\ Wp)}{(W+Wp)}$$

RU= 2WH(W)/(S+K)(W+Wp)

Ra = Ru/FS

Where;
Ru = ultimate capacity of piles(KN)
Ra = capacity of pile(KN)
Ef = efficiency of hammer (refer to table)
W = weight of ram (KN)
H = height of fall of ram(mm)
Wp = weight of pile(KN)
S = average penetration for the last ten blows(mm)
K = 10mm (unless otherwise observed/ computed during driving)

C1 = temporary compression allowance for pile head and cap (refer to table)
C2 = RuL/AEp
C3 = range from 2.54mm to 5.08mmfor resilient soil to 0 for hard pan (rock,very dense sand and gravel)
L = length of pile
A = cross-sectional area of pile
Ep = modulus of elasticity of pile
n = coefficient of restitution (refer to table)
FS = factor of safety(min. = 3)

Required minimum penetration of all piles shall be six (6) meters. However, for exposed piles, the embedded length shall be equal or greater than the exposed length but not less than 6m.

For Values of C1 for Hiley's Formula may refer to page 177 of Standard Specifications for Highways (Bridges and Airports) issued year 2013.Similarly, for values of Efficiency of Hammer, ef and Values of Coefficient of Restitution, n can be referred to page 178 of the same Standard Specifications for Bridges and Airports

400.3 Construction Requirements

400.3.1 Location and Site Preparation

Piles shall be driven where indicated on the Plans or as directed by the Engineer.

All excavations for the foundation on which the piles are to be driven shall be completed before the pile driving, unless otherwise specified or approved by the Engineer. After driving is completed, all loose and displaced materials shall be removed from around the piles by hand excavation, leaving clean solid surface to receive the concrete of the foundation. Any requirement for granular fill and lean concrete shall be indicated on the Plans or as directed by the Engineer.

400.3.2 Determination of Pile Length

Pile length and bearing capacity shall be determined by the Engineer from the results of the test piling and load test.

The criterion for pile length may be one of the following;

1. Piles in sand and gravel shall be driven to a bearing power determined by the use of the pile driving formula or as decided by the Engineer.
2. Piles in clay shall be driven to the depth ordered by the Engineer. However, the bearing power shall be controlled by the pile driving formula if called for by the Engineer.
3. Piles shall be driven to refusal on rock or hard layer when so ordered by the Engineer.

The Contractor shall be responsible for obtaining the correct pile length and bearing capacity according to the criteria given by the Engineer.

400.3.3 Pile Driving

All piles shall be driven as shown on the Plans or as ordered by the Engineer. They shall be driven within an allowed variation of 20mm per meter of pile length from the vertical or batter as shown on the Plans. The maximum allowable variation at the butt end of the pile shall be 75mm in any direction from the location shown on the Plans or as directed by the Engineer. Each pile shall, after driving, be within 150mm from the theoretical location underneath the pile cap or underneath the superstructure in case of pile bents. All piles pushed up by the driving of adjacent piles or any other cause shall be redriven.

Piles shall be used only in places where the minimum penetration of 3 meter firm materials, or 5meters in soft materials can be obtained. Whereas soft upper stratum overlies a hard stratum, the piles shall penetrate the hard materials at sufficient depths to fix the ends rigidly.

All pile driving equipment is subject to the Engineer's approval. The Contractor is responsible for the sufficient weight and efficiency of the hammers to drive the piles down to the required depth and bearing capacity. Hammers shall be gravity hammers, single and double acting steam or pneumatic hammers or diesel hammers. Gravity hammer shall not weigh less than 60% of the combined weight of the pile and driving head but not less than 2000kg.The fall shall be regulated so as to avoid injury to the pile and shall in no case exceed 4.50 meter for timber and steel piles and 2.50 m for concrete piles unless otherwise specified or approved by the Engineer.

The plant and equipment furnished for steam hammers shall have sufficient capacity to maintain, under working condition, the pressure at the hammer specified by the manufacturer. The boiler or pressure tank shall be equipped with an accurate pressure gauge and another gauge shall be supplied at the hammer intake to determine the drop in pressure between the gauges. When diesel hammers or any other types requiring calibration are in used, they shall be calibrated with test piling and/or test loads in accordance with Subsection 400.1.2 Test Piles.

Water jets shall be used only when permitted in writing by the Engineer. When water jets are used, the number of jets and the nozzle volume and pressure shall be sufficient to erode freely the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all time a pressure equivalent to at least 690 KPa at two 19mm jet nozzles. The jets shall be shut off before the required penetration is reached and the piles shall be driven solely by hammers to final penetration as required by the Engineer.

Piles shall be supported in line and position with leads while being driven. Pile driving leads shall be constructed in such a manner as to afford freedom of movement of the hammer, and shall be held in position by the guys or steel braces to insure rigid lateral support to the pile during driving. The leads shall be of sufficient length to make the use of a follower unnecessary and shall be so designed as to meet proper placing of batter piles. The driving of piles with followers shall be avoided if practicable and shall be done only underwritten permission from the Engineer.

The method used in driving piles shall not subject them to excessive and undue abuse producing crushing and spalling of the concrete, injurious splitting and brooming of the wood or deformation of the steel. Manipulation of piles to force them into proper position if considered by the Engineer too excessive will not be permitted.

The pile tops shall be protected by driving heads, caps or cushions in accordance with the recommendation of the manufacturer of the pile hammer and to the satisfaction of

the Engineer. The driving head shall be provided to maintain the axis of the pile with the axis of the hammer and provide a driving surface normal to the pile.

Full length piles shall be used where practicable, Splicing of piles when permitted, shall be in accordance with the provisions of Subsection 400.3.7 and 400.3.8. All piles shall be continuously driven unless otherwise allowed by the Engineer.

400.3.6 Precast Concrete Piles

Precast concrete piles shall be of the design shown on the Plans. Prestressed concrete piles shall be prestressed as prescribed in item 406, Prestressed Concrete Structures. The piles shall be cast separately and concrete in each pile shall be place continuously. The completed piles shall be from stone pockets, honeycombs, or other defects, and shall be straight and true to the form specified. The forms shall be true to line and built of metal, plywood or dressed lumber. A 25mm chamfer strip shall be used in all corners. Form shall be water-tight and shall no be removed until at least twenty-four (24) hours after the concrete is placed

Piles shall be cured and finished in accordance with items 405, Structural Concrete and 406 , Prestressed Concrete Structures.

Cylinder specimens shall be made and tested in accordance with item 405. Piles shall not be moved until the test indicates that the concrete has attained a compressive strength of at least 80 percent of the design 28 day compressive strength and they shall not be transported or driven until the design 28-day compressive strength has been attained.

If testing equipment is not available, as in isolated areas, piles shall not be moved until after 14 days after casting and shall not be transported or driven prior to 28 days after casting. If highly strength cement is used, piles shall not be moved, transported or driven prior to 7 days after casting.

When concrete piles are lifted or moved, they shall be supported at the points shown on the Plans; if not shown, they shall be supported at the quarter points.

400.3.7 Cast-in-place Concrete Piles

1. Drilled Holes

All holes for concrete piles cast in drilled holes shall be drilled dry to tip elevation shown on the Plans. All holes will be examined for straightness and any hole which on visual inspection from the top shows less than one half the diameter of the hole at the bottom of the hole will be rejected. Suitable casings shall be furnished and place when required to prevent caving of the hole before concrete is placed.

All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed before placing concrete.

The use of water for drilling operations or for any other purpose where it may enter the hole will not be permitted. All necessary action shall be taken to prevent surface water from entering the hole and all water which may have infiltrated into the hole shall be removed before placing concrete.

Concrete shall be placed by means of suitable tubes. Prior to the initial concrete set, the top 3 m of the concrete filled pile or the depth of any reinforcing cage, whichever is greater, shall be consolidated by acceptable vibratory equipment.

Casing, if used in drilling operations, may be left in place or removed from the hole as concrete is placed. The bottom of the casing shall be maintained not more than 1.5 m nor less than 0.3 m below the top of the concrete during withdrawal and placing operations unless otherwise permitted by the Engineer. Separation of the concrete during withdrawal operations shall be avoided by vibrating the casing.

2. Steel Shells and Pipes

The inside of shells and pipes shall be cleaned and all loose materials removed before concrete is placed. The concrete shall be placed in one continuous operation from tip to cut-off elevation and shall be carried on in such a manner as to avoid segregation.

The top 3 m of concrete filled shells, or to the depth of any reinforcing cage, whichever is greater, shall be consolidated by acceptable vibratory equipment.
Pipes shall be of the diameter shown on the Plans but in no case less than 5mm. The pipe, including end closures, shall be of sufficient strength to be driven by the specified methods without distortion.

Closure plates and connecting welds shall not project more than 12.5 mm beyond the perimeter of the pile tips.

No shell or pipe shall be filled with concrete until all adjacent shells, pipes, or piles within a radius of 1.5 m or 4 ½ times the average pile diameter, whichever is greater, have been driven to the required resistance.

After a shell or pipe has been filled with concrete, no shell, pipe or pile shall be driven within 6 m thereof until at least 7 days have been elapsed.

3. Drilled Shafts

Drilled shafts are deep foundations formed by boring a cylindrical hole into soil and/or rock and filling the holes with concrete. Drilled shafts are also commonly referred to as caissons, bored piles or drilled piers.

Driiled shafts , like driven piles, transfer structural loads to bearing stratum well below the base of the structure by passing soils having insufficient strength to carry the design loads.

Drilled shafts are classified according to their primary mechanism for deriving load resistance either as floating shafts (i.e., shafts transferring load primarily by side resistance),.Occasionally, the bases of shafts are enlarged (i.e., belled or under-reamed) to improve the load capacity of end bearing shafts on less than desirable soils, or to increase the uplift resistance of floating shafts.

Effects of ground and ground water conditions on shaft construction operations should be considered and delineated, when necessary, the general method of construction to be followed to ensure the expected performance. Because shafts are derive their capacity from side and tip resistance which are a function of the condition of the materials in direct contact with the shaft, it is important that the construction procedures be consistent with the material conditions assumed in the design.. Softening, loosening or other changes in soil and rock conditions caused by the construction method could result in a reduction in

shaft capacity and an increase in shaft displacement. Therefore, evaluation of the effects of shaft construction procedure on load capacity must be considered an inherent aspect of the design.

Drilled shafts are normally sized in 15.24 cm diameter increments with a minimum diameter of 45.72 cm. The diameter of a shaft socketed into rock should be a minimum of 15.24 cm larger than the socket diameter. If a socket must be inspected by the entry of a person, the shaft diameter shall not be less than 76.20 cm.

Drilled shafts constructed in dry, non-caving soils can usually excavated without lateral support of the hole. Other ground conditions where caving, squeezing or sloughing soils are present require a installation of a steel casing or use of a slurry for support of the hole. Such conditions and techniques may result in loosening of soil around the shaft, or altering of frictional resistance between the concrete shaft and surrounding soil.

The center-to-center spacing between shafts is normally restricted to a minimum of 3B to minimize the effects of interaction between adjacent shafts during construction or in service. However, larger spacing may be required where drilling operations are difficult or where construction must be completed in very short time frames.

Particular attention should be given to the potential for deposition of loose or wet material in the bottom of the hole, or the buildup of a cake of soft material around the shaft perimeter prior to concrete placement. If good contact along the shaft cannot be confirmed, it may be necessary to assume that all load is transferred to the tip. If the deposition of soil or loose material in the bottom of the hole is expected, the shaft may have to be designed to carry the entire design load through side resistance.

A number of methods can be used to prevent caving during the drilling of holes and the placement of concrete. It is preferred that drilled shafts be constructed in stable non-sloughing soil without excessive ground water. If impossible, consider the following three different construction methods:

a. The construction of the pile or a shaft in a wet condition while the walls of excavation are stabilized by hydrostatic pressure of water or a mineral slurry until the concrete is placed by tremie methods for the full length of the pile.

   Mineral slurry used in the drilling process shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. The level of slurry shall be maintained at a height sufficient to prevent caving of the hole.

   The mineral slurry shall be premixed thoroughly with clean fresh water and adequate time allotted for hydration prior to introduction into the shaft excavation. Adequate slurry tanks will be required when specified. No excavated slurry pits will be allowed when specified. Steps shall be taken as necessary to prevent the slurry from setting up in the shaft excavation, such as agitation, circulation, and adjusting the properties of the slurry.

   Control tests using suitable apparatus shall be carried out by the Contractor on the mineral slurry to determine density, viscosity, and pH. An acceptable range of values for those physical properties is shown in the following table.

Range of Values (At 20^0 C)

Property(Units)	Time of Slurry Introduction	Time of Concreting (In Hole)	Test Method
Density(KN/m^3)	10.10 to 10.86	10.10 to 11.79	Density Balance
Viscosity (sec. per liter)	28 to 45	28 to 45	Marsh Cone
pH	8 to 11	8 to 11	Ph Paper Or Meter

Note:

a) Increase density values by 0.314 KN/m^3 in salt water
b) If desanding is required; sand content shall not exceed 4 percent (by volume) at any point in the shaft excavation as determined by the American Petroleum Institute sand content test.

Test to determine density, viscosity and pH values shall be done during the shaft excavation to establish a consistent working pattern.

Prior to placing shaft concrete, slurry samples shall be taken from the bottom at intervals not exceeding 3.05 m for the full height of slurry. Any heavy contaminated slurry that has accumulated at the bottom of the shaft shall be eliminated. The mineral slurry shall be within specification requirements immediately before shaft concrete placement.

Excavation Inspection

The Contractor shall provide equipment for checking the dimensions and alignment of each shaft excavation. The Contractor under the direction of the Engineer shall determine the dimensions and alignment of the drilled shaft. Final shaft depth shall be measured after final cleaning.

The base of the shaft excavation may be cleaned using a cleaning bucket followed by airlifting. Reverse circulation techniques may also be used to clean the base of the shaft.

The shaft excavation shall be cleaned so that a minimum of 50 percent of the base will have less than 12.5mm of sediment and at no place on the base more than 37.5 mm of sediment. The Engineer will determine shaft cleanliness.

b. The use of steel casing which is installed during drilling operations to hold the hole open and usually withdrawn during concrete placement.

Casing, if used in operation, shall be metal, smooth, clean, watertight, and of ample strength to withstand both handling and driving stresses and the pressure of both concrete and the surrounding earth materials. The outside diameter of casing shall not be less than the specified size of the shaft. It shall conform to AASHTO M 270 (ASTM A 709) Grade 36 unless otherwise specified.

Temporary casings shall be removed while the concrete remains workable. Generally the removal of the temporary casing shall not be started until concrete placement in the shaft

is at or above ground surface. Movement of casing by rotating, exerting downward pressure and tapping to facilitate extraction or extraction with a vibratory hammer will be permitted. Casing extraction shall be at a slow, uniform rate with the pull in line with the shaft axis.

A sufficient head of concrete shall be maintained above the bottom of the casing to overcome the hydrostatic pressure of water or drilling fluid outside of the casing.

c. The use of permanent casing which left in place within the portion of the pile which is in unstable material.

A permanent casing is applied as protection from the presence of the surface water during drilling and as support later for the installation of the rebar cage and as a concrete form in drilling under water.

Reinforcing Steel Cage Construction and Placement

The reinforcing steel cage consisting of the steel shown on the Plans plus cage stiffener bars, spacers, centraliuzers and any other necessary appurtenances shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted prior to shaft concrete placement.

Where the reinforcing cage length is too long for placement as a single unit, the case may be placed in separate units such that appropriate means of splicing the longitudinal steel is provided for. The Contractor shall submit his plans for such splices to the Engineer for approval.

The reinforcing steel in the hole shall be tied and supported so that the reinforcing steel will remain within allowable tolerances until the concrete will support the reinforcing steel. When concrete is placed by suitable tubes, temporary hold-down devices shall be use to prevent uplifting of the steel cage during concrete placement. Concrete spacers or other approved noncorrosive spacing devices shall be used at sufficient intervals not exceeding 1.5 meters along the shaft to insure concentric location of the cage within the shaft excavation. When the size of the longitudinal reinforcing steel exceeds 25 mm, such spacing shall not exceed 3.00 meters.

Concrete Placement, Curing and Protection

Concrete shall be placed as soon as possible after reinforcing steel cage placement. Concrete placement shall be continuous in the shaft to the top elevation of the shaft. Placement shall after the shaft is full until good quality concrete is evident at the top of the shaft. Concrete shall be placed through a suitable tube.

For piles less than 2.5 meters in diameter. The elapsed time from the beginning of concrete placement shall no exceed 2 hours. For piles 2.5 meters and greater in diameter, the concrete placing rate shall not be less than 9 meters of pile height per each 2-hour period. The concrete mix shall be of such design that the concrete remains in a workable plastic state throughout the 2-hour placement limit.

When the top of pile elevation is above ground, the portion of the pile above ground shall be formed with a removable form or permanent casing when specified.

The upper 1.5 meters of concrete shall be vibrated or rodded to a depth of 1.5 meters below the ground surface except where soft uncased soil or slurry remaining in the excavation will possibly mix with the concrete.

After placement, the temporary exposed surfaces of the shaft concrete shall be cured in accordance with the provision in Subsection 407.3.8- Curing Concrete.

For at least 48 hours after pile concrete has been placed, no construction operations that would cause soil movement adjacent to the shaft, other than mild vibration, shall be conducted.

Construction Tolerances;

The following tolerances shall be maintained in constructing drilled shaft:

a. The drilled shaft shall be within 15.24 cm of the plan position in the horizontal plane at the plan elevation for the top of the shaft.
b. The vertical alignment of the shaft excavation shall no vary from the plan alignment by more than 20,83 mm/m of depth.
c. After all the shaft concrete is placed, the top of the reinforcing steel cage shall be no more than 15.24 cm above and no more than 7.62 cm below plan position.
d. When casing is used, its outside diameter shall not be less than the shaft diameter shown on the plans. When casing is not used, the minimum diameter of the drilled shaft shall be the diameter shown on the plans for diameters 60.06 cm or less, and not more than 2.54 cm less than the diameter shown on the plans for diameters greater than 60.96 cm.
e. The bearing area of bells shall be excavated to the plan bearing area as a minimum. All other plan dimensions shown for the bells may be varied, when approved, to accommodate the equipment used.
f. The top elevation of the shaft shall be within 2.54 cm of the plan top of shaft elevation.
g. The bottom of the shaft elevation shall be normal to the axis of the shaft within 62.5 mm/m of shaft diameter.

Drilled shaft excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances are unacceptable.

400.3.10 Splicing

Splicing when permitted shall made as shown on the Plans and in accordance with this Subsection.

1. Precast Concrete Piles

a. By using prefabricated joints mounted in the forms and cast together with the piles sections and joined together as specified by the manufacturer and approved by the Engineer. The joints shall be of the design and type as specified or shown on the Plans.

b. By cutting the away the concrete at the end of the pile, leaving the reinforcing steel exposed for a length of 40 bar diameter for corrugated or deformed bars and 60 bar diameters for plain bars. The final cut of the concrete shall be perpendicular to the axis of the pile. Reinforcement of the same size as that used in the pile shall be spliced to the projecting steel in accordance with item 404, Reinforcing Steel and the necessary formwork shall be placed care being taken

to prevent leakage along the pile. The concrete shall be of the same quality as that used in the pile. Just prior to placing concrete, the top of the pile shall be wetted thoroughly and covered with a thin coating of neat cement, retempered mortar, or other suitable bonding material to the satisfaction of the Engineer. The form shall remain in place not less than seven (7) days. The pile shall not be driven until the safe design strength has been reached.

c. By any other method shown on the Plans or approved by the Engineer. Curing and finishing of extensions shall be the same as in the original pile.

400.3.11 Cutting Off and Capping Piles

The top of the foundation piles shall be embedded in the concrete footing as shown on the Plans.

Concrete piles shall, when approved by the Engineer, be cut off at such a level that at least 300 mm of undamaged pile can be embedded in the structure above. If a pile is damaged below this level, the Contractor shall repair the pile to the satisfaction of the Engineer. The longitudinal reinforcement of the piles shall be embedded in the structure above to a length equal to at least 40 times the diameter of the main reinforcing corrugated bars (60 bar diameters for plan bars).The distance from the side of any pile to the nearest edge of the cap shall not be less than 200 mm.

When the cut off elevation for a precast pile or for the steel shell or pile for a cast in place concrete pile is below the elevation of the bottom of the pile cap, the pile may be built-up from the butt of the pile to the elevation of the bottom of the cap by means of reinforced concrete extension constructed in accordance with Subsection 400.3.10 or as approved by the Engineer

Cut-offs of structural steel piles shall be made at right angles to the axis of the pile. The cuts shall be made in clear, straight lines and any irregularity due to cutting or burning shall be leveled-off with deposits of weld metal prior to placing bearing caps.

A precast concrete pile shall be considered defective if it has a visible crack, extending around the four sides of the pile, or any defect which, in the opinion of the Engineer, affects the strength or life of the pile.

When a new pile is driven or cast to replace a rejected one, the Contractor at his own expense, shall enlarge the footing as deemed necessary by the Engineer.

400.3.12 Defective Piles

Any pile delivered with defects, or damaged in driving due to internal defect or by improper driving, or driven out of its proper location, or driven below the elevation fixed by the Plans or by the Engineer, shall be corrected at the Contractor’s expense by one of the following methods approved by the Engineer for the pile in question:

Any pile delivered with defects shall be replaced by a new pile.

Additional pile shall be driven/casted at the locations as directed by the Engineer.

The pile shall be spliced or built-up as otherwise provided herein on the underside of the footing lowered to properly embed the pile.

400.3.13 Pile Records

The Contractor shall keep records of all piles driven or installed. A copy of the record shall be given to the Engineer within two (2) days after each pile is driven. The record form to be used shall be approved by the Engineer. The pile records shall give full information on the following:

Driven Piles
1. Pile Type 2. Date of casting and concrete quality (for concrete piles) 3. Date of driving 4. Driving equipment: type, weight & efficiency of hammer, etc. 5. Description of cushion on pile head 6. Depth driven and tip elevation 7. Final set for the last 20 blows (for every 10 piles and when the Engineer so requires the penetration along the whole depth driven shall be recorded) 8. For gravity and single-acting hammers: the height of drop 9. For double acting –hammers the frequency of blows 10. Details of any interruption in driving 11. Level of pile top immediately after driving and the level when all piles in the group are driven 12. Details of re-driving

400.4 Method of Measurement

400.4.1 Timber, Steel and Precast Concrete Piles

1. Piles Furnished

The quantity to be paid for will be the sum of the lengths in metres of the piles of the several types and lengths ordered in writing by the Engineer, furnished in compliance with these Specifications and stockpiles in good condition at the project site by the Contractor and accepted by the Engineer. The length to be paid for will include test and tension piles ordered by the Engineer, but not those furnished by the Contractor at his option. No allowance will be made for piles, including test piles, furnished by the Contractor to replace piles previously accepted by the Engineer that are subsequently lost or damaged while in stockpile, or during handling or driving, and are ordered by the Engineer to be removed from the site of work.

In case extensions of piles are necessary, the extension length will be included in the length of pile furnished, except for cut off lengths used for extensions and already measured for payment.

2. Piles Driven

The quantity to be paid for will be the sum of the lengths in metres of the piles driven in the completed work measured from the pile tip elevation to the bottom of pile caps,

footings or bottom of concrete superstructure in the case of pile bents. Measurement will not include additional piles or test piles driven that may be necessary to suit the Contractor's method of construction and were driven at his option.

400.4.2 Cast-In-Place Concrete Piles

The quantity to be paid for will be the sum of actual lengths in meters of the piles cast and left in-place in the completed and accepted work. Measurements will be from the pile tip to the bottom of cap or footing. Portions of piles cast deeper that the required length through over-drilling will not be measured for payment.

400.4.3 Pile Shoes

The quantity to be paid for, including test pile shoes, will be the number of pile shoes driven shown on the Plans or ordered in writing by the Engineer, furnished by the Contractor in accordance with these Specifications and accepted by the Engineer. Pile shoes furnished by the Contractor at his option or to replace those that are lost or damaged in stockpile or handling will not be measured for payment.

400.4.4 Load Tests

The quantity of the loaf tests to be paid for will be the number of tests completed and accepted except that load tests made to calibrate different types of hammers, if not included in the Bill of Quantities, will not be measured for payment.

Anchor and test piling which are not part of the completed structure will be included in the unit bid price for each "Load Test". Anchor and test piling or anchor and test shafts which are a part of the permanent structure will be paid for under the appropriate Item.

400.4.5 Splices

The quantity to be paid for will be the number of splices which may be required to drive the pile in excess of the estimated length shown on the Plans for cast-in-place steel pipes or shells or in excess of the order length furnished by the Engineer for all other types of piling. Splices made for the convenience of the Contractor or to fabricate piles cut offs will not be paid for.

404.4.6 Pile Dynamic Analysis & Pile Integrity Test

The quantity to be paid for will be the number of piles tested and accepted. Any incidentals not otherwise described hereto are considered subsidiary to the work item and shall not be paid for separately.

400.5 Basis of Payment

The accepted quantities, measured as prescribed in Section 400.4 shall be paid for at the contract unit price for each of the particular item listed below that is included in the Bill of Quantities, which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment tools and incidentals as well as temporary works, staging areas or craneway necessary to complete the work prescribed in this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
400 (4)	PSC Piles, 0.4m x0.4m Furnished	Linear Meter
400 (14)	PSC Piles, 0.4m x0.4m vertical driven	Linear Meter
400 (16)	PSC Piles, 0.4m x 0.4m batter	Linear Meter
400 (20)	Chipping and cutting of driven PSC piles up to cut-off elevation including disposal of debris	pcs
400 (21)	Existing reinforced concrete curb to be demolished and smoothen with mortar	Linear Meter
400 (28)	High Strain Pile Dynamic Analysis (PDA)	each
400 (27) b	Low Strain Pile Integrity Test (PIT)	each

ITEM 401 – RAILINGS

401.1 Description

This item shall consists of furnishing or fabricating and/or placing railings, for bridges and other structures of the material or combination of materials shown on the Plans, constructed in reasonably close dimensions shown on the plans. Railings shall be classified as concrete, steel, aluminum or timber in accordance with the predominating material contained in each.

401.2 Material Requirements

401.2.1 Concrete

It shall conform to the applicable requirements prescribed in Item 405, Structural Concrete.

401.2.2 Reinforcing Steel

It shall conform to the requirements of Item 701, Reinforcing Steel and Wire Rope.

401.2.3 Steel

Structural steel consisting of stainless steel and iron plates, shapes, pipes, fittings and casting shall conform to the requirements of Item 403, ASTM A240, Metal Structures.

401.2.4 Aluminum

It shall conform to the requirements of AASHTO M 193, ASTM B 221 or ASTM B 203 or as called for the Plans.

401.2.5 Timber

It shall conform to the requirements of Item 713, Treated and Untreated Timber
.

401.2.6 Stones and Bricks

Theses shall conform to the requirements of Item 506, stone Masonry and Item 704, Masonry Units.

401.2.7 Paint

It shall conform to the requirements of Item 709, Paints

401.3 Construction Requirements

401.3.1 General

Railing shall be constructed to the lines and grades shown on the Plans and shall not reflect any unevenness in the structures. All railing posts shall be set plumb in the hand or mechanically dug holes, unless driving is permitted. In the latter case, the manner of driving shall be such as to avoid battering or distorting of post. Post holes shall be backfilled with acceptable material placed in layers and thoroughly compacted. When it is necessary to cut post holes in existing pavement, all loose materials shall be removed and the paving replaced in kind. Bridge railing shall not be placed on a span until centering or falsework was been removed, rendering the span self-supporting.

Rail elements shall be erected according to Plans and in a manner resulting in a smooth, continuous installing with the laps in the direction of traffic flow. All bolts except adjustment bolt shall be drawn tight. Bolts shall be sufficient length to extend beyond the nuts by more than 25 mm.

Where painting of the railing components is specified, any damage to the shop coat of the paint shall be corrected by an application of an approved rust-inhibitive primer prior to painting. Ungalvanized surfaces inaccessible to painting after erection shall be field painted before erection. The railing components shall be given the specified number of coats of paint uniformly applied by thorough brushing or by approved pressure spray.

Galvanized surfaces which have been abraded so that the base metal is exposed, threaded portions of all fittings, fastener and cut ends of bolts shall be painted with two (2) coats of zinc-dust and zinc oxide paint.

401.3.2 Metal Railing

Fabrication and erection shall be done in accordance with the requirements of Item 403, Metal Structures. In the case of welded railings, all exposed joints shall be finished by grinding or filling after welding to give a neat appearance.

Metal railing shall be carefully adjusted prior to fixing in-place to insure proper matching of abutting joints, correct alignment and camber throughout their length. Holes for field connection shall be drilled with the railing in-place in the structure at proper grade and alignment. Welded may be substituted for rivets or bolts in field connection with the approval of the Engineer.

401.3.3 Concrete Railing

1. Railing Cast-in-Place

   The portion of the railing or parapet which is to be cast-in-place shall be constructed in accordance with the requirements of Item 405, Structural Concrete. Special care shall be exercised to secure smooth and tight fitting forms which can be rigidly held in line and grade and removed without injury to the concrete.

Forms shall either be of single width boards or shall be lined with suitable material to have a smooth surface which shall meet the approval of the Engineer or as shown on the Plans.

All moldings, panel work and bevel strips shall be constructed according to the detailed Plans with metered joints. All corners in the finished work shall be true, sharp and clean-cut, and shall be free from cracks, spall and other defects.

2. Precast Railings

Moist tamped mortar precast members shall be removed from the molds as soon as predictable and shall be kept damp for a period of at least ten (10) days. Any member that shows checking of soft corners of surfaces shall be rejected.

Expansion joints shall be constructed as to permit freedom of movement. After all work is completed, all loose or thin shells of mortar likely to spall under movement shall be carefully removed from all expansion joints by means of a sharp chisel.

401.3.4 Wooden Railing

Wooden railing shall be constructed in accordance with the requirements of Item 402, Timber Structures.

401.3.5 Stone and Brick Railing

The materials used in masonry brick railing and parapet, and the work to be done shall conform to the requirements of the Specification. The workmanship shall be first class and the finished ion shall be neat in appearance and true to line and grade.

The materials used in masonry brick railing and parapet, and the work to be done shall conform to the requirements of the Specification. The workmanship shall be first class and the finished ion shall be neat in appearance and true to line and grade.

401.4 Method of Measurement

The quantity to be paid for shall be the number of linear meters of specified railing actually completed and accepted measured from center to center of end posts.

401.5 Basis of Payment

The accepted quality, measured as prescribed in Section 401.4, shall be paid for at the contract unit price for Railing, which price and payment shall be full compensation for furnishing and placing all materials including all labor, equipment, tools and incidentals necessary to complete this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
401 (1)	Stainless Steel Railing	lm
401 (2)	Stainless Steel Railing for Stair	lm
401 (3)	Stainless Steel Railing for Ramp	lm
401 (4)	Stainless Steel Railing for 2nd Flr., Lounge/Lobby area	lm
401 (5)	Stainless Steel Railing for Roof Deck	lm

ITEM 403 METAL STRUCTURES

403.1 Description

This work shall consist of steel structures and the steel structure portions of composite structure, constructed in reasonably close conformity with the lines, grades and dimensions shown on the Plans or established by the Engineer.

The work will include the furnishing, fabricating, hauling, erecting, welding and painting of structural metals called for in the Special Provisions or shown on the Plans. Structural metals will include structural steel, rivet, welding, special and alloy steels forgings and castings and iron castings. This work will also include any incidental metal construction not otherwise provided for, all in accordance with these Specification, Plans and Special Provisions.

References

The publications listed below form a part of this Specification to the extent referenced. The Publications are referred to in the text by basic designation only.

Table 1
Equivalent to the following European or French standard below:

ASTM A36	Specifications for carbon structural steel
ASTM A182	Forged or rolled alloy-steel pipe flanges, forced fittings, and valves and parts for high-temperature service
ASTM A240	Heat-resisting chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels
ASTM A307	Specification for carbon steel bolts and studs
ASTM A325	Specification for high strength bolts for structural steel joints
ASTM A366	Steel, sheet, carbon, cold-rolled, commercial quality
ASTM A500	Cold-formed welded and seamless carbon steel structural tubing in rounds and shapes
ASTM A501	Hot-formed welded and seamless carbon steel structural tubing
ASTM A786	Rolled steel floor plates
ASTM A789	Seamless and welded ferritic/austenitic stainless steel tubing for general services
ASTM B88	Seamless copper water tube
ASTM F738	Stainless steel metric bolts, screws and studs
ASTM F836	Style 1 stainless steel metric nuts
AWS D1.1	Structural welding code-steel
NF EN 10025-2/3	Non alloyed structural steel
EN 24014 AND 24032	Hexagon head bolts class 8.8
EN 14399-4 AND 14366-6	Nuts and bolts of high-strength construction suited to prestressing
EN 19-57	European I beams
EN 53-62	European Wide Flange Beam
NF A 45-202	European Standard channel
NF EN 288-2	Description and qualification of a procedure of welding for metallic materials
NF P 22-471	Steel construction welded joints - Fabrication

403.2 Material Requirements

Materials shall comply with the Standards listed in the **Table 1.**

Table-1
Material Standard

Item	American Standard
Structural Steel	ASTM A36
Sheet Steel	ASTM A366
Steel Tube and Pipe	ASTM 500;A501
Copper tube	ASTM B88M
Stainless Steel Tube	ASTM A789M
Stainless steel	ASTM A240
Steel floor plate	ASTM A786
Stainless steel bolts	ASTM F738M or F836M
Carbon steel bolts and nuts	ASTM A307
High strength bolts	ASTM A325

403.3 Construction Requirements

403.3.1 Inspection

The Contractor shall give the Engineer at least fifteen (15) days notice prior to the beginning of work at the mill or shop, so that the required inspection may be made. The term “mill” means any rolling mill, shop or foundry where material for the work is to be manufactured or fabricated. No material shall be rolled or fabricated. No material shall be rolled or fabricated until said inspection has been provided.

The Contractor shall furnish the engineer with copies of the certified mill reports of the structural steel, preferably before but not later than the delivery of the steel to the job site.

The Contractor shall furnish all facilities for inspection and the Engineer shall be allowed free access to the mill or shop and premises at all times. The Contractor shall furnish, without charge, all labor, machinery, material and tools necessary to prepare test specimens.

Inspection at the mill or shop is intended as a means of facilitating the work and avoiding errors and it is expressly understood that it will not relieve the Contractor from any responsibility for imperfect material or workmanship and the necessity for replacing same. The acceptance of any material or finished member at the mill or shop by the Engineer shall not preclude their subsequent rejection if found defective before final acceptance of the work. Inspection of welding will be in accordance with the provisions of Section V of the “Standard Code for Arc and Gas Welding in Building Construction” of the American Welding Society.

403.3.3 Fabrication

These Specifications apply to riveted, bolted and welded construction. The Contractor may, however, with approved of the Engineer, substitute high tensile strength steel bolts equivalent to the rivets in any connection.

Workmanship and finish shall be in accordance with the best general practice in modern bridge shops. Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting, and chipping shall be done carefully and accurately.

Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids or other supports. It shall be kept free from dirt, grease or other foreign matter, and shall be protected as far as practicable from corrosion.

Rolled material before being laid off or worked must be straight. If straightening is necessary, It shall be done by methods that will not injure the metal. Sharp kinks and bends will be cause for rejection of the material.

Preparation of material shall be in accordance with AWS (American Welding Society) D1.1, paragraph3.2 as modified by AASHTO Standard Specification for Welding of Structural Steel Highway Bridges.

Tests

When full size test of fabricated structural members or eyebars are required by the Contract, the Plans or specifications will state the number and nature of the tests, the results to be attained and the measurements of strength , deformation or other performances that are to be made. The Contractor will provide suitable facilities, material, supervision and labor necessary for making and recording the tests. The cost of testing, including equipment handling. Supervision labor and incidentals for making the test shall be included in the contract price for the fabrication and erection of structural steel, whichever is the applicable item in the Contract, unless otherwise specified.

403.3.8 Rivets and Riveting

The size of rivets called for on the Plans shall be the size before heating. Rivet heads shall be of standard shape, unless otherwise specified, and of uniform size for the same diameter or rivet. They shall be full, neatly made, concentric with the rivets holes, and in full contact with the surface of the member. Sufficient rivets for field connections shall be furnished to rivet the entire structure with an ample surplus to replace all rivets burned, lost or cut out.

Rivets shall be heated uniformly to a “light cherry red color” and shall be driven while hot. Any rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale and other adhering matter. Any river which is sealed excessively will be rejected.

All rivets that are loose, burned, badly formed, or otherwise defective shall be removed and replaced with satisfactory rivets. Any rivet whose head is defective in size or whose head is driven off center will be considered defective and shall be removed. Stitch rivets that are loosened by driving of adjacent rivets shall be removed and replaced with satisfactory rivets. Caulking, recapping, or double gunning of rivets heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines when practicable. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use if a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required when the size and length of the rivets warrant their use.

Rivets may be driven cold provided their diameter is not over 9.5 mm.

403.3.9 Bolted Connections, Unfurnished, Turned and ribbed Bolts

1. General

   Bolts under this Subsection shall conform to “Specification for Carbon steel Externally and Internally Threaded Standard Fasteners”, ASTM A 307. Specifications for high strength bolts are covered under Subsection 403.3.10.

   Bolts shall be unfinished, turned or an approved form of ribbed bolts with hexagonal nuts and heads except that ribbed bolts shall have button heads. Bolted connections shall be used only as indicated by the Plans or Special Provisions. Bolts not tightened to the proof loads shall have single self locking nuts or double nuts. Bevel washers shall be used where bearing faces have a slope or more than 1:20 with respect to a plane normal to the bolt axis. Bolts shall be of such length that will extend entirely through their nuts but not more than 6.3 mm beyond them.

   Bolts shall be driven accurately into the holes without damage to the threads. A snap shall be used to prevent damage to the heads. The heads and nuts shall be drawn tight against the work width the full effort of a man using a suitable wrench, not less than 381 mm long for bolts of nominal diameter 19 mm and over. Heads of bolts shall be tapped with a hammer while the nuts are being tightened.

2. Unfinished Bolts

   Unfinished bolts shall be furnished unless other types are specified. The number of bolts furnished shall be 5 percent more than the actual number shown on the Plans for each size and length.

3. Turned Bolts

   The surface of the body of turned bolts shall meet the ANSI roughness rating value of 125. Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size. Diameter of threads shall be equal to the body of the bolt or the nominal diameter of the bolt specified. Holes for turned bolts shall be carefully reamed with bolts furnished to provide for a light driving fit. Threads shall be entirely outside of the holes. A washer shall be provided under the nut.

4. Ribbed Bolts

   The body of ribbed shall be of an approved form with continuous longitudinal ribs. The diameter of the body measured on a circle through the points of the ribs shall be 1.98 mm greater than the nominal diameter specified for the bolts.

   Ribbed bolts shall be furnished with round heads conforming to ANSI B 18.5 unless otherwise specified. Nuts shall be hexagonal, either recessed or with a washer of suitable thickness. Ribbed bolts shall make a driving fit with the holes. The hardness of the ribs shall be such that the ribs do not mash down enough to permit the bolts to turn in the holes during tightening. If for any reason the bolt twists before drawing tight, the holes shall be carefully reamed and an oversized bolt used as a replacement. The Contractor shall provide and supply himself with oversize bolts and nuts for this replacement in an amount not less than ten percent (10%) of the number of ribbed bolts specified.

403.3.10 Bolted Connections (High Tensile-Strength Bolts)

1. Bolts

Bolts shall be AASHTO M 164 (ASTM A 325 or AASHTO M 253) tensioned to a high tension. Other fasteners which meet the chemical requirements of AASHTO M 164 or M 253 and which meet the mechanical requirements of the same specification in full size tests and which have body diameter and bearing areas under the head and nut, or their equivalents, not less than those provided by a bolt and nut of the same nominal dimensions prescribed above, may be used subject to the approval of the Engineer.

Bolts lengths shall be determined by adding the grip-length values given in Table 403.1 to the total thickness of connected material. The values of Table 403.1 compensate for manufacturer's tolerance, the use of heavy semi-finished hexagon nut and a positive "stick-through" at the end of the bolt. For each hardened flat washer that is used and 4 mm to the tabular value and for each beveled washer add 7.9 mm. The length determined shall be adjusted to the next longer 6.3 mm.

Table 403.1
Grip – Length Values

Bolt Size (mm)	To determine required bolt length , add grip (mm)*
9.5	17.5
12.7	22.2
19.0	25.4
22.2	28.6
25.4	31.7
28.6	38.1
31.7	41.3
34.9	44.4
38.1	47.6

* Does not include allowance for washer thickness

2. Bolted Parts

The slope of surface of bolted parts in contact with the bolt head and nut shall not exceed 1:20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. When assembled, all joint surfaces, including those adjacent to the bolt head, nuts or washers, shall be free of scale, except tight mill scale, and shall also be free of burrs, dirt and other foreign material that would prevent solid seating of the parts. Paint is permitted unconditionally in bearing –type connections.

In friction-type connections, the Class, as defined below, indicating the condition of the contact surfaces shall be specified on the Plans. Where no Class is specified, all joint surfaces shall be free of scale, except tight mill scale and shall not have a vinyl wash.

a. Classes A, B and C (uncoated). Contact surfaces shall be free of oil, paint, lacquer or other coatings.

b. Class D (hot-dip galvanized and roughened). Contact surfaces shall be tightly scored by wire brushing or blasting after galvanizing and prior to assembly. The wire brushing treatment shall be a light applicable of manual or power brushing that marks or scores the surface but remove relatively little of the zinc coating. The blasting treatment shall be a light “brush-off” treatment which will produce a dull gray appearance. However, neither treatment should be severed enough to produce any break or discontinuity in the zinc surface.

c. Classes E and F (blast-cleaned, zinc rich paint). Contact surfaces shall be coated with organic or inorganic zinc rich paint as defined in the Steel Structures Painting Council Specification SSPC 12.00

d. Classes G and H (blast-cleaned, metallized zinc or aluminum). Contact surfaces shall be coated in accordance with AWS C2.2, Recommended Practice for Metallizing with Aluminum and Zinc for Protection of Iron and Steel, except that subsequent sealing treatments, described in Section IV therein shall not be used.

e. Class I (vinyl wash). Contact surfaces shall be coated in accordance with the provisions of the Steel Structure Painting Council Pretreatment Specifications SSPC PT3.

AASHTO M 164 (ASTM A 325) Type 2 and AASHTO M 253 bolts shall not be galvanized nor shall they be used to connect galvanized material.

3. Installation

a. Bolt Tension. Each fastener shall be tightened to provide, when all fasteners in the joints are tight at least the minimum bolt tension shown in Table 403.2 for the size of fastener used.

Threaded bolts shall be tightened with properly calibrated wrenches or by the turn-of-nut method. If required, because of bolt entering and wrench operation clearances, tightening by either procedure may be done by turning the bolt while the nut is prevented from rotating Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

AASHTO M 253 and galvanized AASHTO M 164 (ASTM A 325) bolts shall not be reused. Other AASHTO M 164 (ASTM A 325) bolts may be reused, but not more than once, If approved by the Engineer. Retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as a reuse.

b. Washers. All fasteners shall have a hardened washer under the element (nut or bolt head) turned in tightening except that AASHTO M 164 (ASTM A 325) bolts installed by the turn of the nut method in holes which are not oversized or slotted may have the washer omitted. Hardened washers shall be used under both the head and nut regardless of the element turned in the case of AASHTO M 253 bolts if the material against which it bears has a specified yield strength less than 275.75 MPa.

Table 403.2-Bolt Tension

	Minimum Bolt Tension[1], kg	
Bolt Size, mm	**AASHTO M-164 (ASTM A-325) Bolts**	**AASHTO M-253 (ASTM A-420) Bolts**
12.7	5 466	6 758
15.9	8 709	10 569
19.0	12 882	15 821
22.2	13 268	21 999
25.4	23 360	24 312
28.6	25 605	36 786
31.7	32 522	45 858
34.9	38 760	55 111
38.1	47 174	66 905

[1] Equals to 70 percent of specified minimum tensile strength bolts. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a Plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallel line.

c. Calibrated Wrench Tightening. When Calibrated wrenches are used to provide the bolt tension as specified above, their setting shall be such as to induce a bolt tension 5 to 10 percent in excess of this value. These wrenches shall be calibrated at least once each working day by tightening, in a device capable if indicating actual bolt tension, not less than three typical bolts of each diameter from the bolts to be installed. Power wrenches shall be adjusted to installed or cut-out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all tested lot. Nuts shall be turned in the tightening direction when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be retuned to “touch-up” bolts previously tightened which may have been loosened by the tightening of adjacent bolts, until all are tightened to the prescribed amount.

d. Turn-of-Nut Tightening. When the turn-of-nut method is used to provide the bolt tension specified in (a) above, there shall first be enough bolts brought to a “snug tight” condition to insure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness.

   All bolts in the joints shall then be tightened additionally, by the applicable amount of nut rotation specified in Table 403.3 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation, there shall be no rotation of the part not turned by the wrench.

e. Lock Pin and Collar Fasteners. The installation of lock pin and collar fasteners shall be by methods approved by the Engineer.

Table 403.3
Nut Rotation from Snug Tight Condition[1]

	Disposition of Outer Faces of Bolted Parts		
Bolt Length Measured from Underside of Head to extreme end of point	Both faces normal to faces normal to bolt axis	One face normal to bolt axis and other face sloped not more 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)
Up to and including diameters	0.33 turn	0.5 turn	0.66 turn
Over 4 diameters but not exceeding 8 diameters	0.5 turn	0.66 turn	0.625 turn
Over 8 diameters but not exceeding 12 diameters[2]	0.66 turn	0.83 turn	1 turn

[1] Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by ½ turn and less the tolerance should be plus or minus $30^{0,}$ for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45^{0}.

[2] No research work has been performed by the Research Council on riveted and Bolted Structural joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device stimulating the actual conditions.

4. Inspection

The Engineer will determine that the requirements of these Specifications are not in the work. When the calibrated wrench method of tightening is used, the

Engineer shall have full opportunity to witness the calibration test.

The Engineer will observe the installation and tightening of the bolts to determine that the selected tightening procedure is properly used and will determine that all bolts are tightened.

The following inspection shall be used unless a more extensive or different procedure is specified.

a. The Contractor shall use an inspecting wrench which may either be a torque wrench or a power wrench that can be accurately adjusted in accordance with the requirements of Subsection 403.3.10(3) (c) above, in the presence of the Engineer.

b. Three bolts of the same grade, size and condition as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. Length may be any length representative of bolts used in the structure. There shall be a washer under the part turned in tightening each bolt.

c. When the inspecting wrench is a torque wrench, each of the three bolts specified above shall be tightened in the calibration device by any convenient

means to the minimum tension specified for its size in Table 403.2. The inspecting wrench shall then be applied to the tightened bolt and the torque necessary to run the nut or head 5 degrees (approximately 25.4 mm at 304.8 mm radius) in the tightening direction shall be determined. The average torque measured in the test of three bolts shall be taken as the job inspection torque to be used in the manner specified below.

d. When the inspecting wrench is a power wrench, it shall be adjusted so that it will tighten each of the three bolts specified to a tension at least 5 but not more than 10 percent greater than the minimum tension specified for its size in Table 403.2. This setting of wrench shall be taken as the job inspecting torque to be used in the manner specified below.

e. Bolts, represented by the three samples bolts prescribed above, which have been tightening in the structure shall be inspected by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to 10 percent of the bolts, but not less than two bolt head is turned by this application of the job inspecting torque, the connection be accepted as properly tightened. If any nut or bolt head is turned by the application of the job inspecting torque shall be applied to all bolts in the connection, and all bolts whose nut or head is turned by the job inspecting torque shall be tightened and re-inspected, or alternatively, the fabricator or erector, at his option may re-tighten all the bolts in the connection and then resubmit the connection for the specified inspection.

403.3.11 Welding

Welding shall be done in accordance with the best modern practice and the applicable requirement sat AWS D1.1 except as modified by AASHTO “Standard Specifications for Welding of Structural Steel Highway Bridges” or equivalent to the French Standard NFP 22-471 (Steel construction welded Joints-Fabrications).

Except as otherwise provided in these Specifications the design, fabrication, welding and erection of structural steel shall be carried out in accordance with the provisions of American Institute of Steel Construct (AISC) publication “ Specifications for the Design, Fabrication and Erection of Structural Steel for Building” equivalent to the French standard NFP 22-471 (steel construction welded Joints-Fabrication).

The Qualifications of welding procedure shall be qualified in accordance with AWS D1.1 equivalent to European code EN 288-3. “Description and qualification of a procedure of welding for metallic materials”.

All welding shall comply with AWS D1.1 equivalent to French to French regulation NFP 22-471 (steel construction welded joints-fabrication)

403.3.12 Erection

General

The Contractor shall provide the falsework and all tools, machinery and appliances, including driftspins and fitting-up bolts, necessary for the expeditious handling of the work and shall erect the metal work, remove the temporary construction, and do all work necessary to complete the structure as required by the Contract and in accordance with the Plans and these Specifications

If shown on the Plans or in the Special Provisions, the Contractor shall dismantle the old structure on the bridge site in accordance with Item 101, Removal of Structures and Obstructions.

403.3.13 Handling and Storing Materials

Materials to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns and chords, shall be supported on skid placed near enough together to prevent injury from deflection. If the Contract is for erection only, the Contractor shall check the material turned over to him against the shipping lists and report promptly in writing any shortage or damage discovered. He shall be responsible for the loss of any material while in his care, or for any damage caused to it after being received by him.

403.4.13 Falsework

The false work shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor shall prepare and submit to the Engineer working drawings for falsework and working drawings for changes in any existing structure for maintaining traffic, in accordance with Clause 45 of Part G, Div II, Vol. I.

403.4.14 Method and Equipment

Before starting the work of erection, the Contractor shall inform, the Engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment or from carrying out of the work in full accordance with the Plans and Specifications. No work shall be done until such approval by the Engineer has been obtained.

403.3.16 Straightening Bent Materials

The strengthening of plates, angles, other shapes and built-up members, when permitted by the Engineer, shall be done by methods that will not produce fracture or other injury. Distorted members shall be straightened by mechanical means or, if approved by the Engineer, by the carefully planned and supervised application of a limited amount of localized heat, except that heat straightening of AASHTO M 244 (ASTM A 514) or ASTM A 517 steel members shall be done only under rigidly controlled procedures, each application subject to the approval of the Engineer. In no case shall the maximum temperature of the AASHTO M 244 (ASTM A 514) or ASTM A 517 steels exceed 607.2^0C, nor shall the temperature exceed 510^0C at the weld metal or within 152.4 mm of weld metal. Heat shall not be applied directly on weld metal. In all other steels, the temperature of the heated area shall not exceed 648.9^0C (a dull red) as controlled by temperature indicating crayons, liquids or bimetal thermometers.

Parts to be heat-straightened shall be substantially free of stress and from external forces, except stresses resulting from mechanical means used in conjunction with the application of heat.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

403.3.17 Assembling Steel

The parts shall be accurately assembled as shown on the working drawings and any match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surface and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever methods, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully connected with permanent fasteners and all other truss connections pinned and erection bolted. Splices of butt joints of compression members, that are milled to bear and of railing shall not be permanently fastened until the spans have been swung, except that such permanent fastening may be accomplished for the truss members at any time that joint holes are fair. Splices and field connections shall have one-half of the holes filled with erection bolts and cylindrical erection pins (half bolts and half pins) before placing permanent fasteners. Splices and connection carrying traffic during erection shall have three-fourths of the holes so filled, unless otherwise permitted by the Engineer.

Fitting-up bolts shall be of the same nominal diameter as the permanent fasteners and cylindrical erection pins will be 1.6 mm larger.

403.3.18 Riveting

Pneumatic hammers shall be used for field riveting except when the use of hand tools is permitted by the Engineer. Rivets larger than 15.9 mm in diameter shall not be driven by hand. Cup-faced dollies, fitting the head closely to insure good bearing, shall be used. Connections shall be accurately and securely fitted up before the rivets are driven.

Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a “light cherry red” color and shall be driven while hot. This shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shrank, and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured. If necessary, they shall be drilled out.

403.3.19 Pin Connections

Shoes and bearing shall not be placed on bridge seat bearing areas that are improperly finished, deformed, or irregular. They shall be set level in exact position and shall have full and even bearing. The shoes and bearing plates may be set by either of the following methods:

1. Method 1

   The bridge seat bearing area shall be heavily coated with red lead paint and then covered with three layers of 405 to 472 g/m^2 duck, each layer being coated thoroughly on its top surface with red lead paint. The shoes and bearing plates shall be placed in position while the paint is plastic.

   As alternatives to canvas and red lead, and when so noted on the Plans or upon written permission by the Engineer, the following may be used:

Sheet lead of the designated thickness

Preformed fabric pad composed of multiple layers of 270 g/m^2 duck impregnated and bound with high quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall be such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 7 kg/mm^2 detrimental reduction in thickness or extension.

Elastomeric bearing pads.

2. Method 2

The shoes and bearing plates shall be properly supported and fixed with grout. No load shall be placed on them until the grout has set for at least 96 hours, adequate provision being made to keep the grout well moistened during this period. The grout shall consist of one part Portland Cement to one part of fine-grained sand.

The location of the anchor bolts in relation to the slotted holes in expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends shall be adjusted to permit the free movement of the span.

403.3.21 Preparing Metal Surfaces for Painting

All surfaces of new structural steel which are to be painted shall be blast cleaned unless otherwise specified in the Special Provisions or approved in writing by the Engineer.

In repainting existing structures where partial cleaning is required, the method of cleaning will be specified in the Special Provisions.

The steel surfaces to be painted shall be prepared as outlined in the “Steel Structures Painting Council Specifications” (SSPC) meeting one of the following classes of surface preparation.

a. SSPC – SP – 5 White Metal Blast Cleaning
b. SSPC – SP – 6 Commercial Blast Cleaning
c. SSPC – SP – 8 Pickling
d. SSPC – SP – 10 Near White Blast Cleaning

Blast cleaning shall have leave all surfaces with a dense and uniform anchor pattern of not less than one and one-half mills as measured with an approved surface profile comparator.

Blast cleaned surface shall be primed or treated the same day blast cleaning is done. If cleaned surface rust or are contaminated with foreign material before painting is accomplished, they shall be re-cleaned by the Contractor at his expense.

When paint systems No. 1 or 3 are specified, the steel surfaces shall be blast cleaned in accordance with SSPC-SP-10. When paint systems No.2, 4 or 5 are specified, the steel surface shall be blast cleaned in accordance with SSPC-SP-6.

Also, the above Specification shall be considered equivalent to the Fascicule N^0 56 SC 3 ANV ACQPA) “Protection of the metal works against corrosion “ISO 1461 “Coatings by hot galvanization on steel products”.

403.3.23 Painting Metal Surfaces

1. Time of Application

   The prime coat of paint or pretreatment when specified shall be applied as soon as possible after the surface has been cleaned and before deterioration of the surface occurs. Any oil, grease, soil, dust or foreign matter deposited on the surface after the surface preparation is completed shall be removed prior to painting. In the event the rusting occurs after completion of the surface preparation, the surfaces shall be again cleaned.

   Particular care shall be taken to prevent the contamination of cleaned surfaces with salts, acid, alkali, or other corrosive chemicals before the prime coat is applied and between applications of the remaining coats of paint. Such contaminations shall be removed form the surface. Under these circumstances, the pretreatments or, in the absence of a pretreatment, the prime coat of paint shall be applied immediately after the surface has been cleaned.

2. Storage of Paint and Thinner

   All paint and thinner should preferably be stored in a separate building or room that is well ventilated and free from excessive heat, sparks, flame or the direct ray of the sun.

   All containers of paint should remain unopened until required for use. Containers which have been opened shall be used first.

   Paint which has livered, gelled, or otherwise deteriorated during storage shall not be used. Thixotropic materials which may be stirred to attain normal consistency are satisfactory.

403.3.24 Clean-up

Upon completion and before final acceptance, the Contractor shall remove all falsework, falsework piling down to at least 609.6 mm below the finished ground line, excavated or unused materials, rubbish and temporary buildings. He shall replace or renew any fences damaged and restored in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work and shall leave the work site and adjacent highway in a neat and presentable condition, satisfactory to the Engineer. All excavated material or falsework placed in the stream channel during construction shall be removed by the Contractor before final acceptance.

403.4 Method of Measurement

403.4.1 Lump Sum Basis

Lump sum will be the basis of payment unless noted otherwise in the bidding documents. No measurement of quantities will be made except as provided in Subsection 403.5.1.

403.5 Basis of Payment

403.5.1 Structural Steel

1. Furnished, Fabricated and erected

The quantity, determined as provided above, shall be paid for at the contract unit price per kilogram for "Structural Steel, furnished, fabricated and erected", which price and payment shall constitute full compensation for furnishing, galvanizing, fabricating, radiographing, magnetic particle inspection, delivering, erecting ready for use, and painting all steel and other metal including all labor, equipment, tools and incidentals necessary to complete the work.

Pay Item Number	Description	Unit of Measurement
403 (1)	Structural steel canopy trusses	Kilogram
403 (2)	Supply and Install 60mm dia. X 14 meter tie-rod including accessories	set
403 (3)	Supply and Install 32mm dia. X 12 meter tie-rod including accessories	set

ITEM 404 – REINFORCING STEEL

404.1 Description

This item shall consist of furnishing, bending, fabricating and placing of steel reinforcement of the type, size, shape and grade required in accordance with this Specification and in conformity with the requirements shown on the Plans or as directed by the Engineer.

404.2 Material Requirements

Reinforcing steel shall conform to the requirements of the following Specifications:

Deformed Billet-Steel Bars For Concrete Reinforcement	AASHTO M 31 (ASTM A 615)
Deformed Steel Wire For Concrete Reinforcement	AASHTO M 225 (ASTM A 496)
Welded Steel Wire Fabric For Concrete Reinforcement	AASHTO M 55 (ASTM A 185)
Cold-Drawn Steel Wire For Concrete Reinforcement	AASHTO M 32 (ASTM A 82)
Fabricated Steel Bas or Rod Mats For Concrete Reinforcement	AASHTO M 54 (ASTM A 184)
Welded Deformed Steel Wire Fabric of Concrete Reinforcement	AASHTO M 221 (ASTM A 497)
Plastic Coated Dowel Bars	AASHTO M 254 Type A
Low Alloy Steel Deformed Bars For Concrete Reinforcement	ASTM A 206

Bar reinforcement for concrete structures, except No.2 bars shall be deformed in accordance with AASHTO M 42, M 31 and M 53 for Nos. 3 through 11.

Dowel and tie bars shall conform to the requirements of AASHTO M 31 or AASHTO M 42 except that rail steel shall not be used for the bars that are to be bent and restraightened during construction. Tie bars shall be deformed bars. Dowel bars shall be plain round bars. They shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the site of the work, a minimum of one half (1/2) the length of each dowel bar shall be painted with one coat of approved lead or tar paint/

The sleeves for dowel bars shall be metal of an approved design to cover 50 mm (2 inches), plus or minus 6.3 mm of the dowel, with a closed end, and with a suitable stop to hold the end of the sleeve at least 25 mm (1 inch) from the end of the dowel bar. Sleeves shall be of such design that they do not collapse during construction.

Plastic coated dowel bar conforming to AASHTO M 254 may be used.

404.3 Construction Requirements

404.3.1 Order Lists

Before materials are ordered, all order lists and bending diagrams shall be furnished by the Contractor, for approval of the Engineer. The approval of order lists and bending diagrams by the Engineer shall in no way relieve the Contractor or responsibility for the correctness of such lists and diagrams. Any expense incident to the revisions of materials furnished in accordance with such lists and diagrams to make them comply with the Plans shall be borne by the Contractor.

404.3.2 Protection of Material

Steel reinforcement shall be stored above the surface of the ground upon platforms, skid, or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, detrimental rust, loose scale, paint, grease, oil, or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

404.3.3 Bending

All reinforcing bars requiring bending shall be cold-bent to the shapes shown on the Plans or required by the Engineer. Bars shall be bent around a circular pin having the following diameters (D) in relation to the diameter of the bar (d).

Nominal diameter, d, mm	Pin diameter (D)
9 to 20	6d
25 to 28	8d
32 and greater	10d

Bends and hooks in stirrups or ties may be bent to the diameter of the principal bar enclosed therein.

404.3.4 Placing and Fastening

All steel reinforcement shall be accurately placed in the position shown on the Plans or required by the Engineer and firmly held there during the placing and setting of the

concrete. Bars shall be tied at all intersections except where spacing is less than 300mm in each directions, in which case, alternate intersection shall be tied. Ties shall be fastened on the inside.

Distance from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports, so that it does not vary from the position indicated on the Plans by more than 6mm. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shapes and dimensions. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not permitted. Unless otherwise shown on the Plans or required by the Engineer, the minimum distance between bars shall be 40 mm. Reinforcement in any member shall be placed and then inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal may be required. If fabric reinforcement is shipped in rolls, it shall be straightened before being placed. Bundled bars shall be tied together at not more than 1.8m intervals.

404.3.5 Splicing

All reinforcement shall be furnished in the full lengths indicated on the Plans. Splicing of bars, except where shown on the Plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible and with a minimum separation of not less than 40 bar diameters. Not more than one-third of the bars may be spliced in the same cross-section, except where shown on the Plans.

Unless otherwise shown on the Plans, bars shall be lapped a minimum distance of:

Splice Type	Grade 40	Grade 60	But not less than
Tension	24 bar diameter	36 bar diameter	300 mm
Compression	20 bar diameter	24 bar diameter	300 mm

In lapped splices, the bars shall be placed in contact and wired together. Lapped splices will not be permitted at locations where the concrete section is insufficient to provide minimum clear distance of one and one-third the maximum size of coarse aggregate between the splice and the nearest adjacent bar. Welding of reinforcing steel shall be done only of detailed on the Plans or if authorized by the Engineer in writing. Spiral reinforcement shall be spliced by lapping at least one and half turns or by butt welding unless otherwise shown on the Plans.

404.3.6 Lapping of Bar Mat

Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The overlap shall not be less than one mesh in width.

404.4 Method of Measurement

The quantity of reinforcing steel to be paid for will be the final quantity placed and accepted in the completed structure.

No allowance will be made for tie-wires, separators, wire chairs and other material used in fastening the reinforcing steel in place. If bars are substituted upon the Contractor's request and approved by the Engineer and as a result thereof more steel is used than specified, only the mass specified shall be measured for payment.

No measurement or payment will be made for splices added by the Contractor unless directed or approved by the Engineer.

When there is no item for reinforcing steel in the Bill of Quantities, costs will be considered as incidental to the other items in the Bill of Quantities.

404.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 404.4, shall be paid for at the contract unit price for Reinforcing Steel which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
404 (1)	Reinforcing Steel, Grade 60	Kilogram
404 (2)	Reinforcing Steel, Grade 40	Kilogram

ITEM 405 - STRUCTURAL CONCRETE

405.1 Description

405.1.1 Scope

This item shall consist of furnishing, blending, placing and finishing concrete in all structures except pavements in accordance with this Specification and conforming to the lines, grades, and dimensions shown on the Plans. Concrete shall consist of a mixture of Portland Cement, fine aggregate, coarse aggregate, admixture when specified, and water mixed in the proportions specified or approved by the Engineer.

405.1.2 Classes and Uses of Concrete

The whole text under this Sub-section is amended as follows:

Five (5) classes of concrete are provided for in this Item, namely: A, AA, B, C, P and Lean. Each class shall be used in that part of the structure as described herein below and called for on the Plans.

The classes of concrete will generally be used as follows:

Class A - For all superstructures and heavily reinforced substructures such as slabs, beams, girders, columns, arch ribs, box culverts, reinforced abutments, retaining walls, reinforced footings and cribbing concrete, tunnel portals at tunnel and where shown on plans.

Class B - For under footing of bridges, tunnel inverts and minor structures, and where shown on plans.

Class C - For railing and rail post and other thin reinforced section.

Class P - Pre-stressed concrete structures and members.

Seal - Concrete deposited in water.

405.2 Material Requirements

405.2.1 Portland Cement

It shall conform to all the requirements of Subsection 311.2.1.

405.2.2 Fine Aggregate

It shall conform to all the requirements of Subsection 311.2.2.

405.2.3 Coarse Aggregate

The whole text under this Sub-section is amended as follows:

It shall consist of crushed stone, gravel, blast furnace slag, or other approved inert materials of similar characteristics, or combinations thereof, having hard, strong, durable pieces and free from any adherent coatings.

It shall contain not more than one (1) mass percent of materials passing the 0.075 mm. (No. 200) sieve, nor more than 0.25 mass percent of clay lumps, nor more than 3.5 mass percent of soft fragments.

If the coarse aggregate is subject to five (5) cycles of the sodium sulfate soundness test, the weighted loss shall not exceed 12 mass percent.

It shall have a mass percent of wear no exceeding 40 when tested by AASHTO T 96.

If slag is used, its density shall not be less than 1120 kg/m^3 (70 lb./cu.ft.). The gradation of the coarse aggregate shall conform to Table 405.2.

Table 405.1
Grading Requirements for Coarse Aggregate

Sieve Designation		Mass Percent Passing for				
Standard mm	Alternate US Standard	Class A	Class B	Class C	Class P	Class Seal
63.0	2½"		100			
50.0	2"	100	95-100			
37.5	1½"	95-100	-			
25.0	1"	-	35-70		100	100
19.0	¾"	35-70	-	100	90-100	95-100
12.5	½"	-	10-30	90-100	-	25-60
9.5	3/8"	10-30	-	40-70	20-55	-
4.75	No.4	0-5	0-5	0-15*	0-10*	0-10*

* *The measured cement content shall be within plus (+) or minus (-) 2 mass percent of the design cement content.*

405.2.4 Water

It shall conform to the requirements of Subsection 311.2.4

405.2.5 Reinforcing Steel

It shall conform to the requirements of Item 710, Reinforcing Steel and Wire Rope.

405.2.6 Admixtures

Admixtures shall conform to the requirements of Subsection 311.2.7

405.2.7 Curing Materials

Curing materials shall conform to the requirements of Subsection 311.2.8

405.2.8 Expansion Joint Materials:

Expansion joint materials shall be:

1. Preformed Sponge Rubber and Cork, conforming to AASHTO M 153.
2. Hot-Poured Elastic Type, conforming to AASHTO M 173.
3. Preformed Fillers, conforming to AASHTO M 213.

405.2.9 Elastomeric Compression Joint Seals

These shall conform to AASHTO M 220.

405.2.10 Elastomeric Bearing Pads

These shall conform to AASHTO M 251 or Item 412-Elastomeric Bearing Pads.

405.2.11 Storage of Cement and Aggregates

Storage of cement and aggregates shall conform to all the requirements of Subsection 311.2.10.

405.3 Sampling and Testing of Structural Concrete

As work progresses, at least one (1) sample consisting of three (3) concrete cylinder test specimens, 150 x 300mm (6x12 inches), shall be taken from each seventy five (75) cubic meters of each class of concrete or fraction thereof placed each day.

Compliance with the requirements of this Section shall be determined in accordance with the following standard methods of AASHTO:

Sampling of fresh concrete	T 141
Weight per cubic metre and air content (gravi-Metric) of concrete	T 121
Sieve analysis of fine and coarse aggregates	T 27
Slump of Portland Cement Concrete	T 119
Specific gravity and absorption of fine aggregates	T 84
Tests for strength shall be made in accordance with the following:	
Making and curing concrete compressive and flexural tests specimens in the field	T 23
Compressive strength of molded concrete Cylinders	T 22

405.1 Production Requirements

405.4.1 Proportioning and Strength of Structural Concrete

The concrete materials shall be proportioned in accordance with the requirements for each class of concrete as specified in Table 405.2, using the absolute volume method as outlined in the American Concrete Institute (ACI) Standard 211.1. “Recommended

Practice for Selecting Proportions for Normal and Heavy weight Concrete". Other methods of proportioning may be employed in the mix design with prior approval of the Engineer. A change in the source of materials during the progress of work may necessitate a new mix design.

The strength requirements for each class of concrete shall be as specified in Table 405.2.

Table 405.2
Composition and Strength of Concrete for use in Structures

Class of Concrete	Minimum Cement Content per m^3 Kg (bag**)	Maximum Water/ Cement Ratio	Consistency Range in Slump Mm(inch)	Designated Size of Coarse Aggregate Square Opening Std. mm	Minimum Compressive Strength of 150 x 300 mm concrete cylinder specimen at 28 days N/mm^2 (psi)
A	(360) (9 bags)	0.53	50-100 (2-4)	37.5-4.75 (1-1/2"-No.4)	20.7 (3000)
B	(320) (8 bags)	0.58	50-100 (2-4)	50-4.75 (2"-No.4)	16.5 (2400)
C	380 (9.5 bags)	0.55	50-100 (2-4)	12.5-4.75 (1/2"-No.4)	20.7 (3000)
P	440 (11 bags)	0.49	100 max. (4max)	19.0-4.75 (3/4-No.4)	37.7 (5000)
Seal	380 (9.5 bags)	0.58	100-200 (4-8)	25-4.75 (1"-No.4)	20.7 (3000)

** The measured cement content shall be within plus or minus 2 mass percent of the design cement content*
*** Based on 40 kg/bag*

405.4.2 Consistency

Concrete shall have a consistency such that it will be workable in the required position. It shall be of such a consistency that it will floe around reinforcing steel but individual particles of the coarse aggregate when isolated shall show a coating of mortar containing its proportionate amount of sand. The consistency of concrete shall be gauged by the ability of the equipment to properly place it and not by difficulty in mixing and transporting. The quantity of mixing water shall be determined by the Engineer and shall not be varied without his consent. Concrete as dry as it is practical to place with the equipment specified shall be used.

405.4.3 Batching

Measuring and batching of materials shall be done at a batching plant.

Portland Cement

Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch concrete unless the cement is weighed. All bulk cement shall be weighed on an approved weighing device. The bulk cement weighing hopper shall be properly sealed and vented to preclude dusting operation. The discharge chute shall not be suspended from the weighing hopper and shall be so arranged that cement will neither be lodged in it nor leak from it.

Accuracy of batching shall be within plus (+) or minus (-) 1 mass percent.

Water

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not more than 1 percent.

Aggregates

Stockpiling of aggregates shall be in accordance with Subsection 311.2.10. All aggregates whether produced or handled by hydraulic methods or washed, shall be stockpiled or binned for draining for at least 12 hours prior to batching. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. If the aggregates contain high or non-uniform moisture content, storage or stockpile period in excess of 12 hours may be required by the Engineer.

Batching shall be conducted as to result in a 2 mass percent maximum tolerance for the required materials.

Bins and Scales

The batching plant shall include separate bins for bulk cement, fine aggregate and for each size of coarse aggregate, a weighing hopper, and scales capable of determining accurately the mass of each component of the batch.

Scales shall be accurate to one-half (0.5) percent throughout the range used.

Batching

When batches are hauled to the mixer, bulk cement shall be transported either in waterproof compartments or between the fine and coarse aggregate. When cement is placed in contact with moist aggregates, batched will be rejected unless mixed within 1-1/2 hours of such contact. Sacked cement may be transported on top of the aggregates.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer without loss, and, when more than one batch is carried on the truck, without spilling of material from one batch compartment into another.

405.4 Method of Measurement

The accepted concrete to be paid shall be in cubic meter quantity placed and accepted in the completed structure. No deduction will be made for the volume occupied by pipe less than 100mm (4 inches) in diameter or by reinforcing steel, anchors, conduits, weep holes or expansion joint materials.

405.5 Basis of Payment

The accepted quantities as prescribed in Section 405.4 shall be paid for at the contract unit price for each of the Pay Item listed below that is included in the Bill of Quantities.

Payment shall constitute full compensation for furnishing, placing and finishing concrete including all labor, equipment, tools and incidentals necessary to complete the work prescribed in the item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
405 (1)	Structural Concrete, Class A (3,500 psi) for superstructure and retaining wall	Cubic Meter
405 (2)	Structural Concrete, Class B	Cubic Meter
405 (3)	Structural Concrete, Class C	Cubic Meter
405 (4)	Structural Concrete, Class P	Cubic Meter
405 (5)	Seal Concrete	Cubic Meter
405 (6)	Formworks	Square Meter
405 (7)	Lean Concrete	Cubic Meter
405 (8)	Non-shrink Grout	Cubic Meter

PART G - PROTECTION WORKS

ITEM 1501 - BREAKWATER

1501.1 Description

All work on the project site shall conform to the requirements of the Specifications and the Drawings and shall apply to this section, whether herein referred to or not under the direct supervision of the Engineer or his authorized representative.

1501.2 Material Requirements

This Specification covers the construction of the breakwater for the project. The works to be carried out shall be, but not limited to the following:

Rock Mound - Supply and laying of core rocks

ii. Supply and laying of secondary rock
iii. Supply and laying of armour rock

Rock Mound

a. All rocks to be used shall be angular, hard, durable and not likely to disintegrate in seawater.

b. All rocks shall have a minimum unit weight of 2,500 kg per cubic meter (specific gravity 2.5) of solid materials when measured dry.

c. Rocks with specific gravity higher than the above specified is preferable and will readily be accepted. But no adjustment (increase) in the contract price will be made on this account.

d. Rocks that are sub-angular may be used subject to the approval of Engineer. Rounded or well rounded pieces will not be accepted.

e. Rocks of the primary cover layer should be sound, durable and hard. It should be free from laminations, weak cleavages, and undesirable weathering, and should be of such character that it will not disintegrate from the action of the air, sea-water, or in handling and placing. All stone should be angular quarry stone.

f. The greatest dimensions individual rock unit should be no greater than three times the least dimensions.

g. All rocks should conform to the following test designations: Apparent specific gravity, ASTM C-127 and abrasion, ASTM C-131.

h. Weight of the individual pieces of rock.

1) Armour Rock

Refer to the drawings for the required sizes of the armour rocks for the 1st and 2nd layers.

2) Core Rock

Refer to the drawings for the required sizes of the core rock.

Core rock bedding shall be reasonably well graded in weight between the minimum and maximum sizes.

1501.3 Construction Requirements

a) Topographic/Hydrographic Survey:

Prior to commencement of the work, the Contractor shall conduct a topographic/hydrographic survey in conjunction with Engineers instructions. This survey shall form the basis for future quantity measurements.

b) The Contractor shall set out works and be solely responsible for accuracy of such setting out.

Prior to placement of any material, the Contractor shall establish construction markers to clearly define the horizontal and vertical limits of works.

c) Applicable requirements under Section (B.4) Construction Survey and Staking shall apply to this section.

1501.3.1 Execution

The rock mound breakwater can be constructed by any method acceptable to Procuring Entity. Prior to the start of work, the Contractor shall submit to Procuring Entity for approval his method and sequence of construction. Procuring Entity approval of the method and sequence of construction shall not release the Contractor from the responsibility to achieve the satisfactory implementation of the work.

1501.3.2 Rock Causeway

a. Core rocks shall be placed at convenient height and width for each delivery of materials.

b. Armour rocks shall cover the sides, berm and where indicated on the drawings the top of the causeway for core rock protection.

c. Armour rock filler shall not be less than one half (1/2) of the weight of the armour rock.

d. Armour rocks shall be placed with the longitudinal section perpendicular to the slope and longitudinal section of the causeway.

e. No cutting, spalling or coursing of the stones shall be allowed, but it is expected that the work shall be done in a workmanlike and skilled manner, which implies careful selection of stones.

f. The armour rocks filler rock shall be wedded firmly in between the facing of armour rocks so that the latter shall be in the stable position.

g. Armour rocks shall be placed individually by crane equipped with suitable bucket or by other means acceptable to Procuring Entity.

h. Secondary rock of specified sizes and weights could be dumped along the size slopes of the structure after the core rock has been placed up to required elevation as shown on the drawings. Utilizing a crane, the materials can be placed individually maintaining the alignment along the side slopes.

i. Permissible Tolerance

1) Core Rock

Slope	:	plus or minus 0.30 m
Elevation	:	plus or minus 0.30 m

2) Armour Rock

Slope	:	plus or minus 0.30 m
Elevation	:	plus or minus 0.20 m

1501.3.3 Quarry site and Rock Quantity

1) It is the Contractor's responsibility to make necessary surveys/investigations on quarry sites applicable to the Works, taking into consideration the nature of the rock works required under the Contract such as required quality, total quantity and daily required quantity, transportation method and route etc.,

2) The Contractor shall submit data on characteristics of proposed quarry sites together with the location of sites, test results of their products and samples for the approval of Procuring Entity.

3) When the Contractor intends to operate a quarry for the Works, the Contractor shall take all the responsibilities in connection with its operation including, but not limited to, obtaining all necessary permits and approvals, payment of safety measures or like (if any), provisions and maintenance of safety measures and temporary access roads, all of private and public roads and temporary jetties to be used to transport quarried materials and the compliance with all regulations etc. required by the authorities having jurisdiction over any part of the operation.

Should any explosive be used in the quarry operations, the Contractor shall be responsible to meet laws and regulations, wherever applicable, established by the Local Government and Central Government Department concerned.

4) Despite Procuring Entity's previous approval of the natural rock and borrow pits, it reserves the right to suspend any operation in connection with the rock, if, in its opinion, such rock is not suitable for the work. In such case, the Contractor shall comply with Procuring Entity's instructions.

1501.4 Method of Measurement

Unless otherwise directed, measurement for settlement shall be done by providing a calibrated rod attached or welded to the center of a one (1) m x one (1) m steel wire mesh, with distance center to center of wires at 50 mm, and diameter of wires at 8 mm.

Thus measuring device shall be installed at 50.00 m intervals prior to laying of 1st stage rock.

1501.5 Basis of Payment

Quantities of core rock, rubble, armour rock and rock fragments to be paid for shall be measured in cubic meters. The volume to be paid for shall be measured by taking cross-sections of the sea bed on the site of work at 10- meter intervals or closer, if necessary, immediately before placing the rock. The volume of the different classes of rock shall then be computed based on the neat lines and elevations shown on the drawings and on the foregoing data, with probable settlement as shown in the drawings.
Payment will be made under:

Pay Item No.	**Description**	**Unit of Measurement**
1501	Breakwater	cu.m.

Pay Item Number	Description	Unit of Measurement
1501 (1)	Supply and place 3000-4000 kg Armour Rocks	cu.m.
1501 (2)	Supply and place 1000 kg Armour Rocks	cu.m.
1501 (3)	Supply and place 50-100 Core Rocks	cu.m.
1501 (4)	Supply and install Geotextile Fabric	sq.m.

ITEM 1502 – REVETMENT

1502.1 Description

Work under this Contract shall be in accordance with the terms and conditions stipulated in Volume 2, preceding these Technical Specifications and "Other General Requirements" and shall apply to this Section, whether herein referred to or not.

1502.2 Scope of Work

This Specification covers the construction of all revetments for the Project. The works to be carried out, but not limited to, shall be the following:

a) Supply and laying of erosion protection mat (Filter Fabric) as shown in the drawings. Refer to Section 3.7 “Reclamation” of the Specification.

b) Supply and laying of core rock as shown in the drawings.

c) Supply and laying secondary rocks as shown in the drawings.

d) Supply and laying of armour rock as shown in the drawings.

e) Supply and laying of armour rocks with cement grout finish as shown in the drawings

g) Casting of reinforced concrete curbs as shown in the drawings.

1502.2.1 Survey and Setting Out

a) Topographic/Hydrographic Surveys: Prior to commencement of the Work the Contractor shall conduct a topographic/hydrographic survey in conjunction with PFDA instructions. This survey shall form the basis for future quantity measurements.

b) The Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal limits of Works.

1502.3 Material Requirements

a) Type of Revetment (as shown in the drawings).

b) Concrete curb shall be fabricated in accordance with Section 3.2 - Concrete Works. Use fc' = 25 MPa.

c) The weight of individual pieces may exceed the maximum specified in the drawings by up to 25 percent.

d) Mortar for cement grout lining shall consist of cement, sand and water conforming to the requirements given under Section 3.2, “Concrete Works” mixed in the proportion of one part cement to two parts sand by volume, and sufficient water to obtain the required consistency.

1502.3.1 EXECUTION

a) Revetments may be constructed by any method acceptable to Procuring Entity. Prior to start of work, the Contractor shall submit his method and sequence of construction for approval to Engineer. Approval of the method and sequence of construction shall not release the Contractor from the responsibility to achieve the satisfactory implementation of the Work.

b) Core rock shall be placed as uniformly as possible by controlled dumping or by other means acceptable to Procuring Entity.

c) Armour rocks and secondary rocks shall be placed individually by a crane equipped with a suitable bucket or by other means acceptable to Procuring Entity. Cement grout lining where required or as indicated on the Drawings shall have a minimum thickness of 50 mm.

d) Permissible Tolerance

1) Core Rock:

Alignment : plus or minus 0.30 m
Elevation : plus 0.20 m

2) Armour Rock:

Alignment : plus or minus 0.30 m
Elevation : plus 0.20 m

3) Reinforced Concrete Curb

Alignment : plus or minus 0.05 m
Elevation : plus 0.05 m

1503.2 QUARRY SITE AND ROCK QUANTITY

5) It is the Contractor's responsibility to make necessary surveys/investigations on quarry sites applicable to the Works, taking into consideration the nature of the rock works required under the Contract such as required quality, total quantity and daily required quantity, transportation method and route etc.,

6) The Contractor shall submit data on characteristics of proposed quarry sites together with the location of sites, test results of their products and samples for the approval of Procuring Entity.

7) When the Contractor intends to operate a quarry for the Works, the Contractor shall take all the responsibilities in connection with its operation including, but not limited to, obtaining all necessary permits and approvals, payment of safety measures or like (if any), provisions and maintenance of safety measures and temporary access roads, all of private and public roads and temporary jetties to be used to transport quarried materials and the compliance with all regulations etc. required by the authorities having jurisdiction over any part of the operation.

Should any explosive be used in the quarry operations, the Contractor shall be responsible to meet laws and regulations, wherever applicable, established by the Local Government and Central Government Department concerned.

8) Despite Procuring Entity's previous approval of the natural rock and borrow pits, it reserves the right to suspend any operation in connection with the rock, if, in its opinion, such rock is not suitable for the work. In such case, the Contractor shall comply with Procuring Entity's instructions.

1502.4 Method of Measurements

a) Unless otherwise directed measurement for settlement shall be done by providing a calibrated rod attached or welded to the center of a one (1) m x one (1) m steel wire mesh, with distance center to center of wires at 50 mm. and diameter of wires at 8mm. Thus measuring device shall be installed at 50.00 m interval prior to laying of 1st stage rock.

b) Concrete works for reinforced concrete curb shall be measured and paid for by the length in linear meters of each type of curb along its front face at the finished grade elevation. Reinforcing steel bars for R.C. curb shall be measured in accordance with Section Concrete Works.

1502.5 Basis of Payment

Quantities of core rock, rubble, armour rock and rock fragments to be paid for shall be measured in cubic meters. The volume to be paid for shall be measured by taking cross-sections of the sea bed on the site of work at 10- meter intervals or closer, if necessary, immediately before placing the rock. The volume of the different classes of rock shall then be computed based on the neat lines and elevations shown on the drawings and on the foregoing data, with probable settlement as shown in the drawings.
Payment will be made under:

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
1502 (1)	Revetment	cu.m.
1502 (2)	Supply and place 3,500 PSI concrete superstructure and retaining wall	cu.m.
1502 (3)	Geotextile fabric	sq.m.

ITEM 1503 - MULTI-PURPOSE PIER/WHARF

1503.1 Description

Work under this contract shall be in accordance with the terms and conditions stipulated in Volume 2 from these Technical Specifications and "Other General Requirements" and shall apply to this section, whether herein referred to or not.

1503.1.1 Scope of Work

This Section includes furnishing of all labor, materials, equipment and all incidentals for the construction of the multi-purpose pier and all its appurtenances. The works to be carried out shall be, but not limited to the following:

a) Driving of 0.40 m x 0.40 m pre-cast concrete piles
b) RC pipe pile caps and beams
c) Concrete apron construction
d) Installation of accessories such as mooring bollards, bitts, cleats, fenders and timber pile dolphins.

1503.1.2 Survey and Setting Out

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical of works.

1503.2 Material Requirements

a) Submittal

1) Certified Laboratory Test Report

Before delivery of materials, certified copies in triplicate of the reports of all tests required herein under materials shall be submitted for approval by Procuring Entity.

2) Materials Samples

Representative samples of all materials to be used when required by Procuring Entity shall be submitted before the delivery of the materials. Representative samples shall be accompanied by certified laboratory test reports.

b) Materials

1) Precast/Reinforced Concrete (RC/PC) Piles

2) Concrete (fc' = 30.0 MPa)
3) Accessories

i. Mooring Bollards - refer to material requirements in Item 1400
ii. Rubber Fenders - refer to material requirements in Item1402

4) Timber Waling

Timber waling shall be yakal, thoroughly seasoned or dried, sound, straight, free of splits shakes, decays and knots and other defects. Walings shall be sawn square and true to dimensions shown on the drawings. All bolts, nuts, and washers shall be of galvanized steel.

1503.3 Construction Requirements

a) Piling Works

1) All piling works shall follow specification prescribed
2) The pile length shall be as decided and directed by Procuring Entity based on the results of the boring investigations and test pile driving.
3) Test piles which may form part of the structure as directed by DOTC shall be driven to the required depth and “refusal."

b) Replacement of Bed Materials

The method of dumping, placing of well-graded crushed stone (1-100 kg/pc) over the excavated portion of the seabed is subject to Procuring Entity’s approval.

c) Concrete Works

All concrete works shall follow specifications prescribed in Section, "Concrete Works."

d) Shop Drawings

The Contractor will submit shop drawings and erection drawings for formwork, falsework and the reinforcing bar lists for Procuring Entity’s review and approval in accordance with the applicable requirements in Section, “Concrete Works,” and Section, “Piling Works.”

e) Mooring Bollards, Bitts and Rubber Dock Fenders

1. All materials shall be installed at the location shown on the drawings in accordance with the approved manufacturer’s instructions and shop drawings.

2. The Contractor shall submit the detailed construction method based on the manufacturer’s recommendations for Procuring Entity’s approval.

3. The installation and testing procedure for the mooring bollards, bitts and rubber dock fenders shall follow specifications prescribed in Section, “Mooring and Fender System.”

f) Timber Waling

Yakal waling shall be placed along the edge of the wharf or pier as shown on the drawings and secured in placed by means of bolt embedded in the concrete. Refer to the drawings for the details of construction of timber walings and spacing of bolts at designated structures.

The nuts and washers for the bolts shall be countersunk in the timber and the holes shall be placed with hard asphalt. Likewise, the bolt heads with standard cut washers shall be countersunk in the concrete curb and the holes placed with hard asphalt of the same grade. The timber waling shall be lap-joined.

All timber waling shall be painted with two coats of coal tar, the second coat to be applied immediately before contact is made with the concrete.

1503.4 Method of Measurements

The quantity to be paid for shall be per set supplied as indicated in the Bill of Quantities, delivered, installed, painted, and accepted in the final work which shall be paid for at the unit contract price. The unit price shall be considered to include all materials, fabrication, installation, painting, and all other incidental work.

1503.5 Basis of Payment

This specification for the method of measurement and payment of mooring and fender systems necessary for the construction of piers/wharves and their appurtenances.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
1503 (1)	Mooring Bollard (35-Ton,Tee Head) including accessories furnished	set
1503 (2)	Mooring Bollard (35-Ton,Tee Head) including accessories, supply and delivery	set
1532 (3)	Rubber dock fender (400H x 2000L V-Type) Including accessories, furnished	set
1532 (4)	Rubber dock fender (400H x 2000L V-Type) Including accessories, installed	set

ITEM 502 - MANHOLES, INLETS AND CATCH BASINS

502.1 Description

Work under this Contract shall be in accordance with the terms and conditions stipulated in Volume 2, preceding these Technical Specifications and "Other General Requirements" and shall apply to this Section, whether herein referred to or not.

502.2 Material Requirements

Concrete shall meet the requirement of Item 405: “Structural Concrete, Class A”.

Structural concrete used shall attain a minimum 28-day compressive strength of 20.7 Mpa (3000 psi). If the strength is not met at 28 days, all units made from that batch or load would be rejected. Similarly, cracks in units, honeycombed or patched areas in excess of 2,000 sq. mm, excessive water absorption shall be the causes for rejection of the said structure.

502.3 Basis of Payment

The accepted unit will be paid for at the contract unit bid price for each of the Pay Items listed below that appear in the Bill of Quantities, which shall constitute full compensation for furnishing and placing all materials and labor, equipment, tools and incidentals necessary to complete the item.

Excavation and backfilling of completed structure will be measured and paid for as provided in Item 103, “Structural Excavation”. It includes the disposal of all excavated materials and compaction to the Specification of 95 % standard proctor density of the backfilled materials. Bedding for the structure shall have a minimum layer that ranges from 100 mm to 150 mm of approved granular bedding materials, fully compacted and accepted. It shall be measured and paid for as provided in Item 103 (3): “Foundation Fill”.

Payment will be made under:

Pay Item No.	Description	Unit of Measurement
502 (1)	Manholes	ea.
502 (2)	Inlets, RCP Headwall	ea
502 (3)	Catch Basin	ea.

ITEM 505- RIPRAP

505.1 Description

This Item shall consist of the furnishing and placing of riprap with or without grout as the case may be, with or without filter backing, furnished and constructed in accordance with this Specification and to the lines and grades and dimensions shown on the Plans.

505. 2 Materials Requirements

505.2.1 Stones

Stone for riprap shall be blocky in shape, with sharp, angular, clean edges at the intersections of relatively flat faces, except that Class A riprap may consist of round, natural stones.

The stones shall be sound, tough, durable, dense, resistant to the action of air and water, and suitable in all respects for the purpose intended.

Sound pieces of broken concrete obtained from the removal of bridges, culverts and other structures may be substituted for stone with the approval of the Engineer.

Riprap shall consist of the following classes:

- Class A: stones ranging from a minimum of 15 kg to a maximum of 25 kg, with at least 50% of the stones weighing more than 20 kg;
- Class B: stones ranging from a minimum of 30 kg to a maximum of 70 kg, with at least 50% of the stones weighing more than 50 kg;
- Class C: stones ranging from a minimum of 60 kg to a maximum of 100 kg, with at least 50% of the stones weighing more than 80 kg;
- Class D: stones ranging from a minimum of 100 kg to a maximum of 200 kg, with at least 50% of the stones weighing more than 150 kg.

Where shown on the Drawings or instructed, gravel bedding or geotextile shall be placed on the surface immediately before placing the riprap.

505.2.2 Filter Materials

When required, the riprap shall be placed on a filter layer to prevent fine embankment materials to be washed out through the voids of the face stones. The grading of the filter material shall be as specified on the Plans, o in the Special Provisions. If not specified, it will be required that D_{15} of the filter is at least 4 times the size D_{85} for the embankment material, where D_{15} percent and 85 percent, respectively, passing (by mass) in a grain size analysis. Fine aggregate passing grading requirements for Item 405, Structural Concrete, will satisfy foregoing requirements.

505.3 Construction Requirements

505.3.1 Excavation

The bed for riprap shall be excavated to the required depths and properly compacted, trimmed and shaped.

The riprap shall be founded in a toe trench. Unless otherwise specified, the toe trench shall be filled with stone of the same class as that specified for the riprap.

505.3.2 Placing

Stones placed below the water line shall be distributed so that the minimum thickness of the riprap is not less than that specified.

Stones above the water line shall be placed by hand or individually by machines. They shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. Each stone shall be laid with its longest axis perpendicular to the slope in close contact with each adjacent stone. The riprap shall be thoroughly rammed into place as construction progresses and the finished surface shall present an even, tight surface. Interstices between stones shall be filled with small broken fragments firmly rammed into place.

Unless otherwise provided, riprap shall have the following minimum thickness, measured perpendicular to the slope:

- Class A - Stones ranging from a minimum of 15kg to a maximum of 25kg with at least 50 percent of the stones weighing more than 20kg.
- Class B - Stones ranging from minimum of 30kg to a maximum of 70kg with at least 50 percent of the stones weighing more than 50kg
- Class C - Stones ranging from minimum of 60kg to maximum of 100 kg with at least 50 percent of the stones weighing more than 80kg
- Class D - Stones ranging from minimum of 100kg to a maximum of 200kg with at least 50 percent of the stones weighing more than 150kg.

Sound pieces of broken concrete obtained from the removal of bridges, culverts and other structures may be substituted for stone with the approval of the Engineer.

505.4 Basis of Payment

The quantities measured as provided under Subsection 505.4 shall be paid for at the contract unit price, respectively, for each of the Pay Items listed below and shown in the Bid Schedule, which price and payment shall be full compensation for excavation and preparation of the bed, for furnishing and placing all materials including backfill and all additional fill to bring the riprap bed up to the lines, grades and dimensions shown on the plans, and all labor, equipment, tools and incidentals necessary to complete the Item.

Pay Item Number	Description	Unit of Measurement
505 (1)	Riprap, Class A	Cubic Meter
505 (2)	Riprap, Class B	Cubic Meter
505 (3)	Riprap, Class C	Cubic Meter
505 (4)	Riprap, Class D	Cubic Meter
505 (5)	Grouted, Class A	Cubic Meter
505 (6)	Grouted, Class B	Cubic Meter
505 (7)	Grouted, Class C	Cubic Meter
505 (8)	Grouted, Class D	Cubic Meter
505 (9)	Filter layer of granular material	Cubic Meter

ITEM 1406 DEFLECTOR WALL, BULKHEAD CURB AND STAIR LANDING

1406.1 Description

This item shall consist of concrete Deflector Walls, Concrete Bulkhead Curbs, and Concrete Landings in accordance with these and in reasonably close conformity to the lines, grades, designs shown on the Plans.

1406.2 Material Requirements

Concrete used in this item shall be Class A as specified in item 405, Structural Concrete, unless otherwise specified or required by the Engineer.

Reinforcing steel shall conform to the requirement of Item 404 of Vol. 2 “Reinforcing Steel”.

1406.2.1 Concrete Bulkhead Curbs

a) Driving of precast concrete sheet piles, dimension as indicated on the drawings
b) R.C. sheet pile coping
c) Installation of tie rods and concrete block anchorage (where required)
d) Concrete apron construction
e) Installation of accessories such as mooring cleats, bollards and bitts and fenders
f) Furnishing, fabricating, and installing of timber waling (where required)

1406.2.2 Mooring System

a) Designated load capacity of mooring bollards shall be as shown on the drawings, and shall refer to the safe working load. The bollards shall be capable of withstanding a proof test load of 1.5 times the safe working load.

b) Mooring bollards, cleats and bitts shall be of the dimensions, weights, capacities and design in accordance with shop drawings approved by Procuring Entity and shall be fabricated by approved manufacturers with cast steel conforming to the following requirements or approved equivalent.

c) The size of the bolts, nuts and washers shall be in accordance with the specifications of the manufacturer. However, the length of the bolts shall be as indicated on the drawings. The anchor plate shall be connected to the holding down bolt with 12.5 mm weld, as shown on the drawings. All bolts, nuts, washers, etc. that are exposed shall be hot-dipped galvanized to the satisfaction of Procuring Entity. Samples of the bolts, nuts, washers and anchor plates shall be submitted to Procuring Entity for approval before being used in the Works.

d) The upper parts of cleats, bollards and bitts not embedded in concrete shall be painted. The surface of cleats, bollards and bitts shall be cleaned thoroughly by wirebrush or other means prior to painting to remove rust or any other contamination which may interfere with bond of paint to metal. The exposed surface shall be coated with rust proof paint and finishing paint, which shall be coal-tar epoxy of 120 micron thickness in accordance with JIS K5623 or the approved standard. Cleats, bitts and bollards at the new berth shall be installed at the concrete coping of bulkhead walls or at the edge of concrete decks of piers.

e) Alternative

The Contractor can submit to Procuring Entity's approval bitts, cleats or bollards different from this specifications but with the capacities indicated in the drawings.

f) Concrete foundations of bollards and bitts shall conform to the requirements of Item "Concrete Works."

g) Visual Inspection

h) All bollards, cleats and bitts delivered to site shall be inspected by Procuring Entity for any signs of flaws or defects inimical to usage.

i) Mill Test Certificates

j) Two (2) copies of mill test reports shall be submitted certifying that materials meet the specified standards.

k) Tests and Inspection

l) Inspection of all materials and methods of fabrication shall be carried out by the Contractor. However, it reserves the right to inspect all facilities at any time during the manufacture to ensure that the materials and workmanship are in accordance with the specifications and the best workmanship

The following publications listed below shall form a part of these Specifications to the extent indicated by the reference thereto.

Publication

G 5101 SC 46, Carbon Steel
G 3101 SS 41, Rolled Steel for General Structures
JIS B0205 Standard M Screw
JIS B1181 Hexagon Nut

1406.2.3 Rubber Fender Systems

a) Material for fender systems such as rubber fenders, anchor bolts and templates shall be supplied by the Contractor.

b) The Contractor shall install the fender system properly according to the drawings and the instructions prepared by Procuring Entity.

c) Performance Requirements

The fenders shall be procured in accordance with the performance characteristics, under 45%-50% fender deflection, specified hereunder:

Type of Fender	Min. Energy Absorption (Ton-M)	Max. Reaction Force (Ton)
(1)	1.0	15
(2)	1.8	20
(3)	2.8	32

d) Types of Fenders

Type (1) = 200 mm in height and 1000 mm in length
Type (2) = 250 mm in height and 1500 mm in length
Type (3) = 300 mm in height and 1500 mm in length

e) Manufacturing Rubber Main Body

Rubber fenders shall be manufactured at the factories of approved makers.

Basic manufacturing methods shall be as follows:

- Shape of rubber main body: V-type
- Shape shall be V-shaped with internal hollow space
- Fabrication of rubber main body shall be completed at the factory
- No connection of main body shall be permitted out of the factory
- Steel plate shall be embedded in the deck sides of rubber main body.
- The Contractor shall submit manufacturer's methods of manufacturing for approval by Procuring Entity.

1406.2.4 Timber Fender System

i. Materials for fender systems such as creosoted apitong timber piles, connection wire and protector shall be supplied by the Contractor subject to approval of Procuring Entity.

ii. The Contractor shall install the fender system properly according to the drawings and instructions prepared by Procuring Entity.

iii. Related specification will be provided in Item "Piling Works."

1406.2.4.1 Submittals

a) Shop drawings and/or catalogues of mooring cleats, bollards, bitts and rubber fenders indicating size, weight and mounting requirements shall be submitted for approval of Procuring Entity.

b) No materials or fitting shall be ordered without prior approval of Procuring Entity.

1406.3 Construction Requirement

Deflector Walls, Concrete Bulkhead Curbs, and Concrete Landings shall include all works constructed on top of the rock bulkheads.

In no case shall these structures be placed on top of the bulkheads unless a minimum period of one (1) year had elapsed from the completion of the bulkheads or the bulkheads has sufficiently settled.

The line, elevation and form of the Deflector Walls, Concrete Bulkhead Curbs, and Concrete Landings shall be true to line or as shown on the Plans. Unless otherwise specified on the plans, the top shall be level and faces shall be vertical except the curve portion, if any. Special care shall be exercised to smooth and tightfitting forms which can be held rigidly to line and grade and remove without injury to the concrete. Forms shall be of board, combination of G.I. sheets and board or boards lined with suitable materials which will meet with the approval of the Engineer. All corners of the finished work shall be true, sharp and clean-cut and shall be free from cracks, spalls or other defects.

Concrete shall be mixed, placed and finished in accordance with the specification of Item 405, Structural Concrete.

1406.4 Method of Measurement

The quantity of Deflector Walls, Concrete Bulkhead Curbs shall be measured in lineal meters in its final position of the specified cross section and reinforcement as shown on the plans.

The quantity of the Concrete Landings shall be measured in lineal meters of complete structures including reinforcing bars constructed in its final location as per plans.

1406.5 Basis of Payment

The Deflector Walls, Concrete Bulkhead Curbs, and Concrete Landings measured as provided above shall be paid for at the contract unit price per lineal meter of structure placed or at the contract cost per unit which price and payment shall constitute full compensation for furnishing labor, equipment, tools and materials constructing complete as per plan and specification and accepted.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
1406(1)	Deflector Walls	l.m.
1406(2)	Concrete Bulkhead Curbs	l.m
1406(3)	Concrete Landings	l.m.

ITEM 1703 – DREDGING

1703.1 Description

Work under this Contract shall be in accordance with the terms and condition stipulated in these Technical Specifications and "Other General Requirements" shall apply to this Section whether herein specified or not.

1703.2 Scope of Work

Dredging of the sea bed where required (where shown on the drawings)

1703.2.1 General Requirements

a) If dredged materials are to be used for reclamation, separate payments will not be made for dredging. These costs shall be considered as incidental to and part of the reclamation works.

b) A marine survey of the dredged area inside the port shall be carried out by the Contractor and monitored by PFDA after dredging stages are completed. In the event the survey reveals that any finished area was under-dredged, the Contractor shall complete that portion of the dredging.

1) Upon assumed completion of all the dredging operations inside the project area, the Contractor shall sweep the dredged areas within the limits stated in the specification to ensure that no shoals higher than the specified depth exist. The Contractor shall remove all shoals so discovered.

2) The Contractor shall be responsible during the Work for all horizontal layouts and vertical profiling of the dredging work inside the port.

1703.1.2 CHARACTERISTICS OF MATERIALS

Information regarding the characteristics of soils which may be encountered in the performance of this Contract is shown in the Bid Drawings for review.

1703.1.3 INTERFERENCE WITH NAVIGATION

The Contractor shall familiarize with vessel movement and fishery activities in area affected by dredging operations. The work shall be in a manner that will not impede navigation including movement of vessels at adjacent wharves or interfere with fishing operations.

The Contractor shall coordinate dredging works with Harbor Authorities, port users and other Contractors.

1703.1.4 NATURE OF MATERIALS TO BE DREDGED

Refer to borehole logs as indicated in the drawings for characteristics of material to be dredged at each location. The data is made available for information only and PFDA does not warrant its accuracy at any location other than the referenced borehole.

After examination, determine properties of materials to be dredged, the most suitable method and equipment to be employed including disposal of dredged spoil.

1703.1.5 ASSISTANCE TO PFDA

On request of PFDA, furnish use of such boats, equipment, labor and materials forming ordinary and usual part of dredging plant as may be reasonably necessary to inspect and supervise work.

1703.4 Construction Requirements

1703.1.5.1 Dredging shall consist of all underwater excavation/removal of all materials.

1703.1.5.2 The equipment to be used in dredging and filling operations is subject to approval by PFDA.

1703.1.5.3 Dredging shall be carried out only in the locations and in the order as approved by PFDA, and only within limits shown on the drawings or as shown on drawings prepared by the Contractor and approved by PFDA.

1703.1.5.4 Approved dredged materials is to be deposited in areas allocated for port developments whereas dredged material, unsuitable for fill, shall be deposited in areas approved by PFDA.

1703.1.5.5 The dredging and the disposal of the dredged material including placing and operation of equipment and conveying pipes, and transportation of dredged material to disposal sites shall be done without interference with port operations.

1703.1.5.6 Stones which may be encountered in the materials to be dredged, and having a smallest dimension of at least 300 mm may be buried in the seabed. No part of buried stones must extend above a level 500 mm below

the dredging levels indicated. Stones smaller than those mentioned above may be left on the seabed of partly embedded provided that the stones are below the dredging levels indicated.

1703.2 **PREPARATION**

1703.2.1 The Contractor shall mark floating equipment with lights in accordance with International Regulations for Prevention of Collision at Sea and maintain a radio watch on board.

1703.2.2 The Contractor shall place and maintain buoys, markers and lights required to define work and disposal areas.

1703.2.3 The Contractor shall layout work from baseline established by PFDA. He shall be responsible for accuracy of work relative to established baseline and shall provide and maintain equipment as normally required for accurate dredging control.

1703.2.4 The Contractor shall establish and maintain tide gauges in order that proper depth of dredging can be determined. Locate gauges so as to be clearly visible.

1703.2.5 The Contractor shall establish and maintain on-land targets for location and definition of designated dredge area limits. Targets to be suitable for control of dredging operations and locating soundings. Remove targets on completion of work.

1703.3 DREDGING OF SLOPES FOR DIKES

Details on temporary slopes, dredged for the execution of Dikes, to be provided by the Contractor and shall be included in their construction method.

The work shall be measured and approved by PFDA before any sand or stone material is placed unless directed otherwise by PFDA.

1703.4 DREDGING OF BASINS AND APPROACH CHANNEL

The lines shown on drawings indicate the boundaries of the dredging. Carry out dredging to a depth equal to or below the specified level, with a maximum permissible over-dredging of 400 mm below the specified level.

Cut side slopes between original seabed and dredged levels as shown on the drawings unless otherwise authorized in writing by PFDA.

PFDA shall verify that the dredging has been carried out as required. In general, the dredged depths shall be checked by Echo-Sounder recording. The survey pattern and method, and the Echo-Sounder type shall be approved by PFDA. In areas where additional precision is required, the verification shall be carried out by suspending a 6 to 10 m long straight edge from a vessel, so that the underside of the straight edge is horizontal and level with the indicated dredging level. A sounding rod shall be connected to each end of the straight edge and shall extend vertically above the water surfaces in order to determine the vertical movements of the straight edge.

The vessel shall be moved slowly across the area in a manner which will ensure that the total area is covered by the straight edge. Areas where the straight edge cannot pass freely shall be marked and dredged and the check shall be repeated.

In case of excessive over-dredging the Contractor shall backfill the over-dredged areas and/or take all necessary measures as directed by PFDA without cost.

1703.5 DREDGING IN FRONT OF WATERFRONT STRUCTURE

1703.5.1 In addition to the requirements of Sub-section 1703.4, the following shall apply for dredging carried out in front of waterfront structure.

a) The maximum permissible over-dredging is 200 mm.

b) Dredging may proceed unrestricted and provided that in the opinion of PFDA, a stable, temporary slope to the edge of the strip is maintained.

1703.5.2 The Contractor shall be fully responsible for the safety of the permanent structures in the temporary phases of construction. Temporary and permanent bench marks and reference points shall be established as directed by PFDA for recording immediate and future movements of waterfront structures.

1703.5.3 In case of excessive over-dredging, the Contractor shall on his account backfill the over-dredged areas and/or take all necessary measures as directed by PFDA.

1703.6 SPOILS FROM DREDGING

1703.6.1 All dredged material, which in the opinion of PFDA is unsuitable for fill, shall be dumped at the spoil area indicated on the drawings or into the open sea of depth of at least 20 m. MLLW and at least 10 km away from the project site.

1703.6.2 Deposit dredged material suitable for fill in accordance with Sub-Section, "Reclamation."

1703.6.3 All dredged material, which in the opinion of PFDA, is suitable for fill but is in excess of the quantities required for the present project shall be deposited as directed by PFDA.

1703.6.4 Wrecks - should any wreck or obstruction be found, other than that caused by the Contractor, the Contractor is to comply with such instructions as PFDA may issue regarding its removal.

1703.4 Method of Measurement

Before dredging in any location and in accordance with the approved schedule, the Contractor shall perform a new sounding survey over the area to be dredged and its adjoining areas in accordance with "Other General Requirements."

On completion of dredging in any location, perform a sounding survey in accordance with “Other General Requirements” to verify compliance with Contract and as a basis for measurement of dredging quantities.

Do not disturb or displace rip-rap or armour protection during dredging. Reset or replace any disturb or displaced materials without additional compensation or time extension.

Only materials excavated above dredged line and within side slope specified or indicated in the drawings or authorized in writing by PFDA will be measured for payment.

Dredged volumes by section of work shall be considered for inspection and acceptance.

Supply all equipment and assistance needed for inspection and measurement by PFDA. Cost of such assistance is incidental to dredging work and shall not be measured for payment.

Disposal is incidental to dredging work and will not be measured for payment.

No additional cost shall be charged to PFDA where excavation of corals, bedrocks or hard materials has been encountered by the Contractor.

Dredging will be measured in cubic meters, in place measurement determined from approved soundings - taken before and after dredging.

1703.5 Basis of Payment

The quantity as determined in Subsection 1703.6.5, Method of Measurements, shall be paid for all the contract unit price per cubic meter for dredging which price and payment shall constitute full compensation for furnishing and placing all materials and for all labor, equipment, tools and incidentals necessary to complete the Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
1703	Dredging	Cubic Meter

ITEM 1704 - MULTI-PURPOSE PIER/WHARF

1704.1 Description

Work under this contract shall be in accordance with the terms and conditions stipulated in Standard Specifications for Public Works Structures, Volume III, 1995 preceding these Technical Specifications and "Other General Requirements" and shall apply to this section, whether herein referred to or not.

1704.1.1 Scope of Work

This Section includes furnishing of all labor, materials, equipment and all incidentals for the construction of the multi-purpose pier and all its appurtenances. The works to be carried out shall be, but not limited to the following:

a) Driving of 0.40 m x 0.40 m pre-cast concrete piles
b) RC pipe pile caps and beams
c) Concrete apron construction
d) Installation of accessories such as mooring bollards, bitts, cleats, fenders and timber pile dolphins.

1704.1.2 Survey and Setting Out

Contractor shall set out Works and shall be solely responsible for accuracy of such setting out. Prior to placement of any materials, the Contractor shall establish visible construction markers to clearly define horizontal/vertical of works.

1704.2 Material Requirements

a) Submittal

1) Certified Laboratory Test Report

Before delivery of materials, certified copies in triplicate of the reports of all tests required herein under materials shall be submitted for approval by PFDA.

2) Materials Samples

Representative samples of all materials to be used when required by PFDA shall be submitted before the delivery of the materials. Representative samples shall be accompanied by certified laboratory test reports.

b) Materials

1) Precast/Reinforced Concrete (RC/PC) Piles

2) Concrete (fc' = 30.0 MPa)
3) Accessories

i. Mooring Bollards - refer to material requirements in Section 1400
ii. Rubber Fenders - refer to material requirements in Section 1403

4) Timber Waling

Timber waling shall be yakal, thoroughly seasoned or dried, sound, straight, free of splits shakes, decays and knots and other defects. Walings shall be sawn square and true to dimensions shown on the drawings. All bolts, nuts, and washers shall be of galvanized steel.

1704.3 Construction Requirements

a) Piling Works

1) All piling works shall follow specification prescribed in Section 400
2) The pile length shall be as decided and directed by PFDA based on the results of the boring investigations and test pile driving.
3) Test piles which may form part of the structure as directed by PFDA shall be driven to the required depth and “refusal."

b) Replacement of Bed Materials

The method of dumping, placing of well-graded crushed stone (1-100 kg/pc) over the excavated portion of the seabed is subject to PFDA’s approval.

c) Concrete Works

All concrete works shall follow specifications prescribed in Section 405 (1), ""“Structural Concrete Class A."

d) Shop Drawings

The Contractor will submit shop drawings and erection drawings for formwork, falsework and the reinforcing bar lists for PFDA's review and approval in accordance with the applicable requirements in Section 405, "Structural Concrete," and Section 400, "Piling Works."

e) Mooring Bollards, Bitts and Rubber Dock Fenders

1) All materials shall be installed at the location shown on the drawings in accordance with the approved manufacturer's instructions and shop drawings.

2) The Contractor shall submit the detailed construction method based on the manufacturer's recommendations for PFDA's approval.

3) The installation and testing procedure for the mooring bollards, bitts and rubber dock fenders shall follow specifications prescribed in Sections 1400 and 1402, "Mooring and Fender System."

f) Timber Waling

Yakal waling shall be placed along the edge of the wharf or pier as shown on the drawings and secured in placed by means of bolt embedded in the concrete. Refer to the drawings for the details of construction of timber walings and spacing of bolts at designated structures.

The nuts and washers for the bolts shall be countersunk in the timber and the holes shall be placed with hard asphalt. Likewise, the bolt heads with standard cut washers shall be countersunk in the concrete curb and the holes placed with hard asphalt of the same grade. The timber waling shall be lap-joined.

All timber waling shall be painted with two coats of coal tar, the second coat to be applied immediately before contact is made with the concrete.

1704.4 MEASUREMENT AND PAYMENT

Refer to specific sections of this specification for the method of measurement and payment of piles, concrete works, mooring and fender systems necessary for the construction of piers/wharves and their appurtenances. The quantity of waling to be paid for shall be per board foot or per linear meter of timber walings supplied as indicated in the Bill of Quantities, fabricated, installed, painted, and accepted in the final work which shall be paid for at the unit contract price. The unit price shall be considered to include all materials, fabrication, installation, painting, and all other incidental work.

PART H
MISCELLANEOUS STRUCTURES

PART H- MISCELLANEOUS STRUCTURES

ITEM 600- CURB AND GUTTER

600.1 Description

This item shall consist of the construction of curb and gutter either Precast or Cast in place, made of concrete in accordance with this Specifications at the location, and in conformity with the lines, grades, dimensions and design, shown on the Plans or as required by the Engineer.

600.2 Materials Requirements

600.2.1 Material for Bed Course

Bed course materials as shown on the Plans shall consist of cinders, sand, slag, gravel, crushed stone, or other approved porous material of such grading that all the particles will pass through 12.5mm (1/2 inch) sieve.

600.2.2 Concrete

Concrete shall be of the class indicated on the Plans and shall and shall conform to the requirements of item 405, Structural Concrete.

600.2.3 Expansion Joint Filler

Expansion joint filler shall conform to the requirements of AASHTO M 153/ Item 705.

600.2.4 Cement Mortar

Cement mortar shall consist of one part of Portland cement and two parts of fine aggregates with water added as necessary to obtain the required consistency. The mortar shall be used within 30 minutes of preparation.

600.2.5 Bonding Compound.

Where bonding compound is used, it shall conform to AASHTO M 200.

600.3 Construction Requirements

600.3.1 Bedding

Excavation shall be made to the required depth and the base upon which the curb and / or gutter is to be set shall be compacted to a firm and even surface. All soft and unsuitable material shall be removed and replaced with suitable material.

Bed course material shall be placed and compacted to form a new bed of the required thickness as shown on the Plans

600.3.2 Cast in Place Curb and Gutter

600.3.2.1 Placing

Forms shall conform to the requirements of Item 407, Concrete Structures. Metal forms shall be of approved section.

Forms to hold the concrete. Shall be built and set-in-place as described in Item 407, Concrete Structures. Forms for at least 50m of curb and gutter shall be in- place and checked for alignment and grade before concrete is placed. Curbs and gutters constructed on curves shall have forms of either wood or metal and they shall be accurately shaped to the curvature shown on the Plans.

Mixing, placing, finishing and curing of concrete shall conform to the requirements of Item 405, Structural Concrete, as modified by the requirements below.

The concrete shall be placed in the forms in layers of 100 or 125 mm each, and to the depth required. It shall be tamped and spaded until mortar entirely covers the top and the surfaces of the forms. The top of the concrete shall be finished to a smooth and even surface and the edges rounded to the radii shown on the Plans. Before the concrete is given the final finishing, the surface of the gutter shall be tested with a 3-m straight-edge and any irregularities of more than 10 mm in 3m shall be corrected.

The curb and gutter shall be constructed in uniform sections of not more than 50m in length except where shorter sections are required to coincide with the location of weakened planes or contraction joints of the concrete pavements, or for closures, but no sections shall be less than 2m long. The sections shall be separated by sheet templates set perpendicular to the face and top to the curb and gutter. The templates shall be approximately 5mm in thickness and of the same width as that of the curb and/or gutter and not less than 50mm deeper than the depth of the curb and/or gutter. Templates shall be set carefully and held firmly during the placing of the concrete and shall remain in place until the concrete has set sufficiently to hold its shape but shall be removed while the forms are still in place. Preformed joint filler approved by the Engineer may be used in lieu of the sheet template mentioned above. In this event the fiber board shall be pre-cut to the shape of the curb so that its outer edge will be flushed with the abutting curb and/ or gutter.

Expansion joints shall be formed at intervals shown on the plans. Where a curb is placed next to a concrete pavement, expansion joints in the curb shall be located opposite expansion joints in the pavement.

The form shall be removed within 24 hours after the concrete has been placed. Minor defects shall be repaired with mortar containing one part of Portland Cement and two parts of fine aggregates. Plastering shall not be permitted and all rejected portions shall be removed and replaced at the Contractor’s expense. The exposed surface shall be finished while the concrete is still fresh by rubbing the surfaces with a wetted soft brick or wood until they are smooth. The surface shall be wetted thoroughly, either by dipping the brick or wood in water, or throwing water or throwing water on the surfaces with a brush. After the concrete has been rubbed smooth using water, it shall then be rubbed with a thin grout containing one part of Portland Cement and one part of fine aggregates. Rubbing with grout shall continue until uniform color is produced. When completed, the concrete shall be covered with suitable material and kept moist for a period of 3 days, or a membrane –forming material may be applied as provided in Item 405, Structural Concrete. The concrete shall be suitably protected from the weather until thoroughly hardened.

After the concrete has set sufficiently, the spaces on the back of the curb which were excavated for placing the curb shall be refilled to the required elevation with suitable material which shall be tamped in layers of not more than 150mm until consolidated.

600.3.3 Precast Curb and Gutter

600.3.3.1 Placing

The precast concrete curb and gutter shall be set in 20mm of cement mortar as specified in sub-section 600.2.4 to the line level and grade as shown on the approved Plans.

The precast curb shall not be more than 20 cm width at the top portion and not be more than 25cm at the base unless specified on the Plan. The precast curb and gutter shall be 1.0m in length and side be put side by side consecutively with joint in between.

Joints between consecutive curb and gutter shall be filled with cement mortar to the full section of the curb and gutter. Expansion joints shall be formed at intervals shown on the Plans. Where a curb and gutter is placed next to a concrete pavement, expansion joints in the curb and gutter shall be located opposite expansion joints in the pavement.

Minor defects shall be repaired with mortar containing one part of Portland Cement and two parts of fine aggregates. Plastering shall not be permitted and all rejected portions shall be removed and replaced at the contractor's expense. The exposed surface shall be finished by rubbing the surfaces with a wetted soft brick or wood until they are smooth. The surface shall be wetted thoroughly, either by dipping the brick or wood in water, or by throwing water on the surfaces with a brush. After the concrete has been rubbed smooth using water, it shall then be rubbed with a thin grout containing one part of Portland Cement and one part of fine aggregates. Rubbing with grout shall continue until uniform color is produced.

600.3.3.2 Handling Precast Curb and Gutter

1.0 In preparation for handling of the precast curb and gutter, all fabricated curb and gutter of one(1) meter in length shall be provided or inserted with 2-1"Ø PVC pipes for fitting at their required locations. The PVC pipes shall be placed 25mm from both edge during fresh concrete is in plastic state.

2.0 Precast curb and gutter shall be lifted on upright position and not at the points of support and shall be the same during transporting and storage.

3.0 Extreme care shall be exercised in handling and moving precast curb and gutter to avoid cracking.

4.0 No precast curb and gutter shall be used that does not reach its final position in the forms with the required time stipulated prior to installation.

5.0 Precast curb and gutter shall be transferred to the construction site. Fresh curb and gutter shall not be placed against in-situ concrete which has been in a position for more than 30 minutes.

6.0 Precast curb and gutter may only be transported to the delivery point in truck agitators or truck mixer operating at the speed designated by the manufacturer of the equipment, provided that the consistency and workability of the mix concrete upon discharge at the delivery point is suitable for adequate placement.

600.4 Method of Measurement

The length of curb and gutter to be paid for shall be the number of linear meters of curb and gutter (cast in place) or the number of pieces of precast curb and gutter of the required dimensions shown on the Plans measured along its front face in-place, completed and accepted. No deduction shall be made for curb and gutters constructed on curves.

600.5 Basis of Payment

The length of curb and gutter determined in Subsection 600.4, Method of Measurement , shall be paid for at the contract unit price per linear meter for curb and gutter which price and payment shall constitute full compensation for furnishing and placing all materials for concrete, reinforcing steel if required on the Plans, expansion joint materials, forms for drainage openings, excavation for curb and gutter, backfilling, dumping and disposal of surplus materials, and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

Pay Item Number	Description	Unit Measurement
600(1)	Concrete Curb	Linear Meter
	(Cast In Place)	
600(2)	Concrete Gutter	Linear Meter
	(Cast In Place)	
600(3)	Curb and Gutter	Linear Meter
	(Cast In Place)	
600(4)	Concrete Curb	Piece
	(Precast)	
600(5)	Concrete Gutter	Piece
	(Precast)	
600(6)	Curb and Gutter	Piece
	(Precast)	

ITEM 601- SIDEWALK

601.1 Description

This item shall consist of the construction of asphalt or Portland Cement concrete sidewalk in accordance with this specification and to the lines, grades, levels and dimensions shown on the Plans, or as required by the Engineer.

601.2 Material Requirements

601.1.1 Portland Cement Concrete

The cement concrete shall be class A as specified in item 405, Structural Concrete.

601.2.2 Asphalt

Asphaltic material shall be as specified in item 308, Bituminous Plant Mix Surface Course, Cold –Laid, or item 310, Bituminous Concrete Surface Course, Hot-Laid.

601.2.3 Expansion Joint Filler

Unless otherwise ordered, the preformed joint filler shall have a thickness of 5 mm and shall conform to the requirements of item 311, Portland Cement Concrete Pavement.

601.2.4 Forms

Forms shall be of wood or metal as approved by the Engineer and shall extend to the full depth of the concrete. All forms shall be straight, free from warps and of adequate strength to resist distortion.

601.2.5 Bed Course Materials

Bed course material consists of cinders, sand, slag, gravel, crushed stone, or other approve permeable granular material of such grading that all particles shall pass a 12.5mm (½ inch) sieve.

601.2.6 Asphaltic Prime Coat

Prime coat shall cut-back asphalt conforming to the requirements of item 301, Bituminous Prime Coat.

601.3 Construction Requirements

601.3.1 Asphalt Sidewalk

Excavation shall be made to the depth and width required that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm and even surface conforming to the section shown on the Plans. All materials from soft areas shall be removed and replaced with suitable materials.

The bed course shall be compacted in layers not exceeding 100mm to the depths, lines, and levels shown on the Plans.

The prepared bed course material shall receive an application of prime coat in accordance with the requirements of Item 301, Bituminous Prime Coat.

The asphalt mixture shall be placed on the previously primed and prepared bed only when, in the opinion of the Engineer, the bed is sufficiently dry and weather conditions are suitable. The mixture shall be placed in one or more layers of uniform thickness to the total depth shown on the Plans. Each layer shall be smoothed by raking or screeding and shall be thoroughly compacted by rolling with a hand operated roller of a type satisfactory to the Engineer. After compaction, the surfacing shall be of the thickness and section shown on the Plans and shall be smooth, even and of a dense uniform texture. Forms, if used, shall be removed and the shoulders shaped and compacted to the required section.

601.3.2 Cement Concrete Sidewalk

Excavation shall be as specified above. The bed course material shall be placed in accordance with the Item 200, Aggregate Subbase Course.

All forms shall be staked securely in position at the correct line and level. Preformed joint filler shall be set in position shown on the Plans before placing of the concrete is started.

The top of the joint filler shall be placed 5mm below the top surface of the finished sidewalk.

The mixing, placing, finishing and curing of concrete shall be as specified in Item 405, Structural Concrete. The Portland Cement concrete shall be placed to the total depth shown on the plans.

The surface shall be cut through to a depth of 10mm with a trowel at intervals of 1 m or, were required, in straight lines perpendicular to the edge of sidewalk. The surface shall then be brushed. The edges of the sidewalk and the transverse cuts shall be shaped with a suitable tool so formed as to round the edges to a radius of 15mm.

601.4 Method of Measurements

The area to be paid for shall be the number of square meters of sidewalk measured, completed in-place and accepted.

601.5 Basis of Payment

The quantity as determined in Subsection 601.4, Method of Measurements, shall be paid for all the contract unit price per square meter for sidewalk which price and payment shall constitute full compensation for furnishing and placing all materials for asphalt sidewalk, concrete sidewalk, expansion joint materials , for excavating and compacting the foundation bed, for furnishing and placing cinders, gravel or other permeable bed course material, for prime coat material, for forms, and for all labor, equipment, tools and incidentals necessary to complete the Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
601	Sidewalk	Square Meter

ITEM 602- MONUMENTS, MARKERS AND GUIDE POSTS

602.1 Description

This item shall consist of right-of-way monuments, maintenance marker post, kilometer post and/or guide posts, furnished and installed in accordance with the specification at the locations, and in conformity with the sizes, dimensions and design, shown on the Plans, or as required by the Engineer.

602.2 Material Requirements

Concrete shall be the class designated on the Plans and shall be composed of materials conforming to the requirements of Item 405, Structural Concrete.

Reinforcing steel shall conform to the requirements of Item 404, Reinforcing Steel.

Timber shall be of the species and grade shown on the Plans. Treated timber, if required, shall conform to the requirements of Item 410, Treated and Untreated timber.

The metal material shall conform to the requirements shown on the Plans, or as stipulated in the Special provisions.

Paints, if required, shall conform to the requirements shown on the Plans, or as stipulated in the Special Provisions

Warning reflectors, if required, shall conform to the requirements shown on the Plans, or as stipulated in the Special Provisions.

602.3 Construction Requirements

Construction or fabrication and installation of monuments and posts shall be as shown on the Plans or in the Special Provisions or shall include the attaching of warning reflectors and the painting of posts, if required. Each monument and post shall be set accurately at the required location and elevation and in such manner as to insure its being held firmly in place. In constructing precast monuments, the forms shall not be removed until after the concrete has hardened. Monuments that are warped shall be rejected. The exposed surface of the finished monuments shall be uniform, of even texture, and shall be free from holes, cracks and chipped edges. The precast monuments shall not be transported to the work until the concrete has been cured.

602.4 Method of Measurement

The quantities to be paid for shall be the actual number of right-of-way monuments, maintenance marker posts, kilometer posts and/ or guide posts furnished, placed and accepted.

602.5 Basis of Payment

The quantities determined as provided in Subsection 602.4, Method of Measurements, shall be paid for at the contract price per unit of measurement respectively, for each of the particular Pay Item listed below and as shown in the Bid Schedule, which price and payment shall constitute full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
602(1)	Right-of-way monument	Each
602(2)	Maintenance marker posts	Each
602(3)	Kilometer posts	Each
602(4)	Guide posts	Each

ITEM 604 – FENCING

604.1 Description

This item shall consist of furnishing and constructing posts and barbed wire or chain link fences in accordance with the details, and at the locations, shown on the Plans, or as required by the Engineer.

604.2 Material Requirements

604.2.1 Barbed Wire

Barbed wire shall conform to the requirements of ASTM A 121, Class I. The barbed wire shall consist of 2 strands of 12.5 gauge wire, twisted with 2 points, 14 gauge barbs spaced 100 mm apart.

604.2.2 Chain Link Fence Fabric

Chain link fence fabric shall be fabricated from 10 gauge galvanized wire conforming to AASHTO M 181Mand shall be of the type shown on the Plans. Before ordering the chain link fence fabric, the Contractor shall submit a sample of the material to the Engineer for testing and approval.

604.2.3 Concrete Post

Concrete post shall made of Class A concrete in accordance with Item 405, Structural Concrete. The posts shall be cast to a tapered section 3 m long, or to the length shown on the detailed plans, and shall have a smooth surface finish.

604.2.4 Steel Post

Steel posts shall be of the sections and length as specified or as shown on the Plans. The posts shall be copper bearing steel and shall conform to the requirements of AASHTO M 183 for the grade specified.

604.2.5 Woven Wire

Galvanized woven (cyclone) wire fence of the coating class specified shall conform to the requirements of ASTM A 116. Aluminum coated woven wire fence shall conform to the requirements of ASTM A 584.

604.2.5 Steel Reinforcement

Steel reinforcement for concrete posts shall be deformed steel bars conforming to the provisions of Item 404, Reinforcing Steel.

604.2.6 Hardwares

Nuts, bolts, washers and other associated hardware shall be galvanized after fabrication as specified in ASTM A 153.

604.3 Construction Requirements

The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to the required grade and alignment. Fence shall generally follow the contour of the ground. Grading shall be performed where necessary to provide a neat appearance.

Gates shall be performed where necessary as to shown on the Plans.

604.3.1 Erection Post

The post shall be erected vertically in position inside the formwork of the foundation block prior to the placing of concrete and shall be adequately supported by bracing to prevent movement of the post during the placing and setting of the concrete. The posts shall be erected to the height and location shown on the Plans, or as ordered by the Engineer.

604.3.2 Installation of Chain Link Fence Fabric

The chain link fence fabric shall be set to line and elevation, and pulled taut between each post before spot welding or other method of fixing, is carried out. Where splicing of the fence fabric is necessary, or at joints, the lapping of the chain link fence fabric shall be for a minimum of 100 mm and shall occur only at the post. No horizontal splicing will be permitted. The fence fabric shall be fixed to the posts as shown on the Plans. Any surface protective layer damaged during welding and/or construction shall be restored properly.

604.4 Method of Measurement

The quantity to be paid for shall be the number of linear meters measured center to center of posts of fencing erected in place and accepted.

604.5 Basis of Payment

The quantity, as measured in Section 604.4, Method of Measurement, shall be paid for at the contract price per unit of measurement respectively for each of the particular items listed below as shown in the Bid Schedule, which price and payment shall be full compensation for furnishing and placing all materials and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
604(1)	Fencing(Barbed wire)	Linear Meter
604(2)	Fencing(Chain Link Fence Fabric)	Linear Meter
604(3)	Fencing (Posts)	Each
604(4)	Fencing (Gates)	Each
604(5)	Fence (Cyclone wire)	Linear Meter

ITEM 612 – REFLECTIVE THERMOPLASTIC STRIPPING MATERIALS

612.1 Description

This standard specifies the requirement for reflectorized thermoplastic pavement stripping material conforming to AASHTO M 249 that is applied to the road surface in a molten state by mechanical means with surface application of glass beads at a rate of not less than 350g/l of glass beads having a size range of drop-in type and will produce an adherent reflectorized stripe of specified thickness and width capable of resisting deformation by traffic.

612.2 Material Requirements

1.0 Reflectorized Thermoplastic Pavement Material shall be shall be homogeneously composed of pigment, filler, resins and glass reflectorizing spheres.

The thermoplastic material shall be available to both white and yellow.

2.0 Glass Beads (Pre-Mix) shall be uncoated and shall comply with the following requirements:

Refractive Index, min----------1.50

Spheres, Percent, min---------- 90

Gradation:

Sieve	Mass Percent Passing
mm	
0.85	100
.600	75 - 95
0.425	-
.300	15-35
0.18	-
0.15	0--5

612.3 Construction Requirements

612.3.1 Composition

The pigment, beads and filler shall be uniformly dispersed in the resin. The material shall be free from all resin. The material shall be free from all skins, dirt and foreign objects and shall comply with the requirements as specified in Table 612.1.

Table 612.1
Composition Requirements

Component	White	Yellow
Binder,min.	18	18
Glass Beads:		
Min.	30	30
Max.	30	30
Titanium		
Dioxide, min.	10	

Component	White	Yellow
Chrome Yellow		
Component	White	Yellow
Medium, min.		10
Calcium Carbonate		
And Inert Fillers,		
Max.	42	42

612.3.2 Qualitative

The material shall conform to the qualitative requirements as specified in Table 612.2.

Table 612.2
Qualitative Requirements

Property	Requirements	
	White	Yellow
Specific Gravity, max.	2.15	
Drying Time, minutes, max	10	
Bond Strength to Portland Cement Concrete after heating for four(4) hours		
Plus/minus 5 min@ 218 deg C, Mpa, max	1.24	
Cracking Resistance at low temp. after heating for four(4) hours plus. minus 5 min.at 218 plus/minus 2 deg C.	No cracks	
Impact Resistance after heating for four(4) hours plus.minus 5 min.at 218 plus/minus 2 deg C. and forming test specimens, mm/kg, min	115	
Softening Point after heating for four(4) hours plus. minus 5 min. at 218 plus/minus 2 deg C.	102.5 plus/minus 9.5deg C	
Daylight reflectant at 45 degrees-0 degree, %min.	75	45

612.3.3 Application Properties

The material shall readily extrude at a temperature of 211 plus/minus 7 degree C, from approved equipment to produce a line 3.2 to 4.8 mm thick which shall be continuous and uniform in shape having clear and sharp dimensions.

The material shall not exude fumes which are toxic, obnoxious or injurious to persons or property when heated during applications.

The application of additional glass beads by drop-in methods shall be at a rate not less than 350g/l of glass beads having a size range for drop-in type. The typical size range of spheres of drop-in type paints is as follows:

Passing 850 um (#20) sieve and
Retained on 250 um (#60) sieve, % 80 – 100

a) Preparation of Road Surface - the materials should be applied only on the surface which clean and dry. It shall not be laid into loose detritus, mud or similar extraneous matter, or over an old paint markings, or over an old thermoplastic marking which is faulty. In the case of smooth, polished surface stones such as smooth concrete, old asphalt surfacing with smooth polished surface stones

and/or where the method of application of the manufacturer of the thermoplastic materials shall be recommended, and with the approval of the Engineer.

b) Preparation of thermoplastic materials- The materials shall be melted in accordance with the manufacturer's instruction in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic and such the local overheating shall be avoided. The temperature of the mass shall be within the range specified by the manufacturer and shall no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material shall be used as expeditiously as possible and for thermoplastic which have natural resin binders or otherwise sensitive to prolong heating the materials shall not be maintained in a molten condition for more than 4 hours.

c) Laying – Center lines, lane lines and edges lines shall be applied by approved by mechanical means and shall be laid in regular alignment. Other markings may be applied by hand- screed, hand propelled machine or by self-propelled machine approved or directed by the Engineer. After transfer to the laying apparatus the materials shall be maintained within the temperature range specified by the manufacturer and stirred to maintain the right consistency for laying.

In the case of screen application, the material shall be laid to a thickness not less than 3mm or more than 6mm unless authorized by the Engineer when laid over an existing marking. In the case of sprayed application the material shall be laid to thickness of not less than 1.5mm unless authorized by the Engineer. In all cases the surface produced shall be uniform and appreciably free from bubbles and steaks. Where the Contractor Documents require or the Engineer direct that ballotini shall be applied to the surface of the markings, these shall be applied uniformly to the surface of hot thermoplastic immediately after laying such that the quality of ballotini firmly embedded and retained in the surface after completion complies with the requirements of Sub-section 606.2.2, Material Requirements.

Road markings of a repetitive nature, other center lines, lane lines, etc. shall unless otherwise directed by the Engineer be set out with stencils which comply with the size and spacing requirements shown on the Plans.

d) Re-use of Thermoplastic materials- At the end of day's as much as possible the material remaining in the heater and/ or laying apparatus shall be removed. This may be broken and used again provided that the maximum heating temperature has not been exceeded and that the total time during which it is a molden condition does not exceed the requirements of Sub-section 606.2.3, Construction Requirements.

612.3.4 Defective Materials or Workmanship

Materials which are defective or have been applied in an unsatisfactory manner or to incorrect dimensions or in a wrong location shall be removed, the road pavement shall be made good and materials replaced reconstructed and/or properly located, all at the Contractor expenses and to the satisfaction of the Engineer.

612.3.5 Protection of the Traffic

The Contractor shall protect pedestrians, vehicles and other traffic adjacent to the working area against damage or disfigurement by construction equipment , tools and materials or by spatters , splashes and smirches or paint or other construction materials

and during the course of the work, provide and maintain adequate signs and signals for the warning and guidance of traffic.

612.4 Sampling

A minimum weight of 10 kg of Reflectorized Thermoplastic paint shall be taken for every 100 bags or fraction thereof.

612.5 Testing

The material shall be tested in accordance with AASHTO T 250 or with the appropriate method in ASTM designation.

612.6 Packing and Marking

The material shall be packaged in suitable containers to which it will not adhere during shipment and storage. The blocks of cast Thermoplastic material shall be approximately 300 x 915 by 51 mm and shall weigh approximately 23 kg. Each container label shall designate the color, manufacturer's name, batch number and date of manufacture. Each batch manufactured shall have its own separate number. The label shall warn the user that material shall be heated to 211 plus/minus 7 degree C during application**.**

612.4 Method of Measurement

The quantity of pavement markings to be paid for shall be the areas as shown on the Plans of painted traffic line of the stated width and the area as shown on the plans of symbols, lettering, hatching and the like, completed and accepted.

The quantity shown in the Bill of Quantities represents the approximate quantity in square meter of pavement markings, with width as shown applied at the centerline of the road pavements to which it may be increased or decreased depending on the Engineer's decision whether to require additional markings or delete parts of it. Other markings representing symbols, lettering, hatching and others in locations where they may be required by the Engineer shall, likewise, be implemented by the Contractor using reflectorized thermoplastic pavement markings as approved and directed.

612.5 Basis of Payment

The quantities measured as determined in Subsection 612.8, Method of Measurement, shall be paid for at the appropriate contract unit price for the Pay Items shown in the Bid Schedule which price and payment shall constitute full compensation for furnishing and placing all materials, sampling and packing, for the preparation of the surface and for labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
612(1)	Reflectorized Thermoplastic Pavement Markings (White)	Square Meter
612(2)	Reflectorized Thermoplastic Pavement Markings (Yellow)	Square Meter

ITEM 711 – FENCE AND GUARDRAIL

711.1 Description

This item shall consist of furnishing and constructing of fence and guardrail in accordance with the details, and at the locations, shown on the Plans, or as required by the Engineer.

711.2 Material Requirements

711.2.1 Tubular Bars

Tubular bars shall conform to the requirements of ASTM A 513 or ASTM A 500 Grade B having a finish of : For ASTM A 513 shall be dark blue/black, smooth slightly oil coating; and for ASTM 500 shall be blue/ dark grey, slightly grainy, dry. Before ordering the tubular pipes, the Contractor shall submit a sample of the material to the Engineer for testing and for approval. Sizes of the tubular square tubing are shown on the Plans.

Other Mechanicals Properties shall be:

YIELD POINT	72 ksi for ASTM A 513 and 46 ksi for ASTM A 500
TENSILE STRENGTH	87 ksi for ASTM A 513 and 58 ksi for ASTM A 500
ELONGATION IN 2 INCHES	10 % for ASTM A 513 and 23% for ASTM A 500
OUTSIDE CORNER RADIUS	3 x wall maximum

Other Chemical Properties shall be:

IRON	99%
CARBON	0.05% to 23%
MANGANESE	0.3% to 0.6%
PHOPHOROUS	0.04%
SULFUR	0.04% maximum

711.2.2 Concrete Post

Concrete posts shall be made of Class A concrete in accordance with Item 405, Structural Concrete. The posts shall be cast in place having a cross-sectional dimension of 200mm x 200mm with 4 vertical reinforcing bars tied up with 10mm bar stirrups. The posts shall be enveloped with 6 inches hollow blocks stacked around the concrete post and finished with 4” x 8” x 1” bricks cladding plastered on the concrete hollow blocks. Refer to the drawings about the arrangement of the bricks cladding.

711.2.3 Steel Reinforcement

Steel reinforcement for concrete posts shall be deformed steel bars conforming to the provisions of Item 404, Reinforcing Steel.

711.2.4 Hardwares

Nuts, bolts, washers and other associated hardwares shall be galvanized after fabrication as specified in ASTM A 153.

711.2.5 Steel Gates

Steel gates and the tubular pipes shall be constructed as shown on the Plans, or as per order of the Engineer. All parts of the gates and tubular pipes shall be painted with enamel paint.

711.2.6 Welding

Surface to be welded shall be smooth, uniform and free from fins, tears, and other defects which would adversely affect the quality of the weld. Edges of material shall be trimmed by machining, chipping, grinding, or machine gas cutting to produce a satisfactory welding edge wherever such edge is thicker than : 13 mm for sheared edge of material: 16 mm for toes of angles or rolled shapes (other than wide flange sections); 25mm for universal mill plate or edges of flange sections.

The width of the root surface used, shall be not more than 1.5 mm for parts less than 10 mm in thickness nor more than 3mm for parts 10mm or more in thickness.

Butt welds shall be proportioned so that their surface contours will lie in gradual transition curves. For butt welded joints between base metal parts of unequal thickness, a transition shall be provided on a slope or level not greater than 1 in 2.5 to join the offset surfaces. This transition may be provided by sloping the surface of the weld metal or by beveling the thicker part or by combination of these two methods.

Surfaces to be welded shall be free from loose scale, slag, rust, grease or other material that will prevent proper welding. Mill scale that withstands vigorous wire brushing or a light film of drying oil or rust inhibitive coating may remain. Surfaces within 50 mm of any weld location shall be free of any paint or other material that would prevent proper welding or produce objectionable fumes while welding.

No operation or actual welding or gas-cutting shall be performed on a member while it is carrying live load stress or while subject to shock and vibration and from moving loads. Welding and gas cutting shall cease in advance of the application of such loads.

711.2.7 Barbed Wire

Galvanized barbed wire of the coating class specified shall conform to the requirements of ASTM A 121.

Aluminum coated barbed wire shall conform to the requirements of ASTM A 585 with Type I (Aluminum coated) or Type II (Aluminum Alloy) barbs at the option of the manufacturer.

711.2.8 Woven Wire

Galvanized woven wire fence of the coating class specified shall conform to the requirements of ASTM A 116. Aluminum coated woven wire fence shall conform to the requirements of ASTM A 584.

711.2.9 Chain Link Fence

Chain link fence and the required fittings and hardware shall conform to AASHTO M 181, for the kind of metal, coating, size of wire and mesh specified.

Galvanized coiled spring steel tension wire shall be 7 (4.425 mm) gauge, conforming to ASTM A 641 hard temper, with class 3 coatings unless otherwise specified or shown on the drawings.

Aluminized coil spring steel tension wire shall also be 7 (4.425 mm) gauge, hard temper, having a minimum coating mass of 0.12 kg/m^2 of aluminum.

711.2.10 Metal Beam Rail

Steel rail elements shall be corrugated sheet steel beams conforming to the requirements of AASHTO M 180 of the designated class and type.

711.2.11 Timber Rail

The timber rail shall be cut from the specified grade of dry, well seasoned and dressed timber stock of the species specified, which shall meet the applicable requirements of AASHTO M 168.

Where preservative treatment is specified, this shall conform to the requirements of Item 410, Treated and Untreated timber.

Rustic rails shall be straight, sound and free of injurious defects and shall have been cut from the live trees not less than 30 days but not more than 1 year before use. They shall have been stripped of bark before seasoning or shall have been stored under water. Immediately before the logs are used in the work, all knots and projections shall be trimmed and smoothed, and if water cured all bark shall be peeled. Slight curvature of wind to give a pleasing appearance to the structure will be permitted. Logs of only one specie shall be used for construction of any one continuous length of guardrail.

711.2.12 Fence Posts

Wood posts shall conform to the details and dimensions indicated on the Plans. When cedar posts or bracing is furnished, the requirements for peeling may be omitted.

All dimensions timber and lumber required for fences or gates shall be sound, straight and shall be reasonably free from knots, splits and shakes. It shall be of the species and grades indicated on the Plans. And shall be dressed and finished on four sides.

Concrete posts shall be made of concrete conforming to the specified requirements of concrete, for the class specified, and shall contain steel reinforcements as shown on the Plans, conforming to the requirements of Item 710, Reinforcing Steel and Wire Rope.

Steel posts for line-type fencing shall conform to ASTM A 702.

Steel posts shall be galvanized in accordance with AASHTO M 111 except that tubular steel posts shall be galvanized in accordance with ASTM 120. Fittings, hardware and other appurtenances not specifically covered by the Plans and Specifications, shall be galvanized in accordance with ASTM A 120 and shall be standard commercial grade, and in accordance with current standard practice.

Weathering steel posts conforming to the requirements of ASTM A 558, shall be furnished when specified.

Aluminum alloy posts shall conform to the requirements of AASHTO m 181.

711.2.13 Guardrail Posts

Guardrail posts shall conform to the applicable standards contained in AASHTO-AGC-ARTBA “A Guide to standardized Highway Barrier Rail Hardware”.

711.2.14 Guardrail Hardware

Guardrail hardware shall conform to the applicable standards contained in AASHTO AGC-ARTBA “Guide to standardized Highway Barrier Rail Hardware”.

711.2.15 Box Beam Rail

Steel box rail elements shall conform to the applicable standards contained in AASHTO-AGC- ARTBA “A Guide to standardized Highway Barrier Rail Hardware”.

711.3 Construction Requirements

The Contractor shall perform clearing and grubbing as may be necessary to construct the fence to the required grade and alignment. Fence shall generally follow the contour of the ground. Grading shall be performed where necessary to provide a neat appearance. Gates shall be constructed as shown on the Plans.

711.3.1 Construction of Post

Concrete shall be poured in place inside the formworks of the foundation. The reinforcement of the post shall be placed vertically and placed on top of the foundation reinforcement prior to pouring of the foundation. After the concrete foundation attained its initially hardness, installation of reinforcing steel for the post shall be completed before installation of the formworks shall be done. The forms shall be placed vertically in position and shall be adequately supported by bracing to prevent movement of the post during the placing and setting of the concrete. The concrete shall be poured up to the height and location shown on the Plans or as ordered by the Engineer.

711.4 Method of Measurement

The quantity to be paid for shall be the number of linear meters measured center to center of posts of fencing erected in place and accepted.

711.5 Basis of Payment

The quantity, as determined in Sub-section 711.4, Method of Measurement, shall be paid for at the contract price per unit measurement respectively for each of the particular items listed below and as shown in the Bill of Quantities, which price and payment shall be full compensation for the furnishing and placing all materials and for all labor, equipment, tools and incidentals necessary to complete the Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
711(1)	Fence (cyclone wire)	Linear Meter
711 (2)	Gates	Each
	Supply and installation of razor wire # 12, including post and support	
711(3)	Automatic Car Barrier	Set

PART I – ELECTRICAL WORKS

ITEM 1100 – CONDUITS, BOXES & FITTINGS

1100.1 Description

This item shall consist of the furnishing and installation of the complete conduit work consisting of electrical conduits; conduit boxes such as junction boxes, pull boxes, utility boxes, octagonal and square boxes; conduit fittings such as couplings, locknuts and bushings and other electrical materials needed to complete the conduit roughing -in work of this project.

1100.2 Material Requirements

All materials shall be brand new and shall be of the approved type meeting all the requirements of the Philippine Electrical Code and bearing the Philippine Standard Agency (PSA) mark.

Conduits

Conduits shall be standard rigid steel, zinc coated or galvanized. Intermediate metal conduit may be used if shown or specified on the approve Plans. PVC conduits if required shall be schedule 40. Enamel coated steel conduits with rough inner surfaces are not acceptable.

Conduit Boxes

All conduit boxes shall be Code gauge steel and galvanized. Outlet boxes shall be galvanized pressed steel of standard make. In general, outlet boxes shall be at least 100mm square or octagonal, 53 mm deep and 16 mm minimum gauge.

Conduit Fittings

All conduit fittings such as locknuts and bushing shall be galvanized of standard make.

1100.3 Construction Requirements

All works throughout shall be executed in the best practice in a workmanlike manner by qualified and experienced electricians under the immediate supervision of a duly licensed Electrical Engineer.

Conduits

Conduits should be cut square with a hacksaw and reamed. Bends shall be made with the required radius. In making bends only conduit bending apparatus will be used. The use of a pipe tee or vise for bending conduits shall not be permitted. Conduits which have been crushed, deformed or flattened shall not be installed. No running thread shall be allowed. Conduit runs crossing construction joints of the building shall be provided with standard expansion fittings of the approved type.

No conduit shall be used in any system smaller than 12 mm diameter electric trade size nor shall have more than four (4) 90-degree bends in any one run and where necessary, pull boxes shall be provided.

All ends of conduits which are left empty in cabinets and conduit boxes shall be plugged with lead or approved pipe caps so as to prevent the entrance of white ants and dirt within the conduit system. Pull wires shall be inserted in the empty ducts before they are closed with lead or pipe caps and shall be left therein for future use.

On exposed work, all pipes and outlet boxes shall be secured by means of galvanized metal clamps which shall be held in place by means of machine screws. When running over concrete surfaces, the screws shall be held in place by means of expansion sleeves for big pipes and rolled lead sheet for small for small pipes. All pipes shall be run at right angles to and parallel with the surrounding walls. No diagonal run shall be allowed and all bends and offsets shall be avoided as much as possible. Conduits shall be supported at 1,500 mm intervals maximum.

Conduit Boxes & Fittings

Provide conduit boxes for pulling and splicing wires and outlet boxes for installation of wiring devices.

As a rule, provide junction boxes or pull boxes in all runs greater than 30 meters in length, for horizontal runs. For other lengths, provide boxes as required for splices or pulling. Pull boxes shall be installed in inconspicuous but accessible locations.

Support boxes independently of conduits entering by means of bolts, red hangers or other suitable means.

Conduit boxes shall be installed plumb and securely fastened. They shall be set flush with the surface of the structure in which they are installed where conduits are run concealed.

All convenience and wall switch outlet boxes for concealed conduit work shall be deep, rectangular flush type boxes. Four-inch octagonal flush type boxes shall be used for all ceiling light outlets and shall be of the deep type where three or more conduits connect to a single box.

Floor mounted outlet boxes required shall be waterproof type with flush brass floor plate and brass bell nozzle.

All boxes shall be painted with antirust red lead paint after installation.

All conduits shall be fitted with approved standard galvanized bushing and locknuts where they enter cabinets and conduit boxes.

Junction and pull boxes of code gauge steel shall be provided as indicated or as required to facilitate the pulling of wires and cables.

1100.4 Method of Measurement

The work under this item shall be measured either by lengths, pieces, pairs, lot and set actually placed and installed as shown on the approved Plans.

1100.5 Basis of Payment

All works performed and measured and as provided for in the Bill of Quantities shall be paid for at the Unit Bid or Contract Unit Price which payment shall constitute full

compensation including labor, materials, tools and incidentals necessary to complete this item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1100(1)a1	RSC Conduit Pipe-65mm dia. X 3m , with locknut,	lm
1100(1)a2	bushing	lm
1100(1) f1	RSC Conduit Pipe-50mm dia. X 3m , with locknut,	lm
1100(1)f2	bushing	lm
1100(1)f3	Polyvinyl Chloride Pipes (PVC) 20mm dia. x3m	lm
1100(1)f4	Polyvinyl Chloride Pipes (PVC) 25mm dia. x3m	lm
1100(1)f5	Polyvinyl Chloride Pipes (PVC) 32mm dia. x3m	lm
1100(1)f6	Polyvinyl Chloride Pipes (PVC) 40mm dia. x3m	lm
1100(1)f7	Polyvinyl Chloride Pipes (PVC) 50mm dia. x3m	lm
1100(4)d2	Polyvinyl Chloride Pipes (PVC) 63mm dia. x3m	lm
1100(4)d3	Polyvinyl Chloride Pipes (PVC) 90mm dia. x3m	pc
1100(4)d6	Polyvinyl Chloride Pipes (PVC) 100mm dia. x3m	pc
1100 (3) c1	PVC Elbow, 25mm dia. X90^0	pc
1100(11)a1	PVC Elbow, 32mm dia. X90^0	pc
1100(11)b1	PVC Elbow, 63mm dia. X90^0	pc
1100(11)d1	PVC Adapter, 20mm dia.	pc
1100(14)b	Junction Boxes	pc
1100(19)	Utility Boxes, metal	pc
1101(1)b1	Square box, metal	pc
1101(1)b2	Pull Box, 350 x 350 x 100mm	length
1101(1)b3	Electrical Manhole, 1100mm x 1100mm	length
1101(1)b4	Electrical Handhole, 650mmx650mm	length
	Earth Rod Copper Clad, 20mmx3m	length
	Concrete (Cable) Trench, 600 x 600mm	
	Insulated Copper Conductor, 2.0 mm^2 TW	

ITEM 1101 – WIRES AND WIRING DEVICES

1101.1 Description

This Item shall consist of the furnishing and installation of all wires and wiring devices consisting of electric wires and cables, wall switches, convenience receptacles, PVC pipe, heavy duty receptacles and other devices shown on the approved Plans but not mentioned in these specifications.

1101.2 Material Requirements

Wire and cables shall be of the approved type meeting all the requirements of the Philippine Electrical Code and bearing the PS mark. Unless specified or indicated otherwise, all power and lighting conductors shall be insulated for 600 volts.

All wires shall be copper, soft drawn and annealed, smooth and of cylindrical form and shall be centrally located inside the insulation.

All wiring devices shall be standard products of reputable electrical manufacturers. Wall switches shall be rated at least 10A, 250 Volts and shall be spring operated, flush, tumbler type. Duplex convenience receptacles shall be rated at least 15A, 250 Volts,

flush, parallel slots. Single heavy duty receptacles shall be rated at least 20A, 250 volts, 3- wire, flush, polarized type.

1101.3 Construction Requirements

Conductors or wires shall not be drawn in conduits until after the cement plaster is dry and the conduits are thoroughly cleaned and free from dirt and moisture. In drawing wires into conduits, sufficient slack shall be allowed to permit easy connections for fixtures, switches, receptacles and other wiring devices without the use of additional splices.

All conductors of convenience outlets and lighting branch circuit homeruns shall be wired with a minimum of 3.5 mm in size. Circuit homeruns to panel board more than 30 meters shall not be smaller than 5.5 mm. No conductor shall be less than 2 mm in size.

All wires of 14mm and larger in size shall be connected to panels and apparatus by means of approved type lugs or connectors of the solderless type, sufficiently large enough to enclose all strands of the conductors and securely fastened. They shall not loosen under vibration or normal strain.

All joints, taps and splices on wires larger than 14 mm shall be made of suitable solderless connectors of the approved type and size. They shall be taped with rubber and PVC tapes providing insulation not less than that of the conductors.

No splices or joints shall be permitted in either feeder or branch conductors or branch conductors except within outlet boxes or accessible junction boxes or pull boxes. All joints in branch circuit wiring shall be made mechanically and electrically secured by approved splicing devices and taped with rubber and PVC tapes in a manner which will make their insulation as that of the conductor.

All switched and receptacles shall be fitted with standard Bakelite face plate covers. Device plates for flush mounting shall be installed with all four edges in continuous contact with finished wall surfaces without the use of coiled wire or similar devices. Plastic fillings will not be permitted. Plates installed in wet locations shall be gasketed.

When more than one switch or device is indicated in a single location, gang plate shall be used.

1101.4 Method of Measurement

The work under this Item shall be measured either by meters, rolls, pieces, set, actually placed and installed as shown on the Plans.

1101.5 Basis of Payment

All works performed and measured and as provided for in this Bid of Quantities shall be paid for at the Unit Bid or Contract Unit Price which payment shall constitute full compensation including labor, materials, tools and incidentals necessary to complete this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1101(1)a5	Electric wire, 2.0mm^2 TW	lm
1101(1)b6	Electric wire, 3.5mm^2 TW	lm
1101(1)b6	Electric wire, 3.5mm^2 THHN	lm
1101(1)b7	Electric wire, 5.5mm^2 THHN	lm
1101(1)b8	Electric wire, 8mm^2 TW	lm
1101(1)b8	Electric wire, 8mm^2 THHN	lm
1101(1)b9	Electric wire, 14.0mm^2 TW	lm
1101(1)b9	Electric wire, 14mm^2 THHN	lm
1101(1)b10	Electric wire, 22mm^2 TW	lm
1101(1)b10	Electric wire, 22mm^2 THHN	lm
1101(1)b11	Electric wire, 30.0mm^2 TW	lm
1101(1)b12	Electric wire, 38.0mm^2 THHN	lm
1101(1)b13	Electric wire, 50.0mm^2 TW	lm
1101(1)b13	Electric wire, 50.0mm^2 THHN	lm
1101(1)b14	Electric wire, 60.0mm^2 THHN	lm
1101(1)b15	Electric wire, 80mm^2 TW	lm
1101(1)b16	Electric wire, 100mm^2 THHN	lm
1101(1)b17	Electric wire, 125mm^2 THHN	lm
1101(1)b19	Electric wire, 200.0mm^2 THHN	lm
1101(3)a11	1 x 200.0 mm^2 XLPE	lm
1101(3)a12	1 x 300.0 mm^2 XLPE	lm
1101(3)a13	1 x 400.0 mm^2 XLPE	lm
1101(5)	Telephone Wire no.22/3c	lm
1101(6)a7	Bare Copper Wire, 50mm^2	lm
1101(6)a8	Bare Copper Wire, 80mm^2	lm
1101(7)a1	Single Pole wall Switch	set
1101(7)a2	Double Pole wall Switch	set
1101(7)a3	Triplex (3-single pole wall switch)	
1101(7)a4	Three way wall switch	
1101(8)a2	Convenience Outlet, Duplex/receptacles (GT)	set
1101(8)a3	Convenience Outlet, Duplex Parallel, Weatherproof (GT)	set
1101(8)a1	Telephone Outlet	set
1101(8) a2	Special Purpose outlet for A.C.U, WH, etc.	set
1101(8)a3	Incandescent Receptacle	set
1101(9)a1	Ground Well, 300 x 300	pc
1101(9)a2	Grounding Plate , 900 x 900 x1.5	pc
1101(9) a3	Grounding rod, 20 mm dia. x 3m w/ clamp	each
1101(10)	Electrical Tape (PVC)	roll
1101(11)	Rubber Tape	roll
1101(12)	PVC adapter, 20 mm dia.	lm
1101(17)	PVC End Bell, 50mm dia.	ea
1101(18)	PVC End Bell, 63mm dia.	ea
1101(19)	PVC End Bell, 90mm dia.	ea
1101(20)	PVC End Bell, 110mm dia.	ea
1101(21)	Hand Dryer	ea
1101(22)	Cadweld connector	ea
1101(23)	Tf Wire, 1.25 mm2	lm
1101(24)	UTP Cat 5 Cable	roll
1101(25)	Lan outlet, RJ 45	

ITEM 1102 - POWER LOAD CENTER, SWITCHGEAR AND PANELBOARDS

1102.1 Description

This Item shall consist of furnishing and installation of the power load center unit substation or low voltage switchgear and distribution panelboards at the location shown or the approved Plans complete with transformers, circuit breakers, cabinets and all accessories, completely wired and ready for service.

1102.2 Material Requirements

All materials shall be brand new and shall be of the approved type. It shall conform with the requirements of the Philippine Standard (PS) mark.

Power Load Center Unit Substation

The Contractor shall furnish and install an indoor –type Power Load Center Unit Substation at the location shown on the approved Plans if required. It shall be totally metal-enclosed, dead front and shall consist of the following coordinated component parts:

High Voltage Primary Section:

High voltage primary incoming line section consisting of the following parts and related accessories:

(a) One (1) Air-filled Interrupter Switch , 2- position (open-close) installed in a suitable air filled metal enclosure and shall have sufficient interrupting capacity to carry the electrical load. It shall be provided with key interlock with the cubicle for the power fuses to prevent access to the fuses unless the switch is open.

(b) Three (3) - power fuses mounted in separate compartments within the switch housing and accessible by a hinged door.

(c) One (1) set of high voltage potheads or 3-conductor cables or three single conductor cables.

(d) Lightning arresters shall be installed at the high voltage cubicle if required.

Items (a) and (b) above could be substituted with a poor circuit breaker with the correct rating and capacity.

Transformer Section

The transformer section shall consist of a power transformer with ratings and capacities as shown on the Plans. It shall be oil liquid-filled non-flammable type and designed in accordance with the latest applicable standards.

The transformer shall be provided with four (4 approximately 2 ½ % rated KVA taps on the primary winding in most cases one (1) above and three (3) below rated primary voltage and shall be changed by means of externally gang-operated manual tap charger only when the transformer is de-energized. Tap changing under load is acceptable if transformer has been so designed.

The following accessories shall be provided with the transformer, namely: rain valve, sampling device, filling connection, oil liquid level gauge, ground pad, top filter press connection, lifting lugs, diagrammatic nameplate, relief valve, thermometer and other necessary related accessories.

The high-voltage and low-voltage bushings and transition flange shall be properly coordinated for field connection to the incoming line section and low voltage switchboard section, respectively.

Low-Voltage Switchboard Section

The low-voltage switchboard shall be standard modular- unitized units, metal-built, dead front, safety type construction and shall consist of the following;

(a) Switchboard Housing

The housing shall be heavy gauge steel sheet, dead front type, gray enamel finish complete with frame supports, steel bracings, steel sheet panelboards, removable rear plates, copper busbars, and all other necessary accessories to insure sufficient mechanical strength and safety. It shall be provided with grounding bolts and clamps.

(b) Secondary Metering Section

The secondary metering section shall consist of one (1) ammeter, AC, indicating type ; one (1) voltmeter , AC, indicating type, one (1) ammeter transfer switch for 3-phase; one (1) voltmeter transfer switch for 3-phase; and current transformers of suitable rating and capacity.

The above-mentioned instruments shall be installed in one compartment above the main breaker and shall be complete with all necessary accessories completely wired, ready for use.

(c) Main Circuit Breaker

The main circuit breaker shall be draw-out type, manually or electrically operated as required with ratings and capacity as shown on the approved Plans.

The main breaker shall include insulated control switch if electrically operated, manual trip button, magnetic tripping devices, adjustable time overcurrent protection and instantaneous short circuit trip and all necessary accessories to insure safe and efficient operation.

(d) Feeder Circuit Breakers

There shall be as many feeder breakers as are shown on the single diagram or schematic riser diagram and schedule of loads and computations on the plans. The circuit breakers shall be draw out or molded case as required. The circuit breakers shall each have sufficient interrupting capacity and shall be manually operated complete with trip devices and all necessary accessories to insure safe and sufficient operation. The number, ratings, capacities of the feeder branch circuit breakers shall be as shown on the approved Plans.

Circuit breakers shall each be of the indicating type, providing “ON”, “OFF” and “TRIP” positions of the operating handles and shall each be provided with nameplate for branch circuit designation. The circuit breaker shall be so designed that an overload or short on one pole automatically causes all poles to open.

Low-Voltage Switchgear

(For projects requiring low-voltage and switchgear only)

The Contractor shall furnish and install a low-voltage switchgear at the location shown on the Plans. It shall be metal- clad , dead front, free standing, safety type construction and shall have copper busbars of sufficient size, braced to resist allowable root mean square (RMS) symmetrical short circuit stresses, and all necessary accessories.

The low-voltage switchgear shall consist of the switchgear housing, secondary metering, main breaker and feeder branch circuit breakers and all necessary accessories, completely wired, ready for service.

Grounding System:

All non-current carrying metallic parts like conduits, cabinets and equipment frames shall be properly grounded in accordance with the Philippine Electrical Code, latest edition.

The size of the ground rods and ground wires shall be as shown on the approved Plans. The ground resistance shall not be more than 5 ohms.

Panelboards and Cabinets

Panelboards shall conform to the schedule of panelboards as shown on the approved Plans with respect to supply characteristics, rating of main lugs or main circuit breaker, number and ratings and capacities of branch circuit breakers.

Panelboard shall consist of a factory completed dead front assembly mounted in an enclosing flush type cabinet consisting of code gauge galvanized sheet steel box with trim and door. Each door shall be provided with catch lock and two (2) keys. Panelboards shall be provided with directories and shall be printed to indicate load served by each circuit.

Panelboards cabinets and trims shall be suitable for the type of mounting shown on the approved Plans. The inside and outside of panelboard cabinets and trims shall be factory painted with one rust-proofing primer coat and two finish shop coats of pearl gray enamel paint. Main and branch circuit breakers for panelboards shall have the rating, capacity and number of poles as shown on the approved Plans. Breaker shall be thermal magnetic type. Multiple breaker shall be of the common trip type having a single operating handle. For 50-ampere breaker or less, it may consist of single- pole breaker permanently assembled at the factory into a multi-pole unit.

1102.3 Construction Requirements

The Contractor shall install the Power Load Center Unit Substation or Low-Voltage Switchgear and Panelboards at the location shown on the approved Plans.

Standard panels and cabinets shall be used and assembled on the job. All panels shall be of dead front construction furnished with trims for flush or surface mounting as required.

1102.4 Method of Measurement

The work under this Item shall be measured either by set and pieces actually placed and installed as shown on the approved Plans.

1102.5 Basis of Payment

All works performed and measured and as provided for in the Bill of Quantities shall be paid for at the Unit Bid or Contract Unit Price which payment shall constitute full compensation including labor, materials, tools and incidentals necessary to complete this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1102(1)a1	Panel boards with main lugs and branch breakers Distribution Panel, 1100AF/ 1100AT 460v 3P w/ 1–1000AF/1000AT 3P, 1-100AF/100AT 3P branches in NEMA 1 Enclosure (Free Standing)	
1102(1)a2	Panel boards with main lugs and branch breakers Distribution Panel, 1100AF/ 1100AT 460v 3P w/ 1–1000AF/1000AT 3P, 1-100AF/100AT 3P branches in NEMA 1 Enclosure (Free Standing)	
1102(1)a3	Panel boards with main lugs and branch breakers Distribution Panel, 600AF/ 600AT 230v 3P w/ 2– 100AF/100AT 3P, 2-225AF/125AT 3P, 1-400AF/250AT 3P, 1-100AF/60AT 2P, 2-100AF/70AT 2P branches in NEMA 1 Enclosure (Free Standing)	set
1102(1)a4	Panel boards with main lugs and branch breakers Distribution Panel, 500AF/ 450AT 230v 3P w/ 1– 100AF/100AT 3P, 1-225AF/125AT 3P, 2-100AF/60AT 2P, 1-100AF/70AT 3P, 2-100AF/70AT 2P branches in NEMA 1 Enclosure (Free Standing)	set
1102(1)a5	Main Distribution Panel w main lugs & branch breakers Distribution panel,M100A,2P,230V, B-1-60A 3P, 1-40A,3P,-30A,3P,NEMA 1 Enclose (surface mounted)	set
1102(1)a6	Main Enclosed Circuit Breaker, 3P 1200A, 460V(Surface Mounted), NEMA 1	set
1102(1)a7	Main Enclosed Circuit Breaker, Lighting Panel 225AF/125AT, 230V 3P w/ 15-50AF/20AT, 10-50AT/30AT branches in NEMA 1 (Flushed Mounted)	set
1102(1)a8	Air Circuit Breaker, 3P 2500AF/2500AT 600V	set
1102(1)a9	Air Circuit Breaker, 3P 2000AF/2000AT 600V	set
1102(1)a10	Air Circuit Breaker, 3P 1300AF/1300AT 600V	set
1102(1)a11	Air Circuit Breaker, 3P 225AF/150AT 600V	set
1102(5)a	Main Enclosed Automatic Circuit Breaker Main : 1200AF/1200AT 460v 3P 3Ww/ Transfer Switch 200A 500V 3Phln NEMA 1 Enclosure (Free standing)	set
1102(5)a1	Main Enclosed Automatic Circuit Breaker Main : 1300AF/1300AT 460v 3P 3Ww/ Transfer Switch 200A 500V 3Phln NEMA 1 Enclosure (Free standing)	set
1102(3)a1	Panelboards with main and branch breakers Lighting Panel, 400AF/250AT 230v 3P w/ 4- 50AF/20AT, 1-50AF/30AT, 1-100AF/100AT, 1-225AF/150AT branches in NEMA 1 Enclosure (Flushed type)	
1102(4)a1	Panelboards with main and branch breakers Lighting Panel, 100AF/100AT 230v 3P w/ 7- 50AF/20AT, 9-50AF/30AT branches in NEMA 1 Enclosure (Flushed type)	set
1102(4)a2	Panelboards with main and branch breakers Lighting Panel: 100AF/100AT 230v 3P w/ 11- 50AF/20AT, 5-50AF/30AT branches in NEMA 1 Enclosure (Flushed type)	set
1102(4)a3	Panelboards with main and branch breakers Lighting Panel: 225F/125AT 230v 3P w/ 12-50AF/30AT branches in NEMA 1 Enclosure (Flushed type)	set
1102(4)a4	Panelboards with main and branch breakers Lighting Panel: 225F/125AT 230v 3P w/ 15-50AF/30AT branches in NEMA 1 Enclosure (Flushed type)	set
1102(4)a5	Panelboards with main and branch breakers Lighting Panel: 225F/200AT 230v 3P w/ 1-225AF/125AT 3P, 1-100AF/60AT 3P,1-100AF/50AT 2P, 4-100AF/30AT 2P, branches in NEMA 3R Enclosure	set
1102(4)a6	Panelboards with main and branch breakers Lighting Panel: 100AF/50AT 230v 2P w/ 6-50AF/20AT 2P, 2-50AF/30AT 2P, branches in NEMA I Enclosure (Flushed Type)	set
1102(4)a7	Panelboards with main and branch breakers Lighting Panel: 225F/125AT 230v 3P w/ 7-50AF/20AT, 14-50AF/30AT branches in NEMA 1 Enclosure (Flushed type)	set
1102(4)a8	Panelboards with main and branch breakers Lighting Panel: 100F/60AT 230v 3P w/ 9-50AF/20AT, 3-50AF/30AT branches in NEMA 1 Enclosure (Flushed type)	set
1102(12)	Lightning Strike Counter Box	set

1102 (13)	Lighting Control Panel	set
1102(14)	Galvanized Steel Light Pole, 1.8 m ht.	pc
1102(15)	7.6 m ht. galv. Stl. Light pole ,w/ 73 watts LED Luminaire	set
1102(16)	Low Voltage Switchgear w/o metering facilities 1300AF/ 1300AT 460v 3P	set
1102(17)	Low Voltage Switchgear w/o metering facilities 1500AF/ 1500AT 460v 3P	set
1103(2)a34	Fluorescent Lamp Assembly, 2 x 40 watts, 220V, 60Hz Electronic Ballast	set
1103(9)a3	Emergency Light, with self-contained battery, LED 2 X 1 WATTS Lead Head, 120-277 vac, 60Hz	set
1103(12)a1	Floodlight 150watts, 230V, Metal Halide	set
1103(12)a2	Post Lamp w/ bulb Street Galv. Pole 9.15m ht. w/ 130 watts LED Luminaire	set
1104.21.1	Diesel Generator Set	set
1104.22	Motor Starting Panel	ls
1104.23	Electrical Manhole, 1100 x 1100 mm	ea
1104.24	Grounding rod, 20 mm dia. x 3m w/ clamp	ea
1104.25	Cadweld connector	ea
1104.26	Dry Type Transformer, 750 kva, 460v/230v	set
1104.27	Transformer, 750 kva 34.5kv/460v	set
1104.28	Ground well, 200 x 300 mm	ea
1104.29	Telephone outlet	set
1104.30	Exhaust Fan, ceiling cassette	set
1104.31	Motor Control Center w/ Main , Branch Breakers and Motor Starter Controllers Main 1000AF/1000AT 460V 3Phw/ 6 -225AF/175AT branches in NEMA 1 Enclosure (Free standing)	set
1104.32	Motor Control Center w/ Main , Branch Breakers and Motor Starter Controllers Main 225AF/150AT 460V 3Phw/ 1-100AF/70AT, 4-100AF/40AT branches in NEMA 1 Enclosure (Free standing)	set
1104.33	Dry Type Transformer, 350 KVA, 460V/230V, 3PH, 3W, 60HZ	set
1104.34	Transformer, 850 KVA, 13.2kv/230V, 3PH, 3W, 60HZ (oil Immersed type)	set
1104.35	Telephone Terminal Cabinet	set

ITEM 1103 INTERIOR LIGHTING

1103.1 Description

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1103.1a American National Standards Institute (ANSI)

ANSI C78.1381 (1989; R 1997) Electric Lamps - 70-Watt M85 Metal-Halide Lamps

ANSI C82.2 (1984; R 1995) Fluorescent Lamp Ballasts - Methods of Measurement

1103.1b American Society for Testing And Materials (ASTM)

ASTM A366/A366M (1997) Commercial Steel (CS) Sheet, Carbon, (0.15 Maximum Percent) Cold-Rolled E1-1998

ASTM A580/A580M (1998) Stainless Steel Wire

ASTM A641/A641M (1998) Zinc-Coated (Galvanized) Carbon Steel Wire

ASTM A653/A653M (2000) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1103.1c Illuminating Engineering Society of North America (IES)

IES LHBK (1993) Lighting Handbook, Reference and Application

1103.1d Institute of Integrated Electrical Engineers Of The Philippines (IEEE)

IIEE PEC Philippine Electrical Code

1103.1e National Electrical Manufacturers Association (NEMA)

NEMA C78.41	(1995) Electric Lamps - Low-Pressure Sodium Lamps
NEMA C78.1377	(1996) Electric Lamps - 175-Watt, M57 Single-Ended Metal-Halide Lamps
NEMA C78.1382	(1996) Electric Lamps - 100-Watt M90 Single-Ended Metal-Halide Lamps
NEMA C78.1384	(1997) Electric Lamps - 150-Watt M102 Single-Ended Metal-Halide Lamps
NEMA C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA LL 1	(1997) Procedures for Linear Fluorescent Lamp Sample Preparation and the TCLP

1103.1f National Fire Protection Association (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 101	(2000) Life Safety Code

1103.1g Underwriters Laboratories Inc. (UL)

UL 20	(2000; Bul. 1999 and 2000) General-Use Snap Switches
UL 924	(1995; R 1997, Bul. 1999 and 2000) Emergency Lighting and Power Equipment
UL 935	(1995; R 1998, Bul. 1999 and 2000) Fluorescent-Lamp Ballasts
UL 1029	(1994; R 1997, Bul. 2000) High-Intensity-Discharge Lamp Ballasts
UL 1570	(1995; R 1999, Bul. 2000) Fluorescent Lighting Fixtures
UL 1572	(1995; R 1999, Bul. 2000) High Intensity Discharge Lighting Fixtures

1103.2 RELATED REQUIREMENTS

"Basic Electrical Materials and Methods," applies to this section, with the additions and modifications specified herein. Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 1104, "Interior Exterior Lighting."

Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

1103.3 DEFINITIONS

1103.3.1 Average Life

Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

1103.3.2 Total Harmonic Distortion (THD)

The root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1103.4 SUBMITTALS

1103.4.1 Submit the following:

a. Product Data

1. Fluorescent lighting fixtures

2. Fluorescent electronic ballasts

3. Fluorescent electromagnetic ballasts

4. Fluorescent lamps

5. Emergency lighting equipment

b. Samples

a. Lighting fixtures, complete with lamps and ballasts

c. Test Reports

a. Operating test

Submit test results as stated in paragraph entitled "Field Quality Control."

d. Operation and Maintenance Data

a. Lighting Control System

Submit operation and maintenance data as specified herein, showing all control modules, light fixtures, and all interconnecting control wire, conduit, and associated hardware.

1103.5 QUALITY ASSURANCE

1103.5.1 Fluorescent Electronic Ballasts

Submit ballast catalog data as required in the paragraph entitled "Fluorescent Lamp Electronic Ballasts" contained herein. As an option, submit the fluorescent fixture

manufacturer's electronic ballast specification information in lieu of the actual ballast manufacturer's catalog data. This information shall include published specifications and sketches, which covers the information required by the paragraph entitled "Fluorescent Lamp Electronic Ballasts" herein. This information may be supplemented by catalog data if required, and shall contain a list of vendors with vendor part numbers.

1103.5.2 Lighting Fixtures, Complete With Lamps and Ballasts

Submit one sample of each fixture type and large order item for inspection, review, and approval. The sample shall be retained for comparison against the remainder of the fixtures. The sample may be used in the final fixture installation.

1103.6 ELECTRONIC BALLAST WARRANTY

Furnish the electronic ballast manufacturer's warranty. The warranty period shall not be less than 5 years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage shall not exceed 12 months, thereby permitting 4 years of the ballast 5 year warranty to be in service and energized. The warranty shall state that the malfunctioning ballast shall be exchanged by the manufacturer and promptly shipped to the using Owner facility. The replacement ballast shall be identical to, or an improvement upon, the original design of the malfunctioning ballast.

1103.2 Material Requirements

1103.2.1 FLUORESCENT LIGHTING FIXTURES

UL 1570. Fluorescent fixtures shall have electronic ballasts unless specifically indicated otherwise.

1103.7.1 Fluorescent Lamp Electronic Ballasts

The electronic ballast shall as a minimum meet the following characteristics:

a. Ballast shall comply with UL 935, NEMA C82.11, and NFPA 70 unless specified otherwise. Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.

b. Power factor shall be 0.95 (minimum).

c. Ballast shall operate at a frequency of 20,000 Hertz (minimum).

d. Ballast shall have light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ballast shall have 10 percent flicker (maximum) using any compatible lamp.

e. Ballast shall be UL listed Class P with a sound rating of "A."

f. Ballast enclosure size shall conform to standards of electromagnetic ballasts. Ballast shall have circuit diagrams and lamp connections displayed on ballast packages. Ballast shall operate lamps in a parallel circuit configuration that permits the operation of remaining lamps if one or more lamps fail or are removed.

g. Ballast shall operate in an instant start mode.

h. Electronic ballast shall have a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled "Electronic Ballast Warranty" herein.

1103.7.2 T-8 Lamp Ballast

a. Ballast shall be capable of starting and maintaining operation at a minimum of 10 degrees C for F32T8 lamps, unless otherwise indicated.

b. Total harmonic distortion (THD): Shall be 10 percent (maximum).

c. Input wattage.

(1) 32 watts (maximum) when operating one F32T8 lamp.

(2) 62 watts (maximum) when operating two F32T8 lamps

1103.7.3 Fluorescent Electromagnetic Ballasts

UL 935. Ballasts shall be high power factor type (0.9 minimum), and shall be designed to operate on the voltage system to which they are connected. Ballasts shall be Class P and shall have sound rating "A". Electromagnetic ballasts for T-8 lamps shall be energy saving. Fixtures and ballasts shall be designed and constructed to limit the ballast case temperature to 90 degrees C when installed in an ambient temperature of 40 degrees C.

1103.7.4 Electromagnetic Energy-Saving Ballasts

NEMA C82.1. Provide energy-saving fluorescent ballasts of the CBM certified full light output type. Ballasts shall have an average input wattage of 40 or less when operating one 32-watt F32T8 lamp tested in accordance with ANSI C82.2 methods. Provide ballasts which are compatible with energy-saving lamps.

1103.7.5 Electromagnetic Ballasts for Compact Fluorescent Lamps

Provide electromagnetic ballasts for compact fluorescent lamps.

1103.8 Fluorescent Lamps

a. T-8 rapid start lamps shall be rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 minimum, color temperature of 3500 K, and an average rated life of 20,000 hours.

b. T-8 rapid start lamp, 17 watt maximum, nominal length of 610 mm, 1300 initial lumens, CRI of 75 minimum, color temperature of 3500 K, and an average rated life of 20,000 hours.

Average rated life is based on 3 hours operating per start.

1103.9 Compact Fluorescent Fixtures

Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Providing assemblies designed to retrofit

incandescent fixtures is prohibited except when specifically indicated for renovation of existing fixtures. Fixtures shall use lamps as indicated.

1103.10 Open-Tube Fluorescent Fixtures

Provide with self-locking sockets, or lamp retainers two per lamp. Provide lamps with shatter resistant coating, non-yellowing, nominal thickness of 0.38 mm, and with 97 percent minimum light transmission.

NEMA C78.42 wattage

****
NOTE: Metal-halide lamp safe operation requires lamps to be turned off at least 15 minutes per week or lamp may rupture near the end of its expected life. Lamp rupture may discharge glass and extremely hot quartz (greater than 900 degrees C) into the surrounding area. Therefore, designs for metal-halide lamps shall include weekly turnoff instructions when continuously operated, 24 hours per day, 7 days per week. These instructions shall be detailed on the drawings for posting at the control locations. For indoor use, color rendition index (CRI) and color temperature (CCT) may need to be specified.
****
1103.11 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated.

1103.12 Emergency Lighting Unit

Provide as indicated. Emergency lighting units shall be rated for 12 volts, except units having no remote-mounted lamps and having no more than two unit-mounted lamps may be rated 6 volts. Equip units with brown-out sensitive circuit to activate battery when ac input falls to 75 percent of normal voltage and 15 minute time delay feature for areas with HID lighting. Provide integral self-testing module.

1103.3 Construction Requirements

The work to be than under this division of specifications consists of the fabrication, furnishing, delivery and installation, complete in all details of the electrical works, at the subject premises and all work materials incidental to proper completion of the installation, except those portions of the work which are expressly stated to be done by other fields. All works shall be done in accordance with the rules and regulations and with the specifications.

1103.3.1 INSTALLATION

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Installation shall meet requirements of NFPA 70. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures.

Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed fixtures may be supported from suspended ceiling support system ceiling tees when the ceiling system support wires are

provided at a minimum of four wires per fixture and located not more than 150 mm from each corner of each fixture.

For recessed fixtures, provide support clips securely fastened to ceiling grid members, a minimum of one at or near each corner of each fixture. For round fixtures or fixtures smaller in size than the ceiling grid, provide a minimum of four wires per fixture and locate at each corner of the ceiling grid in which the fixture is located.

Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently or with at least two 19 mm metal channels spanning, and secured to, the ceiling tees. Provide wires for lighting fixture support in this section.

1103.14 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.

1100.7 Specifications on Lighting fixtures and lamp

All lighting fixtures and lamps are as specified and listed on lighting fixture schedule.
For fluorescent lamp, it shall be 40- watt rapid start cool-white. All fluorescent ballast shall be 230 volt, high power factor, of good quality materials and approved by the Philippine National Standards (PNS),

1100.8 Auxiliary Systems

All auxiliary systems such as telephone and intercom system, time clock system, fire alarm system and public address/nurse's call, paging system installations shall be done in accordance with the approved design.

All materials to be used shall conform to the Philippine National Standards (PNS).

Important requirement regarding supervision of the work and submission of certificate of completion.

All wiring installation herein shall be done under the direct supervision of a licensed Electrical Engineer at the expense of the Contractor. The contractor shall submit the certificate of completion duly approved by the owner's representative.

All grounding system installation shall be executed in accordance with the approved plans.

Grounding system shall include building perimeter ground wires, ground rods, clamps, connectors, ground wells and ground wires taps as shown in the approved design.

1100.10 Test and Guarantee

Upon completion of the electrical construction work, the contractor shall provide all test equipment and personnel and to submit written copies of all test results.

The contractor shall guarantee the electrical installation are done in accordance with the approved plans and specifications. The contractor shall guarantee that the electrical system are free from all grounds and from all defective workmanship and materials and

will remain so for a period of one year from date and acceptance of works. Any defect shall be remedied by the Contractor at his own expense.

1100.4 Method of Measurement

The method of measurement for the interior lighting, and appurtenances shall be measured as prescribed in the Bill of Quantities.

1100.5 Basis of Payments

The accepted quantity, measured as prescribed in Section 1100.4, Method of Measurement, shall be paid for at the contract unit price, which price and payment shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1103 (1)	Fluorescent lighting fixtures w/ electronic ballast, 2-40 watts (Surface mounted)	set
1103 (2)	Fluorescent lighting fixtures w/ Electronic Ballast, 1-40 watts box type, surface mounted	set
1103 (3)	LED Bulb w/Medium Base, Keyless Type, Porcelain Receptacle Outlet , 10 watts	set
1103 (4)	Down Light / Pinlight Fixture w/LED (203mmØ) 9 watts to 12 watts	set
1103 (5)	Self -contained emergency light pack, non-maintained 3hrs. duration w/ quartz halogen lamps, 2-10 watts, 230 volts	set

ITEM 1104 EXTERIOR LIGHTING

1104.1 Description

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.1.1American National Standards Institute (ANSI)

ANSI C78.1381 (1989; R 1997) Electric Lamps - 70-Watt M85 Metal-Halide Lamps

ANSI C82.4 (1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

1.1.2American Society for Testing and Materials (ASTM)

ASTM A123/A123M (2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153/A153M (2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware - AASHTO No.: M232

ASTM B108 (1999) Aluminum-Alloy Permanent Mold Castings

1.1.3Illuminating Engineering Society of North America (IES)

IES LHBK (1993) Lighting Handbook, Reference and Application

1.1.4Institute of Electrical and Electronics Engineers, Inc. (IEEE)

IEEE C2 (1997) National Electrical Safety Code (ANSI/IEEE)

IEEE C136.3 (1995) Roadway Lighting Equipment - Luminaire Attachments

IEEE C136.10 (1996) Roadway Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing

1.1.5Institute Of Electrical Engineers of the Philippines (IIEE)

IEEE (PEC) Philippine Electrical Code

1.1.6National Electrical Manufacturers Association (NEMA)

NEMA C78.41 (1995) Electric Lamps - Low-Pressure Sodium Lamps

NEMA C78.42 (1995) Electric Lamps - Guidelines for High-Pressure Sodium Lamps

NEMA C78.1377 (1996) Electric Lamps - 175-Watt, M57 Single-Ended Metal-Halide Lamps

NEMA ICS 2 (1993) Industrial Control and Systems Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC

NEMA ICS 6 (1993) Industrial Control and Systems Enclosures

1.1.7 National Fire Protection Association (NFPA)

NFPA 70 (1999) National Electrical Code

1.1.8Underwriters Laboratories Inc. (UL)

UL 773 (1995; R 2000) Plug-In, Locking Type Photocontrols for Use with Area Lighting

UL 773A (1995; R 1999) Nonindustrial Photoelectric Switches for Lighting Control

UL 1029 (1994; R 1997, Bul. 2000) High-Intensity-Discharge Lamp Ballasts

UL 1572 (1995; R 1999, Bul. 2000) High Intensity Discharge Lighting Fixtures

1104.2 Material Requirements

"Basic Electrical Materials and Methods," applies to this section, with the additions and modifications specified herein.

1104.3 DEFINITIONS

1104.3.1 Average Life

Time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

1104.4 SUBMITTALS

1104.4.1 Submit the following:

a. Shop Drawings

1. Luminaire drawings
2. Poles

b. Product Data

1. Luminaires
2. Lamps
3. Lighting contactor
4. Photocell switch
5. Steel poles
6.Brackets

c. Samples

1.Luminaires

Submit one sample of each luminaire type, complete with lamp and ballast. Sample will be returned to the Contractor for installation in the project work.

d. Test Reports

1.Test Data for luminaires

e. Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

1104.5 QUALITY ASSURANCE

1104.5.1 Drawing Requirements

1104.5.2 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and

minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

1104.5.3 Poles

Include dimensions, wind load determined in accordance with AASHTO LTS-3, pole deflection, pole class, and other applicable information.

1104.5.4 Test Data for Luminaires

a. Distribution data according to IES classification type as defined in IES LHBK.

b. Computerized horizontal illumination levels in lux at ground level, taken every 3050 mm. Include average maintained lux level and maximum and minimum ratio.

1104.6 DELIVERY, STORAGE, AND HANDLING

1104.6.1 Poles

Do not store poles on ground. Support poles so they are at least 305 mm above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1104.6.1.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 1639, "Interior Distribution System". Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 1651, "Interior Lighting."

1104.6.1.2 LUMINAIRES

Provide luminaries as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

1104.6.1.3 Lamps

Light Emitting Diode (LED)) Lamps, 95 ~ 107 watts

IP 66 rated LED light with three different surge protection options provide a minimum of IEEE/ANSI C6241 Category 6 (10kV/5kV) protection. LED light engines are rated 100,000 hours at 25 deg. Centigrade. Saves an expected 40 - 60% over comparable HID luminaires.

Light Emitting Diode (LED) Lamps, 150 watts JHBL IP rated high bay

For under carriage application, a non-class 2 drivers standard for maximum life at high temperature. IP 65 rated suitable for use in ambient temperatures from -40 deg. Fahrenheit (-40 deg. Centigrade) to 133 deg. Fahrenheit (55 deg. Centigrade).

1104.7 LIGHTING CONTACTOR

NEMA ICS 2, electrically held contactor. Contacts shall be rated 240 volts, 30 amperes, and 2 poles. Coils shall be rated 240 volts. Contactor shall have silver alloy double-break contacts and shall require no arcing contacts. Provide contactor with hand-off-automatic selector switch. Contactor shall be hermetically sealed.

1104.8 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 240 volts ac, 60 Hz with single-throw contacts for mechanically held contactors rated 1000 watts. Switch shall turn on at or below 32 lux and off at 22 to 107 lux. A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Provide switch:

a. In a high-impact-resistant, non-corroding and nonconductive molded plastic housing with a fixture mounted, locking-type receptacle conforming to IEEE C136.10 and rated 1800VA, minimum.

1104.9 POLES

Provide poles designed for wind loading of 161 km/hr determined in accordance with AASHTO LTS-3 while supporting luminaires having effective projected areas indicated. Poles shall be anchor-base type designed for use with underground supply conductors. Poles shall have oval-shaped hand hole having a minimum clear opening of 65 by 130 mm. Handhole cover shall be secured by stainless steel captive screws.

1104.9.1 Steel Poles

AASHTO LTS-3. Provide steel poles having minimum 11-gauge steel with minimum yield/strength of 331 MPa and hot-dipped galvanized in accordance with ASTM A123/A123M factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 248 MPa.

1104.9.2 Pole Foundations

Anchor bolts shall be steel rod having a minimum yield strength of 344.5 MPa; the top 305 mm of the rod shall be galvanized in accordance with ASTM A153/A153M.

1104.9.3 Installation of Poles

IEEE C2, NFPA 70, and to the requirements specified herein.

1104.9.4 Steel

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad at the bottom end. Provide galvanized nuts, washers, and ornamental covers for anchor bolts. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location. After installation, paint exposed surfaces of steel poles with two finish coats.

1104.9.5 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations. Set adjustable window slide for 32 lux photocell turn-on.

1104.10 GROUNDING

Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures.

1104.11 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that the equipment operates in accordance with the requirements of this section.

1104.4 Method of Measurement

The method of measurement for the exterior lighting, and appurtenances shall be measured as prescribed in the Bill of Quantities.

1104.5 Basis of Payments

The accepted quantity, measured as prescribed in Section 1104.4, Method of Measurement, shall be paid for at the contract unit price, which price and payment shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the item.

Pay Item Number	Description	Unit of Measurement
1104(1)	High Bay Aluminum Reflector, Dome Luminaire 150 watts LED (Surface Mounted)	set
1104(2)	Flood lamp w/ bulb, 150 watts	set

ITEM 1213 – PUBLIC ADDRESS SYSTEM

1213.1 Description

The work includes supply and installation of complete paging system but not limited to power amplifiers, preamplifiers, speakers and related accessories.

1213.1.1 Reference

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

National Building Code
Underwriters Laboratories Inc. (UL) - USA:

UL 864 Standard for Control Units for Fire Protective Signaling Systems
UL 1711 Amplifiers for Fire Protective Signaling Systems

UL 2572 Communication and Control Units for Mass Notification Systems
Other:
NEC Article 250 Grounding
NEC Article 300 Wiring Methods
NEC Article 760 Fire Protective Signaling Systems
Compliant with Unified Facilities Criteria UFC 4-021-01

1213.1.2 Submittals

1. Two copies of all submittals shall be submitted to the Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

A. Manufacturer's Data

Submit manufacturer's data for all materials and equipment to be incorporated in the work, as follows:

a. Power Amplifier;
b. Pre-Amplifier;
c. Radio AM/FM,
d. CD Player,
e. Selector Switches;
f. Ceiling Speaker;
g. Wall Type Speaker;
h. Desk Top Microphone; and
i. Other equipment necessary to complete the paging system

B. Shop Drawings

Submit shop drawings for the overall system and for each major component. Drawings shall illustrate how each item of equipment will function in the system and shall include an overall system schematic indicating relationship of intercommunication units on one diagram.

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

3. Show system layout, configurations, and terminations.

Operating and Maintenance Instructions

Six bound sets of instructions for operating and maintenance shall be furnished.

C. Manuals:

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.

2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.

3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

1213.2 Material Requirements

Equipment and components of program distribution and paging systems shall conform to applicable requirements of Article 810, NFPA 70. The system shall be an integrated design of a single manufacturer and shall consist of amplifier, pre-amplifier, control panel, speakers, microphone, and interconnecting cables complete with rack and supports. All speakers shall operate from a 70-volt distribution system.

(a) Provide pre-amplifier/mixer either separately or as an integral part of power amplifier. If separate, it shall be completely self-contained, requiring only a 240 VAC power source. Pre-amplifier shall employ only solid-state devices

1213.2.1 Performance characteristics.

(1) Inputs: microphone-low impedance, 150 ohms nominal auxiliary-high impedance, 500,000 ohms or greater;
(2) Frequency Response: 20-20,000 Hz ± 2db.
(3) Total Harmonic Distortion: 1 percent or less at rated output.
(4) Output Noise Level: minimum 60 db below rated output.
(5) Output: shall be sufficient to drive power amplifier to rated output.
(6) Controls: On/Off switch with “Power On” indicator lamp or LED Master Gain (Rotary)
(7) Individual gain per input (Rotary);
(8) All controls shall be front panel mounted.

(b) Power amplifier shall employ only solid-state devices. Performance characteristics are as follows:

(1) Power Output: As indicated.
(2) Frequency Response: 100-10,000 Hz, + 3db.
(3) Signal to Noise Ratio: 60 db or greater at rated output.
(4) Total Harmonic Distortion: less than 3 percent at rated output.
(5) Controls: On/Off switch with “Power On” indicator lamp or LED Volume (Rotary). All controls shall be panel-mounted.
(6) Power requirements: 240 VAC, 60 Hz.

(c) Provide ceiling and wall type speakers with the following ratings and features:

(1) Sensitivity (Sound Pressure): 92db minimum, measured at 1-watt input, 1.2 meters on axis.
(2) Frequency Response: 80 to 12,000 Hz ± 3 db.
(3) Dispersion: 90°.
(4) Transformer with 4-level taps: 1.5, 5, 10 watts.
(5) Minimum 20 gauge steel or aluminum back boxes of acoustically damped construction. Provide for relief of backpressure. Assembly shall be rust proofed.
(6) Suitable speaker grille for recessed mounting to provide a flush appearance; shall be made of minimum 20-gauge steel or aluminum.
(7) One-inch voice coil.

Provide horn type speakers with ratings as indicated.

1213.2.2 AM/FM Equipment

AM/FM tuner shall be rack-mounted and shall as a minimum, conform to the following characteristics:

a. Tuning Range: AM - 540 to 1605 kHz
FM - 88 to 108 MHz

b. Selectivity: 60 dB on FM
40 dB on AM

c. Sensitivity: FM- 1.5 microvolts
AM- 2.0 microvolts
Capture ratio: 1.0 dB

d. Power requirement: 240 VAC, 60 Hz.

1213.2.3 Compact Disc Player

Player shall have three beam laser pickup, dual digital to analog converter, random access and random mode programmable playback. Player shall have as a minimum conform to the following:

a. Frequency: 10-20kHz ± 1 dB
b. Signal-to Noise: 100 dB minimum
c. Dynamic Range: 96 dB minimum
d. THD: 0.007% maximum at 1 kHz
e. Channel Separation: 90 dB minimum at 1 kHz
f. Quantization: 16 bits minimum linear per channel
g. Conversion rate: 4 minimum x over-sampling
h. Disc size: 5 and 3-inch

Provide microphone suitable for desk mounting. Performance characteristics:

a. Type: Dynamic
b. Impedance: Low impedance, 150 ohms nominal.
c. Frequency Response: 60 to 12,000 Hz.
d. Output Level: 58db minimum.
e. Four zones selector switches with indicating lights.

D. Software Modifications

1. Provide the services of a qualified technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.

2. Provide all hardware, software, programming tools and documentation necessary to modify the Public Address System on site. Modification includes addition and deletion of messages, circuits, zones and changes to system operation. The system structure and software shall place no limit on the type or extent of software modifications on-site.

E. WARRANTY:

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain covered for a period of at least one (1) year from the date of acceptance and turnover. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.5. MAINTENANCE:

A. Maintenance and testing shall be on a semi-annual schedule or as required by the local provider. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The Public Address System shall be tested in accordance with the requirements of NFPA 72.

A. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the warranty.

B. EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a fire protective signaling system, meeting the latest National Electrical Code of the Philippines.

1213.3 Construction Requirements

1213.3.1 INSTALLATION

a. Power Wiring

Provide power wiring, raceway, and outlet boxes for intercommunications system as specified in Section 16402, "Interior Wiring Systems."

b. Control Circuit Wiring

Install control circuits in accordance with PEC 2000 and as indicated. Provide type of control circuit wire and number of conductors as recommended by inter communication system manufacturer.

c. Signal Wiring

Wire speakers with 1.5mm² twisted pair wire. Provide shielding if required by manufacturer. Microphone wiring shall be as recommended by equipment manufacturer.

d. Backboxes

Provide backboxes having characteristics suitable for speakers mounted in them.

e. Mobility

System sub-assemblies shall be capable of relocation by running new cables to applicable junction box, patch-board or control unit.

f. Weatherproofing

Weatherproof all units mounted outdoors or subject to increment conditions.

1213.3.2 FIELD TESTS

Conduct testing specified herein in the presence of the Owner.

1213.3.2.1 Intercommunication System Tests

An operational system test shall be performed to verify conformance of intercommunication system to this specification. The Contractor shall notify the Owner two (2) weeks prior to when tests are to be performed so that Owner shall witness tests. These tests shall include originating and receiving messages at specified stations, at proper volume levels, without cross talk or noise from other links or non-designated units.

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72.

1213.3.2.2 Re-testing

Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense.

1213.3.3 INSPECTION:

Make observation to verify that units and controls are properly labeled, and interconnecting wires and terminals identified. Owner shall observe system features specified.

1213.3.4. INSTRUCTION:

(a) Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

(b) The contractor or installing dealer shall provide a user manual indicating "Sequence of Operation."

1213.4 Method of Measurement

The method of measurement for the Public Address System, and appurtenances shall be measured as prescribed in the Bill of Quantities.

1213.5 Basis of Payments

The accepted quantity, measured as prescribed in Section 1213.4, Method of Measurement, shall be paid for at the contract unit price, which price and payment shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the item.

Pay Item Number	Description	Unit of Measurement
1213	Public Address System	set

ITEM 1212 CLOSED CIRCUIT TV SYSTEMS (CCTV)

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL CABLE AND TELECOMMUNICATIONS ASSOCIATION (NCTA)

NCTA RP	(2003) NCTA Recommended Practices for Measurements on Cable Television Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA OS 1	(2008; Amd 2010) Standard for Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 76.605	Technical Standards

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jul 2012) Standard for Flexible Metal Conduit
UL 1581	(2001; Reprint Aug 2013) Electrical Wires, Cables, and Flexible Cords
UL 1660	(2004; Reprint Apr 2013) Liquid-Tight Flexible Nonmetallic Conduit
UL 1666	(2007; Reprint Jun 2012) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 360	(2013; Reprint May 2013) Liquid-Tight Flexible Steel Conduit
UL 5	(2011) Surface Metal Raceways and Fittings
UL 514B	(2012) Conduit, Tubing and Cable Fittings
UL 514C	(1996; Reprint Nov 2011) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 651	(2011; Reprint Mar 2012) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 651A	(2000; Rev thru Sep 2007) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 98	(2004; Rev thru Apr 2006) Enclosed and Dead-Front Switches
UL 969	(1995; Reprint Nov 2008) Standard for Marking and Labeling Systems

1212.1 Description

The Contractor shall install a complete CCTV system as shown on the plans and Drawings.

The work includes supply and installation for the complete Close Circuit Television System, but not limited to cameras, camera enclosure, relay box, remote controller, cabling system, and related accessories.

Closed circuit television system, commonly referred to as CCTV, also known as video surveillance is the use of video cameras to transmit a signal to a specific place, on a limited set of monitors. It differs from broadcast television in that the signal is not openly transmitted, though it may employ point to point (P2P), point to multipoint (P2MP), or mesh wired or wireless links. Though almost all video cameras fit this definition, the term is most often applied to those used for surveillance in areas that may need monitoring such as banks, stores, and other areas where security is needed.

1212.1.1 Submittals

1212.1.1.1 Manufacturer's Data

Submit manufacturer's data for all materials and equipment to be incorporated in the work.

1212.1.1.2 Shop Drawings

Submit shop drawings for the overall system and each major component. Drawing shall illustrate how each item of equipment will function, system schematic diagram, one line diagram and equipment layout.

1212.1.1.3 Operation and Maintenance

Submit three copies of operating and maintenance manual.

1212.1.2 Material Requirements

1212.1.3 Product

DVR should be extremely reliable, easy-to-install digital video recorder that delivers essential video recording features in an economical package. The units must utilize a chassis no larger than two rack units in height, and be suitable for either a desktop situation or mounting into a standard 19" equipment rack. The unit must feature power recovery upon interruption, and an operation status record log. The Digital Video Recorder shall feature full triplex operation to allow for simultaneous live or playback viewing and recording operations. It shall be available in four, nine, and sixteen channel configurations, all with a minimum of two audio channels. All configurations must be offered in 80GB, 160GB, 320GB, or 640GB hard drive capacities. The DVR must include a Main Monitor output to display the video in full-screen format, multi-screen format, or sequential format. The system must also have a Call Monitor output to display any selected camera in fullscreen call up, sequential display, and alarm call up operations. The front panel must provide immediate control of all recording, searching, and management functions, as well as controlling PTZ cameras. A minimum of the following manufacturer's PTZ cameras must be compatible:

The Digital Video Recorder must offer the following dome control functions from the front panel:

Select Preset number, Go to Preset, Set Preset, Focus Near, Focus Far, Tilt Up, Tilt Down, Pan Left, Pan Right, Iris Open, Iris Close, Zoom In, Zoom Out, Display PTZ Hint

It shall be compatible with the Touch Tracker Series dome controller.

The Digital Video Recorder must be able to easily be added to an existing network via

TCP/IP or viewed via a web browser to search for video, monitor and configure cameras, and receive alarm notifications from a remote workstation using a built-in web server. Up to eight users shall be allowed to simultaneously connect to the unit using the Viewer.

It shall include a minimum of four live viewing modes, to include, but not necessarily be limited to; basic live view, freeze, 2X digital zoom, and custom sequencing. In addition, the user must be able to set up to eight recording schedules, and play back the recorded video in speeds ranging from 1/100 to 100X the original speed.

The Digital Video Recorder shall offer highly refined search capability, with multiple search modes and conditions that include event lists, time, alarm lists, and filters. To make it quick and easy to find specific video clips, the ability to utilize thumbnail searches with eight different time intervals must be available. In addition, the unit must support adjustable motion detection and covert cameras for enhanced security. The adjustable motion detection conditions shall include sensitivity, target area, target size, motion duration, and track direction.

The Unit must include both a built-in CD-RW and Secure Digital (SD) card slot to archive a still image (JPEG), archive .AVI format video clips, backup system settings, and update system software. Unalterable digital signatures of recorded video shall ensure the image authenticity.

1212.1.4 Performance Specifications – DVR

The DVR system shall meet the following minimum performance specifications:

System Design	Non PC-based, embedded operating system with DSP hardware and upgradeable system firmware
Archiving	80 GB, 160 GB, 320 GB and 640 GB Hard Drive (Full/Alarm/Select); SD memory card (.JPG or .AVI format); CD-RW Video Input
Video Input	1.0 Vpp (signal 714mV, sync 286mV) 75 ohms (BNC unbalanced)
AGC Range:	0.5~2.0 Vpp
Chrominance:	0.286 Vpp
Color sub-carrier lock range:	200Hz
Video Output Level	1.0 Vpp ± 10%, 75 ohms (BNC unbalanced)
Video Output Frequency	3dB ± 1dB at 3 MHz 30 IPS NTSC/25 ips PAL, best recording Mode
Video Output Burst Level	286mv ± 10% or Vector ± 10°
Compression Pixel qty	720 x 240 NTSC (720 x 288 PAL)
Impedance	75 ohms/Hi-impedance x 16 switchable
Number of Audio Tracks	Two
Audio Compression	8/22/44 kHz sampling, µ-law
Audio Input	10k ohms, 2.6Vp-p (RCA)
Audio Output	1k ohms, 2.6Vp-p, 100~2k Hz (RCA)
Audio Output Level	-15dBs ± 4dBs (input –8dBs 1kHz sine wave)
work Interface	Ethernet (RJ-45, 10/100M)
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/PTZ control/System Setup Serial Port, RS-232, RS-485–variable bit rate from 1200 up to 115200 bps, 8 data bits, no parity, 1 stop bit. RS-485 signals are provided to the rear panel with a push-in type terminal block connector.
Recording Rate	60 ips for 720 x 240 (NTSC) / 50 ips for 720 x 288 (PAL)
Password Protection	Menu Setup, Remote Access
Software Upgrade	Via SD memory card
Picture Compression	M-JPEG
Recording Capacity	80, 160, 320 or 640 GB (1 or 2 fixed HDD) 1 CD-RW
Memory Card	Supports SD memory card
Features Access	Via front panel, client software or web browser
Composite Monitor Outputs	Main and Spot
Controller Compatibility	AD Touch Tracker

1212.1.5 Minimum Electrical Requirements

The DVR system should meet the following minimum requirements:

a. Electrical Power

(1) Power Supply (Adapter)	Input: 100-240 VAC, 47-63 Hz, Output: 12 VDC, 5 A
(2) Power Consumption	33 Watts (12 VDC, 3A) without Hard Drive; Up to 55 Watts (12 VDC, 3 A) with Hard Drive
(3) Power Interrupt	Auto recovery to recording mode

b. Physical Dimensions

(1) Unit Dimensions (WxHxD)	430 x 55 x 405 mm (17 x 2 x 16 in)
(2) Unit Weight	15.45 lbs/34.06 kg (two hard drives)

c. Environmental

(1) Operating Temperature	5°C to 40°C (41°F to 104°F)
(2) Humidity	30% to 80%
(3) Storage Temperature	-20°C to 60°C (-4°F to 40°F)

d. Regulatory

(1) Emissions	FCC 15b, Class B EN55022 1998/A1: 2000/A2:2003 Class B EN61000-3 2:1995/A1:1998/A2:2003 EN61000-3-3:1995/A1:2001
(2) Immunity	EN50130-4 (1996)
(3) Safety	CE UL 60950-1 TUV EN 60950-1: 2001+A11 C-Tick Australia PSE Japan

1212.1.6 Minimum Specifications for Client Software

The client software for the DVR system shall meet the following minimum specifications:

a. Processor	Intel-Pentium, 4MHz
b. Memory	512 MB RAM Operating
c. System Windows® 2000, and XP	
d. Video Card	64 MB of RAM capable of 32- bit true color display
e. Free Hard Disk Space	160 MB for software installation
f. Network Card	10Base-T network for LAN operation

1212.1.7 Dome Fix Camera Description

The Discover™ dome contains either a high-resolution, high resolution wide dynamic range, or standard resolution color fixed camera with choice of 2.5-6 mm, 3.8-9.5 mm and 9-22 mm variable focal auto iris lens mounted in a high impact vandal resistant housing.

Performance Specifications

The assembly shall be a low profile housing, which is made from polycarbonate and composite materials with a polycarbonate viewing bubble.

a. The vandal resistant housing and camera.

b. Within the housing there shall be a mounting bracket with a gimbal arrangement to allow adjustment of the camera in the x, y and z-axis. The gimbals shall have locking screws to resist movement once the camera is adjusted.

c. The housing shall include tamper resistant fasteners to prevent entry without a special tool. Tamper resistant fasteners shall be pin-in Torx Type.

d. Installed within shall be a high-resolution, high resolution wide dynamic range or standard resolution fixed camera with choice of 2.5-6 mm, 3.8-9.5 mm and 9-22 mm variable focal auto iris lens.

e. The housing shall be mountable in two base configurations: surface mount dome and flush mount dome.

f. Optional wall, pendant, inside corner, external corner, pole and electrical box mounting options will also be available.

g. The housing shall include a threaded hole for ¾" conduit in the back, as well as a ½" side entry.

h. The housing shall meet the requirements of NEMA 4X (IP66) for weather resistance. An optional field installed heater shall be available.

i. The housing cover shall include a gasket and retain the fasteners for easier installation. A lanyard shall retain the housing cover to aid installation.

j. The bubble shall meet impact resistance equivalent to 120 pounds (54.4 kg) of force with repeated strikes. The bubble shall have a thickness of 2.5mm (±0.1mm).

k. The high-resolution camera shall be a high-resolution color 1/3-inch CCD type with 540 lines of resolution and light sensitivity of 0.65 lux at F1.2.

l. The camera shall be available in NTSC and PAL formats.

m. Dip-switch settings shall control Night-Saver, White Balance (Normal, Extended), line lock, flickerless mode, backlight compensation and automatic gain control.

n. The Wide Dynamic Range camera shall be a high-resolution color 1/3" Pixim type with 504 lines of resolution and light sensitivity of 0.95 lux at F1.2.

o. The camera shall support NTSC and PAL formats.

p. The camera shall support on screen menu display and shall control Night-Saver, DVR-Saver, White Balance, Wide Dynamic Range, line lock, video format (NTSC, PAL), Digital Slow Shutter, digital zoom and general picture adjustment.

q. The standard resolution camera shall be a high-resolution color 1/3" CCD type with 330 lines of resolution and light sensitivity of 3.0 lux at F1.4. The camera shall be available in NTSC and PAL formats.

r. Three lens options shall include a 2.5-6 mm (F-stop 1.3) variable focal, 3.8-9.5 (F-stop 1.2) variable focal and 9-22 mm (F-stop 1.3) variable focal lens. Each shall feature DC auto iris with level control.

s. The camera shall operate from 12Vdc or 24Vac (60 Hz NTSC or 50 Hz PAL) and draw a maximum of 3 watts.

1212.1.8 PTZ Camera Description

High-speed programmable dome with high resolution DSP6 with Day (color) and Night (black and white) camera modes. Day and Night mode controlled by the removal of an infrared filter. Electronic Image Stabilization compensates for physical movement and vibration of the dome. Has 23X optical zoom and 230X total zoom capability.

Performance Specifications

The dome assembly must be comprised of a high-speed pan/tilt assembly, high-resolution Day (color) or Night (black and white) Mode camera with 230X zoom. The 230X zoom is to be achieved with no less than a 23X optical zoom lens with up to 10X digital zoom magnification. Electronic Image Stabilization feature provides stable images when the dome is subjected to mechanical oscillation or vibration. The camera/lens assembly must provide for continuous, full-time auto focus.

The pan mechanism must incorporate a sealed precision slip ring to provide 360□□of continuous pan rotation. The tilt mechanism must provide for 110□□travel. Precise manual panning and tilting must be achievable through a combination of variable speed operator control (speed ranges) and automatic adjustment of these speed ranges dependent upon zoom factor. Pan and Tilt speeds must range from 0.25 to 100□□per second. Pan and tilt preset positions must be obtained at a speed of 220□□per second. High-speed, DC servomotors must be used to maintain high torque through the entire operating range. These motors must use pulse width modulation and encoder feedback to control the acceleration, speed, and deceleration of the motors to ensure smooth, precise, accurate and fluid movement. The design shall use direct drive motors and no belt to ensure long term reliable operation.
The design of the dome shall not require the use of a bubble indoors to be covert, but should support the option of a clear, smoked, silver or gold bubble.

The dome assembly shall contain a built-in multi-protocol receiver/driver for use with matrix switching systems using one of the following protocols: AD Manchester control code and a single 18 AWG shielded twisted pair (STP) to support up to three daisy chained domes a maximum of 1,500 m (5,000 feet), SensorNet control code and a single 22 AWG unshielded twisted pair (UTP) to support up to 32 daisy chained domes a maximum of 1,000 m (3,200 feet), SEC RS-422 control code and two pairs of 22 AWG shielded twisted pair (STP) cabling to support up to 10 daisy chained domes a maximum of 1,000 m (3,200 feet) or AD-UTC and RG59U video cable to control a dome a maximum of 500 m (1,600 feet). The receiver/driver will provide all voltages for camera controls, pan and tilt functions and all motorized lens functions.

In addition, the dome shall support selected third party protocols for integration to other systems.

The dome must natively support the National Transportation Communications for ITS Protocol (NTCIP) version 1205:2001 v01.08, implemented via the RS422 communication interface.

The dome must include standard support for unshielded twisted pair dome connections, which allow the use of CAT2-6 cabling for transmission of video or video with up-the-coax dome control signals up to 300 meters (1000 feet).

The dome shall support 96 Presets 16 Patterns and 16 Preset Sequences. The dome shall also support a Home Position that automatically returns the dome to a Preset, Pattern or Preset Sequence after a specified period of inactivity, 1-60 minutes. A freeze frame function must be available that maintains a static image on-screen during dome movement and lens adjustment when presets and patterns are called. This freeze frame function helps to preserve hard drive space when a digital video recorder is used.

The dome must support a minimum of eight privacy zones to prevent users from viewing sensitive or secured areas. So as not to interfere with normal surveillance operations, these on-screen “shields” must block out only the area that has been defined as sensitive. The privacy zones should not cause the screen to blank out when the sensitive area is within the camera’s field of view. On the monitor, the privacy zones should appear larger or smaller depending on the camera’s zoom factor.

The dome must support on-screen programming of dome parameters, including proportional flip, direction indicators and azimuth, maximum zoom stop, line-lock or internal crystal synchronization, AGC, white balance, Electronic Image Stabilization (EIS) selection, alarm actions and default states, infrared filter removal threshold, and home position. On-screen programming of dome name, 16 Area names, 96 Preset names, 16 Pattern names and four alarm names must also be provided. All of this on-screen programming, as well as the rest of the on-screen displays must be available in the following languages: English, French, Italian, German, Spanish, and Portuguese.

A DirectSet menu must be to provide easy access to common dome settings when installed with compatible controllers. This DirectSet menu

must provide access to the following features: dome configuration menu, auto iris/auto focus resume, flip, default apple peel pattern, night mode, day mode, auto day/night mode, enable EIS low, enable EIS high, disable EIS, activate smooth scan, activate stepped scan, activate random scan, activate a preset sequence and display the dome information screen.

Password protection must be provided to prevent unauthorized access.

Dome direction indicators and azimuth reading; Dome, Area, Preset, Pattern, Preset Sequence and alarm names; and zoom, focus, and iris status must be displayable on the monitor. All on-screen text character attributes must be user-selectable solid or translucent white, with or without black outline.

On-screen display of dome usage statistics must be available. This usage information must provide a record of the number of pan, tilt, and zoom commands issued by the dome; operating time, time from last reset in seconds and total reset count.

The dome assembly design shall contain a single alarm input standard or four alarm inputs as an option and be field programmable to receive “normally open” or “normally closed” contacts. If operating on a Sensor Net or RS-422 network, the dome shall be capable of receiving the alarm and transmitting the alarm back to the switching system and/or reacting to the alarm event independent of the switching system. If operating on a Manchester network, the dome must be able to process the alarm internally, and automatically activate a Preset, Pattern or Preset Sequence.

The dome assembly shall contain a single auxiliary output standard or four independent auxiliary outputs as an option. Each open collector output must respond as momentary or latching (depending on system capability).

The open collector of each auxiliary shall be required to handle + 12 VDC at a maximum of 40 milliamps.

The complete dome assembly must be capable of operating to full specification with an applied voltage of 18 to 30 VAC at a frequency. The complete dome assembly must be capable of operating to full specification with an applied voltage of 18 to 30 VAC at a frequency of 50 or 60 Hertz and meet Class 2 standards. The power consumption cannot exceed 16 watts with all functions operating. The dome assembly shall have surge protection for the video, communications, power, and alarm connections of 50 or 60 Hertz and meet Class 2 standards. The power consumption cannot exceed 16 watts with all functions operating. The dome assembly shall have surge protection for the video, communications, power, and alarm connections.

The camera shall be a ¼-inch CCD interline transfer device. Day (color) Mode shall provide a minimum horizontal resolution of 470 lines with a usable video signal with a scene illumination of better than 0.5 Lux (20 IRE with AGC on) and 0.03 Lux (with an open shutter selection of 1/4 sec). Night (black and white) Mode shall provide a minimum horizontal resolution of 470 lines with a usable video signal with a scene illumination

of 0.01 Lux (20 IRE with AGC on) and 0.009 Lux (with an open shutter selection of 1/4 sec).

The video output synchronization shall be 2:1 interlace and will observe the NTSC (Daycolor mode) or EIA RS-170 standards. Line-lock with an adjustable vertical phase must also be provided.

The lens must be a color corrected, 3.6-82.8 mm, F1.6 and must have continuous autofocus with manual override. The lens must also have auto-iris with manual iris override. The auto focus and auto iris resume settings shall be configurable via on-screen menu settings.

The dome shall incorporate a twist-lock release base for ease of installation and service. Two versions of the twist-lock base must be available. A standard base will enable the installer to wire directly the dome's housing/eyeball assembly before twisting the assembly onto the base. This standard base option shall support one alarm input and one auxiliary output. A second base that enables the installer to wire the appropriate cables onto an I/O board contained within the twist-lock base must also be available. The I/O base enables wiring to be completed once, and for the housing/eyeball assembly to be connected and disconnected to the twist-lock base without disturbing the wires or connections. This I/O base option shall support four alarm inputs and four auxiliary outputs. Each base will include diagnostic LED's to indicate power and proper communications to and from the matrix.

An installation tool that enables service personnel to connect and disconnect the
housing/eyeball assembly without the use of a ladder or lift must be available. The dome and bases must be available separately so installation of the bases can be accomplished by qualified personnel prior to the purchase of the dome or housing/eyeball assembly. An outdoor housing must also be available and shall provide for the same ease of installation and service.

Upon initial power up and after dome resets, diagnostic tests must be run, including communication loopback, camera loopback, and motor circuit tests. The results of these tests must be displayable on the monitor. After initialization, the dome shall automatically pan, tilt and zoom to its previous position.

1212.3 Construction Requirements

1212.3.1 Installation

All work shall be in accordance with the manufacturer's recommendation.

1212.3.2 Commissioning and Testing

Commissioning and testing shall be carried out on the entire installation, fully carried out in part or as whole in accordance with the requirements of this specification.

1212.3.3 Training

Training shall be provided of the Owner's staff until they are familiar with the operation and maintenance of the complete installation.

1212.4 Method of Measurement

Digital Video Recorder, Closed Circuit TV Camera of the type specified will be measured by the number of set installed and accepted.

Cable / wiring will be not be measured including Testing and Commissioning which will be measured and considered by one (1) lot.

1212.5 Basis of Payment

The quantities accepted as provided in Method of Measurement, shall be paid for at the Contract Unit Price per unit of measurement for each of the Pay Items listed below and shown in the Bill of Quantities, which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

Payment will be made in accordance with the Bill of Quantities.

Pay Item Number	Description	Unit of Measurement
1212	CCTV (including roughing-ins and fittings)	Lump Sum

ITEM 313 - NAVIGATIONAL AID

3.13.1 Description

This section covers the procurement and installation of light beacons for navigational aid. Unless otherwise instructed by the PFDA, the Contractor shall procure and install beacons at the location as indicated on the drawings.

3.13.2 Material Requirements

3.13.2.1 General Description

For reference and guidance, hereunder are the general descriptions of the light beacons to be procured and installed by the Contractor.

3.13.2.2 Description of Navigational Aids

Materials shall conform with the specified material or equivalent.

a. Light Beacons

1) Dimension and Requirement: The beacon shall be 3 meters height with Pole shape complete with lighting equipment.

The body shall be hot dipped galvanized mild steel consisting of:

i) One (1) set man-guard with round section, one (1) piece step ring

and two (2) pieces of step for maintenance.

ii) One (1) piece of weatherproof door for battery space.

2) Weight: Approximately 407 kg

3) Painting: The exterior of the beacon shall be painted with the following:

i) Two (2) primer coats epoxy resin anti-corrosive paint (410 g/m^2 100 microns each).
ii) One (1) under-coat of vinyl resin paint (390 g/m^2, 40 microns).
iii) Three (3) finish coat of tin free anti-fouling paint (680 g/m^2 100 microns each).

The interior of the beacon shall be painted with the following:

i) One (1) shop prier of inorganic zinc silicate alcohol soluble and self-curing paint (115 g/m^2, 15 microns).
ii) Two (2) primer coats of epoxy resin anti-corrosive paint (380 g/m^2, 110 microns each).
iii) Two (21) finish coat of epoxy resin paint (145 g/m^2, 40 microns each).

1) Lighting Equipment: The lighting equipment shall be maintenance free Type. The light source shall be Hi-brilliant Light Emitting Diodes (LED). The lantern base and lid shall be anti-corrosive aluminum alloy covered with polycarbonate resin lens.

The luminous range shall be three (3) miles and over. The equipment shall be engaged to prevent theft.

2) Power Source: The solar module shall be covered by clear tempered glass and fixed by stainless steel flanges. Provide marine type junction box to avoid any water leakage.

Provide stainless wire or approved equal for bird spike.

The battery shall be fully sealed type with over charged-proof device.

3.13.3 Construction Requirements

a. Prior to procurement of light beacons, the Contractor shall submit the manufacturer's catalogue, with detailed information of the product, for approval of PFDA. The Contractor shall carry out detailed hydrographic survey in the vicinity of the place where light beacons are intended to be installed for PFDA's approval. The contractor shall also secure permit/clearance to install the light beacons from the Philippine Coast Guard.

b. After installation, the actual location of light beacons as installed shall again be surveyed and the results thereof shall be submitted to PFDA for his approval.

3.13.4 Measurement and Payment

a) Light Beacon to be installed on causeway or on pier.

Measurement and payment of quantity of light beacons shall be based on the number of sets of light beacon complete installed including reinforced concrete base certified by PFDA.

b) The work includes the furnishing of all labor, materials, and equipment required to install all navigation aids, in accordance with these Specifications and where shown on the Drawings and to the approval of PFDA.

c) The Contractor shall satisfy himself and shall be deemed to have satisfied himself as to the nature of the sub-soil conditions, topographic and hydrographic conditions

d) The Contractor shall be deemed to include in his unit prices allowances to cover all risks, except noted otherwise for any contingencies that may arise during or in connection with the works.

ITEM 104 – BUILDING WORKS

104.1 Description

104.1.1 General

This section specifies minimum requirements of building works without civil works in accordance with the plans and drawing.

104.1.2 Codes and Standards

Work performed under these specifications shall be in accordance with the following codes and standards. Unless otherwise specified, the applicable governing editions and addenda to be used for all references or codes or standards specified herein shall be interpreted to be the jurisdictionally approved editions and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addendum in effect at the date of this document shall apply. These references shall govern the building works only except where they conflict with the specifications.

104.1.3 Test Requirements

The testing shall be conducted in accordance with the specified source below. Testing is to be considered part of the defined scope of work, and all associated costs are the responsibility of the Contractor unless otherwise specifically identified.

1. National Building Code of the Philippines
2. National Structural Code of the Philippines (NSCP 2015, Seventh Edition)
3. "Code of Standard Practice for Steel Buildings & Bridges," AASHTO
4. "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings," American Institute of Steel Construction (AISC)
5. "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use," American Society for Testing and Materials, ASTM A6
6. "Structural Welding Code," American Welding Society, AWS, D1.1
7. "Specifications for Assembly of Structural Joints Using High Strength Steel Bolts" as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (U.S.A.)
8. "Handbook on Bolt, Nut and Rivet Standards," Industrial Fasteners Institute (U.S.A.)

9. "Steel Structures Painting Manual, Volumes 1 and 2, Systems & Specifications," SSPC (Steel Structures Painting Council, U.S.A.).

104.1.4 Submittals

The following, as a minimum, shall be submitted:

1. Manufacturer's literature;
2. Shop drawings; and
3. Certificate of conformance or compliance.

104.2 Material Requirements

104.2.1 Damp Proofing

Damp proofing materials shall be a product of a reputable manufacturer acceptable to the Employer. Material shall conform to the requirements specified below;

Material	Standard
Asphalt	ASTM D449, Type II
Asphalt Primer	ASTM D41
Coal Tar Bitumen	ASTM D450, Type II or Type III.
Creosote	ASTM D43.
Fibrous Asphalt	ASTM D2823
Saturated Felt	ASTM D226, Asphalt Saturated, Type I, (15 pound); ASTM D227, Coal-Tar-Saturated

104.2.2 Cement Plastering

1. Aggregates
   a. Portland Cement Plaster Basecoats: ASTM C144, natural sand; grade per ANSI A42.2
   b. Portland Cement Plaster Finish: ASTM C144.
2. Portland Cement: For uses not otherwise specified: ASTM C150, Type I
3. Water: Potable and free from deleterious material which would impair the Works.

104.2.3 Carpentry and Joinery

1. Materials for carpentry works shall conform to the following specifications and shall be used whenever indicated on the plans or noted in the schedule.

    a. Kinds of Lumber

        i. Yakal- Door jambs, wood plates and all other wood works coming in contact with concrete, masonry or plaster work, with applied wood preservative treating solution.

ii. Apitong - Pressure-treated, for ceiling joists and framings, studs, nailers and other interior framework not visible on the outside.
iii. Tanguile - Kiln-dried, for trims, baseboards, moldings, cabinet works and shelvings of offices, door jambs and casings, and exposed framework of closets and cabinet partitions.

b. Pressured-treated lumber shall contain any of the following net retention of solid preservative.

i. Boliden Salts -16 kg dry chemical per cubic meter of wood.
ii. Wolman Salts - 11 kg dry chemical per cubic meter of wood.
iii. Tanalith Salts- 12 kg dry chemical per cubic meter of wood.

c. Certificate of origin and treatment, certifying to net retention of preservatives used, and species of lumber treated shall be submitted by the Contractor.

d. Where it is necessary to cut or bore pressure-treated lumber on the job, two coats of prepared concentrated preservatives solution is to be applied to the end-cut of bored surface.

2. Plywood - Commercial Standard (CS45)
   a. For interior partitions to receive seamist or varnish finished; kalantas or ribbon grain tanguile veneers as indicated; shall be water resistant, Class B, 6 mm minimum thickness.
   b. For interior partitions to be painted - Ordinary rotary cut tanguile veneers, water resistant, Class B, 6 mm minimum thickness.
   c. For interior ceiling - Ordinary rotary-cut tanguile veneers, water resistant, Class B, 6 mm minimum thickness.

3. Fasteners
   a. Nail - smooth shank, zinc-coated, common wire nails of local manufacture.
   b. Screws - shall be brass or cadmium plate.
   c. Wires - shall be galvanized wires.

4. Plastic laminate: Standard grade, 1.5 mm thick FORMICA "NATIONAL PANEL" or equivalent as approved by the Engineer.

5. Glue shall be waterproofed glue resorcinol formaldehyde synthetic resins; glue as used in the manufacture of plywood shall be of malemineura, suitable for hot press process.

104.2.4 Glazing

1. Glass: FS DD-G-451, heat strengthened or full tempered as required by glass size to maintain specified thickness, type and thickness.

2. Glazing Gaskets: ASTM C509, continuous extruded black neoprene with Shore A Durometer hardness as required. Fully vulcanized gasket corners where compatible with installation procedures.

3. Setting Blocks: Neoprene blocks, 70 to 90 Shore A Durometer hardness.

4. All other materials: Manufacturer's standard for the items required or type best suited for the intended use.

104.2.5 Masonry Units

1. Delivery of Materials: Materials (except bulk materials) shall be delivered in manufacturer's unopened container fully identified with manufacturer's name, trade name, type, class, grade, size and color.

2. Mortar: Design mix Type M per ASTM C270. Quicklime shall not be used for mortar.

3. Sand: ASTM C144

4. Mortar Waterproofing Admixture: Aluminum tristearate, calcium stearate, or ammonium stearate.

5. Concrete Masonry Units: ASTM C90, Grade N

    a. Aggregates: Concrete aggregates complying with ASTM C33 with a dry net unit weight of not less than 2,000 kilograms per cubic meter.
    b. Cure units in a moisture controlled atmosphere or in an autoclave at normal temperature and pressure, and limit moisture absorption to 35 percent of saturation at time of delivery and until time of installation. Comply with ASTM Type I classification.
    c. Nominal face size: 200 mm by 400 mm with nominal width of 150 mm for exterior panel and 100 mm for interior panel unless otherwise dimensioned.
    d. Linear shrinkage shall be less than 0.03 percent.
    e. Exposed Units: The Contractor shall provide units for exposed construction with fine textured surface, sharp straight edges, and without defects on exposed edges, corners or surfaces which would impair appearance.

6. Water: Clear, and free of deleterious material which would impair the Work.

7. Reinforcing bars: ASTM A615, Grade 40, unless otherwise specified.

    a. The Contractor shall provide reinforcing bar in bottom bond course on framed structural slab and each bond course above at spacing not to exceed 1.2 meters on center vertically. Reinforcement in bond course in top course of wall shall be provided. Bottom reinforced bond course at walls on reinforced concrete curbs shall be omitted.
    b. The Contractors shall provide reinforcing in vertical cells at 600 mm maximum on center horizontally. Reinforcing dowels from structural slab shall be provided. Wire spacers shall be used to maintain reinforcing clear from walls of cells.
    c. The Contractor shall provide a reinforced depression in the slab for walls on slabs on grade. Reinforced bottom bond course shall be omitted.

104.2.6 Ceiling Suspension System

Ceiling suspension components shall meet the properties and specifications governing the material. They shall be extruded or manufactured true to details indicated in the

drawings with clean, straight, sharply defined profiles and free from defects impairing it strength or durability.

The ceiling system exposed surfaces shall be given an anodic coating conforming to stainless steel finish.

104.2.7 Metal Support System

1. Materials: Steel materials for metal support systems shall be provided with galvanized coating ASTM A525, G-60; aluminum coating ASTM A463, T1-25; or a 55 percent aluminum-zinc coating.
2. Materials for Use in Nonload-Bearing Wall Framing for Attachment of Lath [and] [Plaster] [and] [Stucco]: ML/SFA "Specifications for Metal Lathing and Furring."

104.3 Construction Requirements

It shall conform to each of the material requirements as herein stipulated.

104.4 Method of Measurement

The work executed under this item shall be measured by actual units of materials installed at the building complete and ready for service. The computed unit shall bear type of materials covered and shall be accepted by the Engineer.

104.5 Basis of Payment

All works performed and measured and as provided for in this Bill of Quantities shall be paid for at the Unit Bid or Contract Unit Price which payment shall constitute full compensation including labor, materials, tools and incidentals necessary to complete this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
104 (1)	Finishes (plain cement for column, wall and floor)	
104 (1)a	Cement Plaster Finish (Wall)	sq.m.
104 (1)b	Plain Cement Floor Finish	sq.m.
104 (1)c	Stone Facing Finish (Column)	sq.m.
104(2)	CHB Wall 6” (with rebars, finishing)	sq.m.
104(3)	Ceramic tiles (glazed, unglazed) Windows/type	sq.m.
104(4)	Doors (complete with jamb, silt, knob, hinges, stopper, etc.)	
104(5)	Tempered Glass Door in Aluminum Framed including fittings, handle, lockset and other	set

	accessories, 800mm x 2100mm	
104(6)	Tempered Glass Door in Aluminum Framed including fittings, handle, lockset and other accessories, 900mm x 2100mm	set
104(6)a	Aluminum Framed Glass Window (Sliding Type) including lockset and other accessories, 1350mm x 1000mm	set
104(6)b	Aluminum Framed Glass Window (Awning Type with Fixed Glass) including lockset and other accessories, 1100mm x 1000mm	set
104(6)c	Aluminum Framed Sliding Window w/ 5.5mm thk. Clear Glass including lockset and other accessories, 1170mm x 1200mm	Set
104(6)d	Aluminum Framed Glass Window (Awning Type with Fixed Glass) including lockset and other accessories, 1350mm x 1000mm	Set
104(6)e	Aluminum Framed Glass Window (Awning Type with Fixed Glass) including lockset and other accessories, 1700mm x 1000mm	Set
104(6)f	Aluminum Glass Awning Window including lockset and other accessories, 1200mm x 500mm	Set
104(6)g	Tempered Glass Fixed Window	Set
104(6)h	Aluminum Glass Awning Window including lockset and other accessories, 1800mm x 350mm	Set
104(6)i	Aluminum Side Panel with Framed	Set
104(6)j	Aluminum Frame Jalousie Glass Window, 1000mm x 1100mm	Set
104(7)	Pre-Fabricated Aluminum Framed Louvers (Powder Coated), 900mm x 800mm	Set
	Pre-Fabricated Aluminum Louvers Panels (Powder	Set

104(8)	Coated), 1200mm x 5050mm	set
104(9)	Pre-Fabricated Aluminum Framed Louvers (Powder Coated), 2600mm x 350mm	set
104(10)	Pre-Fabricated Aluminum Framed Louvers (Powder Coated), 2500mm x 350mm	set
104(11)	Pre-Fabricated Aluminum Framed Louvers (Powder Coated), 2400mm x 350mm	set
104(12)	Wooden Doors including lockset and other accessories, 800mm x 2100mm	set
104(13)a	Tanguile Flush Type Hallow Core Door, both face ordinary plywood in duco paint finish including lockset and other accessories, 800mm x 2100mm	set
104(13)b	Tanguile Flush Type Hallow Core Door, both face ordinary plywood in duco paint finish including lockset and other accessories, 800mm x 2100mm	set
104(14)	Pre-Fabricated Roll-up door (2.20m x 3.30m)	set
104(15)	Double Louvered Door Closet (2.2mx0.98m)	set
104(16)	PVC Door & Jamb Flush Type with Fixed Louver (2.1mx.7m)	set
104(17)	Waterproofing (roof deck)	sq.m.
104(18)	Ceiling (gypsum board, marine plywood)	sq.m.
104(19)	Metal Painting works	sq.m.
104(20)	Painting Works (Non-metal)	sq.m.
104(21)	Wall Partition (Men/Women)	set
104 (22)	PVC Plastic Strip Curtain Door - 2.105m x 2.30m	set

104 (23)	Tanguile Solid Core w/ Fix Louver & Fix Glass Window Provide Lockset At Handle & 2 Pairs 3-1/2" x 3-1/2" Loose Pin Butt Hinges. - 1.60m x 2.10m	set
104 (24)	Polycarbonate Canopy (Twinwall Sheet), 6.0mm thk.	Sq.m.
104 (25)	Aluminum Glass Sliding Window including lockset and other accessories, 1700mm x 1600mm	Set
104 (26)	Aluminum Tempered Glass Fixed Window, 3300mm x 1600mm	Set
104 (27)	Aluminum Tempered Glass Fixed Window, 4500mm x 2450mm	Set
104 (28)	Aluminum Tempered Glass Fixed Window, 3375mm x 2450mm	Set
104 (29)	Aluminum Tempered Glass Fixed Wall	Set
104 (30)	Lavatory Counter Top	Sq.m.
104 (31)	Welded Wire Mesh (50mm x 50mm)	Sq.m.

ITEM 105 – FIRE DETECTION AND ALARM SYSTEM

105.1 Description

The work includes providing a complete fire alarm system including associated equipment and appurtenances. Provide each system complete and ready for operation. Equipment, materials installation, workmanship, inspection, and testing shall be in strict accordance with the required and advisory provisions of NFPA 72A, Fire Code of the Philippines and NFPA 72E, except as modified herein. Devices and equipment for fire alarm service shall be listed by Underwriters Laboratories Inc., or approved by the Factory Mutual System. In the NFPA publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" shall be interpreted to mean the Owner's Fire Protection Engineer.

Prior to installation, submit data for approval by the Owner, showing that the Contractor has successfully installed interior fire alarm systems of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having such required experience. The data shall include the names and locations of at least two installations where the Contractor or the subcontractor referred to above, has installed such systems. The Contractor shall indicate the type and design of each system and

certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months.

Furnish the services of a qualified fire alarm system manufacturer's representative or technician, experienced in the installation and operation of the type of system being provided, to supervise the testing, including formal testing, adjustment of the system, instruction to Owner personnel.

105.2 Material Requirements

105.2.1 Submittals

The Owner's Fire Protection Engineer will review and approve submittals. Shop drawings and descriptive data shall be approved prior to procurement, fabrication, and installation.

Manufacturer's Data:

a. Fire Alarm Panel, including all attached modules;
b. Manual stations;
c. Cabinets;
d. Batteries;
e. Battery Charger;
f. Smoke Detectors;
g. Control Modules:
h. Alarm bells;
i. Conductors; and
j. Conduit

105.2.2 Shop Drawings

Provide drawings that clearly and completely indicate the function of the control panel and devices connected thereto. Indicate termination points of devices and indicate the interconnection of modules required for proper operation of the system. Indicate interconnection between modules and devices connected thereto. Drawings shall be not less than 457 mm x 610 mm.

105.2.3 Operation and Maintenance Manual

Provide six copies, bound securely in durable, hard cover, water-resistant binders. Include instructions for operating and maintaining system components, assemblies, and accessories; include a detailed description of the control panel and system operation under both routine and emergency conditions. Include as-built circuit diagrams complete with conductor color codes, a parts list by name, model number, and manufacturer, and a listing of smoke detector locations, with the serial number and firing voltage for each. General system descriptions included in manufacturer's catalogs or advertising media will not be acceptable in meeting the operation and maintenance manual requirement.

SPARE PARTS

Spare parts shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, stamping, or tagging. Keys and locks for equipment shall be identical where possible.
Furnish the following:

a. Four keys or tools for resetting manual stations;
b. Four keys for locks of control panels or cabinets;
c. One of each type smoke detector;
d. One heat detector;
e. Zone Module: and
f. One manual pull station.

GENERAL

All System components shall be the products of a single supplier. The manufacturer shall list all products for their intended purpose. The control panel assemblies and connected field appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as to ensure that a fully functioning is designed and installed. The system supplied under this specification shall be a microprocessor-based direct wired. The system shall utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.

System Operation:

Sequence of Operations

Upon the alarm activation of any area smoke detector, heat detector, manual pull station, sprinkler water flow, the following functions shall automatically occur:

a. The internal audible device shall sound at the control panel.
b. The LCD display shall indicate all applicable information associated with the alarm condition including; zone, device type, device location and time/date.
c. All system activity/events shall be documented on the system printer.
d. Any remote or local annunciator LCD/LED's associated with the alarm zone shall be illuminated.
e. Activate notification audible appliances.
f. Activate automatic smoke control sequences.
g. All automatic events programmed to the alarm point shall be executed and the associated outputs activated.

Supervisory Operation

Upon supervisory activation of any sprinkler valve supervisory switch, fire pump off-normal, deluge valve fire suppression system trouble, the following functions shall automatically occur:

a. The internal audible device shall sound at the control panel.
b. The LCD display shall indicate all applicable information associated with the supervisory condition including; zone, device type, device location and time/date.
c. All system activity/events shall be documented on the system printer.
d. Any remote or local annunciator LCD/LED's associated with the supervisory zone shall be illuminated.

Trouble Operation

Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:

a. The internal audible device shall sound at the control panel or command center.
b. The LCD keypad display shall indicate all applicable information associated with the trouble condition including; zone, device type, device location and time/date.
c. All system activity/events shall be documented on the system printer.
d. Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.

COMPONENTS OF DESIGN

Fire Alarm Control Panel

The control panel shall be a multi-processor based system designed specifically for fire, one-way and two-way emergency audio communications, smoke control, extinguishing agent releasing system, and guard patrol applications. The control panel shall be listed and approved for the application standard(s) as listed under the General section.

The control panel shall include all required hardware, software and site-specific system programming to provide a complete and operational system. The control panel shall be designed such that interactions between any applications can be configured, and modified using software provided by a single supplier. The control panel operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

The control panel shall include the following capacities:

a. Support analog/addressable points as indicated on the plans.
b. Support network connections up to 63 other control panels and annunciators.
c. Support up to 1740 chronological events.
d. Provide electronic addressing of analog/addressable devices.
e. Provide an operator interface control/display that shall annunciate, command and control system functions.
f. Provide an internal audible signal with different programmable patters to distinguish between alarm, supervisory, trouble and monitor conditions.
g. Provide a discreet system control switch provided for reset, alarm silence, panel silence, drill switch, previous message switch, next message switch and details switch.
h. Provide system reports that provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs.
i. Reports shall be displayed by the operator interface or capable of being printed on a printer.
j. Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
k. Provide an authorized operator to perform test functions within the installed system.

The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain the electrical charge of the battery.

System Message Processing and Display Operations

The control panel shall be capable of supporting a printer. All system control panel printer ports shall be configurable to output any combination of alarm, supervisory, trouble, monitor, or service group event messages. The control panel shall be capable of supporting a LCD display. The display on each system node (cabinet) shall be configurable to display the status of any and all combinations of all alarm, supervisory, trouble, monitor, or service group event messages. The system program shall have a minimum of 100 system definable service groups definable within the program to allow facilitate the testing of installed system based on the physical layout of the system. Service groups that disable the wiring of circuits serving multiple floors or fire zones shall not be considered as equal.

Advanced Windows® based programming with program version reporting to document any and all changes made during system start-up or system commissioning. Time and date stamps of all modifications made to the program must be included to allow full retention of all previous program versions data.

The operator display shall clearly identify unacknowledged and acknowledged alarm, supervisory, trouble, and monitor status messages.

The system shall provide the ability to download data from the analog/addressable detectors to a PC while the system is on-line and operational in the protected premises. The downloaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.

Power Supply

System power supply(s) shall provide multiple power limited 24 VDC output circuits as required by the panel. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system functions. Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciate as battery trouble and identify the specific power supply affected. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

Reports

The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD, and shall be capable of being printed on any system printer. The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.

The system shall provide a report that gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.

The system shall provide a report that gives a chronological listing of up to the last 1740 system events.

The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.

Smoke Detectors General

Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive or least sensitive. In addition to the five sensitivity levels the detector shall provide a pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector's alarm sensitivity value. An alternate alarm sensitivity level shall be provided for each detector, which can be set to any of the five (5) sensitivity settings manually or automatically using a time of day event. In addition to the five alternate sensitivity levels the detector shall provide an alternate pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector's alternate alarm sensitivity value. The detector shall be able to differentiate between a long drift above the pre-alarm threshold and fast rise above the threshold. The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal that 75% to 99% compensation has been used. The detector shall provide a dirty fault signal that 100% or greater compensation has been used. The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

The detectors address shall be set by electronic means only, no mechanical means such as programming by pins, dipswitches or rotary switches shall be used.

Photoelectric Smoke Detector

Provide analog/addressable photoelectric smoke detectors at the locations shown on the drawings. The detector shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 75% and 100% of the allowable environmental compensation value.

Fixed Temperature-ROR Heat Detector

Provide analog/addressable combination fixed temperature / rate-of-rise detectors at the locations shown on the drawings. The heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate of rise alarm point of 15°F

(9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 70 ft. (21.3m) centers and be suitable for wall mount applications.

Optical Beam Smoke Detector: Provide projected smoke detector as indicated on plans to be used with a control panel. The projected beam smoke detector shall be a 4-wire, 24VDC device, with a beam spread of 18.3 meters with a maximum range of 70 meters; and shall operate as indicated on the plans. The detector shall consist of transmitter and receiver capable of being powered separately or together. The detector shall feature a bank of four alignment LEDs' on both receiver and transmitter that are used to ensure proper alignment of the unit without special tools. The detector shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on the lenses. Units shall be provided with ceiling and wall mounting brackets.

Detector Bases

Provide standard detector mounting bases suitable for mounting on either North American 1-gang, 3½ or 4-inch octagon box and 4 inch square box, or European BESA or 1-gang box. The base shall, contain no electronics and support all series detector types.

Manual Stations - Double Action Single Stage

Provide analog/addressable double action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 ½ (64mm) deep 1-gang boxes and 1 ½ (38mm) deep 4 square boxes with 1-gang covers. The detectors address shall be set by electronic means only, no mechanical means such as programming by pins, dipswitches or rotary switches shall be used.

Bells

Provide 200 mm surface-mounted type with matching back box and shall be UL/FM approved. Bells shall be underdome, vibrating type, suitable for use in an electrically supervised circuit, with a sound output rating of at least 85 decibels at 3 meters. Provide bells specifically listed for outdoor use in exposed locations. Bells shall have a separate screw terminal for each conductor connection.

Relay Module

Provide addressable control relay circuit modules at the locations shown on the drawings. The module shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware.

Provide addressable notification appliance circuit modules at the locations shown on the drawings. The module shall provide one (1) supervised Class B notification circuit. The module shall provide polarized audible / visual selection for 24Vdc @ 2amps, audio outputs at 25Vrms @ 50 watts or 70 Vrms @ 35 watts.

Isolation Module

Provide addressable fault isolator circuit modules each circuit. The module shall be capable of isolating and removing a fault from a Class A data circuit while allowing the remaining data loop to continue operating.

WIRING

Provide in accordance with NFPA 70 and NFPA 72A. Conductors shall be copper. Conductors for 220-volt circuits shall be 3.5 mm minimum; single conductors for low-voltage dc circuits shall be 2.0 mm minimum or 3.5 mm as shown on drawings. Conductors shall be color-coded. Provide wiring in rigid metal conduit. Identify conductors within each enclosure where a tap, splice, or termination is made. Identify conductors by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Wire the alarm initiating and notification signal devices so that removal will cause the system trouble device to sound. Pigtail or "T" taps connections to alarm initiating devices, evacuation alarm bells, horns, and fire warning light is not acceptable. Each conductor used for the same specific function shall be distinctively color-coded. Use two different color codes for each interior alarm circuit; one for each loop. Each circuit color code wire shall remain uniform throughout circuit.

MONITORING SOFTWARE

Provide smoke detector monitoring software.

GROUNDING

Fire alarm panel shall be grounded, by connecting to the building grounding system. Resistance to ground shall not exceed 25 ohms.

105.3 Construction Requirements

INSTALLATION

Equipment, materials, installation, workmanship, inspection, and testing shall be in accordance with NFPA publications and as modified herein.

PRELIMINARY TESTS

Conduct the following tests during installation of wiring and system components. Correct any deficiency pertaining to these requirements prior to formal functional and operational tests of the system.

Ground Resistance

Measure the resistance of each connection to ground. Ground resistance shall not exceed 25 ohms.

Dielectric Strength and Insulation Resistance

Test the dielectric strength and the insulation resistance of the system interconnecting wiring by means of an instrument capable of generating 500 volts dc and equipped to indicate leakage current in 1000 meg-ohms. For the purpose of this test, the instrument shall be connected between each conductor on the line and between each conductor and ground at the control panel end of the line, with the other extremity open circuited

and all series-connected devices in place. The system shall withstand the test without breakdown and shall indicate a resistance of not less than 500,000 ohms, the measurement being taken after an electrification of not more than 1.0 minute with a dc potential of not less than 100 volts nor more than 550 volts.

Smoke Detector Tests

Prior to formal inspection and tests, clean and perform sensitivity tests on each smoke detector. Clean the smoke detectors in accordance with the manufacturer's recommended procedures.
FIELD INSPECTION AND TEST

Before final acceptance of the work, test each system to demonstrate compliance with the contract requirement. Each system shall be subjected to complete functional and operational tests including tests in place of each smoke detector. When tests have been completed and corrections made, submit a signed and dated certificate with a request for formal inspection and tests.

FORMAL INSPECTION AND TEST

The Owner's Fire Protection Engineer will witness formal tests after receipt of written certification that preliminary tests have been completed and that the system is ready for final inspection. The system manufacturer's technical representative shall be present for the final inspection and test. Preliminary test shall be repeated and functional and operational tests conducted, as requested by the Fire Protection Engineer. Correct defects and conduct additional tests to demonstrate that the system conforms to contract specifications.

105.4 Method of Measurement

Fire alarm control panel, fire alarm horn, manual pull station, smoke detector, heat detector, fire alarm annunciator panel, zone addressable module, will be measured by the set installed and accepted. Wire and cable of the size and insulation type will not be measured and must be installed and accepted.

105.5 Basis of Payment

All works performed and measured and as provided for in this Bid of Quantities shall be paid for at the Unit Bid or Contract Unit Price which payment shall constitute full compensation including labor, materials, tools and incidentals necessary to complete this Item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
105 (a)	Smoke detector w/ base	Set
105 (b)	Fire alarm bell	Set
105 (c)	Manual pull station switch	Set
105 (d)	Fire Alarm Control Panel	Set

ITEM 1001 – PLUMBING WORKS

1001.1 Description

This Item shall consist of furnishing and installation of plumbing system, inclusive of all pipings and pipe connections, valve, controls, and all accessories ready for service in accordance with the approved plans and specifications.

1001.2 Material Requirements

1001.2.1 Scope of Work

Unless otherwise specified, the Contractor or his subcontractor shall furnish all materials, tools, equipment, apparatus, appliances, accessories, transportation, labor and supervision required for the complete installation and testing of the Plumbing System ready for use in accordance with the best practice of the Plumbing trade as listed herein but not limited to the following:

a. The Plumbing Contractor is required to refer to all architectural, structural, mechanical, fire protection, and electrical plans and investigate all possible interference and conditions affecting his work.

b. All work shall comply with the pertinent provisions of the Plumbing Code of the concerned city or town, the Code on Sanitation of the Philippines, and/or the National Plumbing Code of the Philippines.

c. Domestic water supply and distribution system (potable and non-potable) including supply pipes to the equipment, fixtures and hose bibbs inclusive of all valves, fittings, and other accessories to complete the system.

d. All building sanitary drains, waste and venting systems including floor drains.

e. Building storm drainage system including collection system from roof drains, mechanical drains, plant boxes drains, and storm drainage catch basins up to the street drainage system and non-potable (rainwater) water tank.

f. Supply and installation of all plumbing fixtures, fittings, trims and accessories.

g. Supply and installation of a triplex-type constant pressure booster system and a 34 gallon capacity bladder tank, to include concrete base, controls, valves, pipes, fittings, liquid level control, and other accessories for complete installation.

h. Supply and installation of elevator pit pumps to include controls, valves, pipes, fittings, and other accessories for complete installation.

i. Supply and installation of pipes, fittings, valves, miscellaneous metal works, and all required appurtenances for the Non-potable R.C. water tank, and elevator pits.

j. Testing for leakage of all water supply and distribution system, drains, waste, sewer and venting system plus pressure testing and disinfection of the water supply and distribution system.

k. Testing for leakage of the non-potable water tank.

l.Test run of all pumps and other equipment under Plumbing Works.

m. Securing of all permits and licenses as required.

n. Excavation and backfilling in connection with the work shall be included.

o. Preparation and submittal of two (2) sets of as-built plans.

p. Furnishing of written one (1) year warranty on the plumbing system.

1001.2.2 Work Not Included in this Section

a. Construction of the Non-potable R.C. Water Tank and Booster Station.

Work Not Included in this Section

a. Construction of the Non-potable R.C. Water Tank and Booster Station.
b. Construction of all elevator pits.

NOTES ON DRAWINGS

a. The Drawings show the general arrangements of all pipings. However, where local and/or actual conditions at the job site necessitate a deviation or re-arrangement, the Contractor shall prepare and submit the new arrangement for the Engineer's approval.

b. Small scale Drawings do not possibly indicate all offsets, fittings and other parts of the system required. The Contractor shall arrange such work accordingly, furnishing such fittings, traps, valves and accessories as may be required to meet such conditions.

QUALITY ASSURANCE

a. The work covered in this contract is to be installed according to the specifications, codes, ordinances and requirements of the following:

(1) National Plumbing Code of the Philippines
(2) The Code on Sanitation of the Philippines
(3) Environmental Management Bureau, DENR

b. All construction permits and fees required for the work shall be obtained by and at the expense of the Contractor. The Contractor shall furnish the Owner final certificates of inspection and approval from the proper government authorities after the completion of the Work.

WORKMANSHIP AND COORDINATION WITH OTHER TRADES

a. All work shall be performed in first class and neat workmanship by mechanics skilled in their trades and such mechanics and their work shall be satisfactory to the Engineer.

b. The Plumbing Contractor is required to refer to the General Conditions and to all architectural, structural, electrical, mechanical and fire protection plans and Specifications and hall investigate all possible interferences and conditions affecting his work.

PRODUCTS

MATERIALS

General

a. Except as specified, the Contractor shall submit for the Engineer's approval, four (4) copies of a complete list of manufacturer's names of all equipment and materials he proposes to use, within thirty (30) days after award of contract.

b. The Contractor shall assume the cost of materials and the entire responsibility for any change in the work as shown on contract drawings which may be occasioned by approval of materials other than those specified.

Pipes and Fittings Schedule

a. Cold (Potable) and Non-Potable Water Lines – for risers, downfeeds & distribution lines shall be Polypropylene (PP-R) pipe and fittings PN 20 conforming to DIN specifications DIN 8077 and DIN 8078 or ASTM 2389, forming polyfusion homogeneous joint. All threaded inserts should be made of nickel-plated brass conforming to DIN 2999.

b. Exterior Non-Potable Water Lines (Piping Works at Water Tank and Pump Room) - shall be Galvanized Iron Pipe (GIP), schedule 40. All GIP shall conform to ASTM A-53. Fittings shall be malleable iron, class 150, used screwed connection from 12mm dia. to 65 mm dia. and flanged connection from 75mm dia. and larger. When buried underground, the GI pipe shall be coated with coal tar and wrapped with burlap for corrosion protection.

c. Soil, Waste and Vent Pipes - shall be Polyvinyl Chloride (PVC) pipes conforming to ASTM D2729, Series 1000.

d. Downspouts/Collector Pipes/ AHU and FCU Drains - shall be Polyvinyl Chloride (PVC) pipes conforming to ASTM D2729, Series 1000.

e. Storm Drainage Lines – shall be Polyvinyl Chloride (PVC) pipes series 1000 conforming to ASTM D2729 for sizes 100mm to 250mm diameter. Use reinforced concrete drain pipes (RCP), tongue and groove, mortar joints for sizes 300 mm diameter and larger conforming to ASTM C-76 Class IV Wall B.

Valves

a. Gate Valve - 75 mm & larger, shall be double disc type, iron body with bronze trim, flanged connection, rated 150 psig working pressure. Gate valves installed in vertical pipin shall be of solid wedge type. Gate valves installed inside structures shall be of rising stem type with stuffing box stem seals. Gate valves, which are buried or submerged, shall be non-rising stem types with O-ring stem seals. For 65 mm and smaller, shall be solid wedge type, rated 150 psig working pressure. Valves shall be of bronze construction with screwed bonnet, rising stem, and teflon impregnated packing. PPR gate valves may be used at above ground interior installations.

b. Check Valve - Check valves 50 mm and smaller shall be rated 150 psig, of cast bronze body, Y-pattern, regrinding, horizontal swing check type, with threaded ends conforming to ASTM-B-62 or approved equal. Check valve larger than 65 mm shall

be rated at 150 psig, of cast iron body, swing check type conforming to ASTM-A-216 or approved equal.

c. Float Valve - shall be hydraulically operated, diaphragm actuated valve with the pilot control and float mechanism mounted on the cover of the main valve. The float positions the pilot control to close the valve when float contacts the upper stop and to open the valve when the float contacts the lower stop.

d. Angle Valve - Angle valves 50 mm and smaller for water service shall be rated 125 psig with bronze body, seat and disc; screwed bonnet; rising stem; Teflon impregnated packing; and threaded ends.

e. Flap Valve - cast iron body, minimum 150 psig working pressure.

Other Materials

a. Drains – shall have cast iron body with integral trap and socketed end, brass strainer.

(1) Floor/Shower Drains – similar to METMA M200-D
(2) AHU Drains – similar to METMA M200-O
(3) Trench Drain – similar to METMA M200-U
(4) Planters Box Drains - similar to METMA M200-T (Standpipe to be covered with stainless wiremesh and be made longer to suit requirement).

b. Roof Strainers - Sanitary basket strainers shall be of brass wires constructed on slotted holes on brass ring with secondary strainer to insure continuous flow of water,similar to METMA M-319-58.

c. Cleanout

(1) Floor Level Cleanout: Shall be of cast bronze or brass with countersunk thread and screwed plug, all items chromium plated.
(2) Above Ceiling Cleanout: Shall be of cast bronze or brass with screwed plug and square head.

d. Hose Bibbs – 20 mm standard hose connection, 15mm male tapered threads, polished chrome plated, angle type with lock shield and hardwell.

e. Water Hammer Arrestors - shall be of stainless steel construction, with heavy duty balanced expansion bellows. Water hammer arrestors shall be provided in cold water (potable) and non-potable water piping.

f. Unions - unions for water piping 15 mm and larger in diameter shall be flange pattern of galvanized wrought iron. Gasket for flanged unions shall be of the best quality fiber, plastic or leather.

Outdoor Pipe Lines and Appurtenances

a. Drainage Junction Boxes/ Catch Basins and Area Drains - shall be cast-in-place 140 kg/cm² (13.73 MPa) reinforced concrete sections with pre-cast reinforced concrete cover and steel gratings, respectively.

b. Thrust Blocks - 140 kg/cm² (13.73 MPa) plain concrete.

Jointing

a. Flanged Joint Gasket – "GARLOCK" or approved equal.

b. Screwed Joints – U.S. Federal Specifications GG-P-251.
.
c. PVC Pipes and Fittings – socket type with PVC solvent cement, elastomeric rubber O-ring gasket, or as per the Manufacturer's recommendations.

d. Polypropylene - High density pipes and brass fittings and joints shall be used.

e. G.I. Pipes and Fittings - Carefully reamed threaded joints. Apply seal tape, or paint with red lead paint at all joints lengths.

f. Dissimilar Pipes - Adaptor fittings shall be used.

g. Concrete Drain Pipe – Bell and spigot or tongue and groove with cement mortar.

IDENTIFICATION AND APPROVAL OF MATERIALS

a. Each length of pipe, fittings, traps, fixtures, and device used in the Plumbing System shall have cast, stamped or marked on it, the manufacturer's trademark or name, the weight, type and class of products when so required by the Standards.

b. Within thirty (30) days after award of the Contract, the Contractor shall submit for the Engineer's approval, the names of suppliers and materials proposed including trade names and/or samples of the materials if deemed necessary.

SUBSTITUTION AND TESTING OF MATERIALS

a. Materials intended to be substituted for those originally specified shall be accepted only after a formal request for substitution, accompanied by:

(1) Reasons for substitutions;

(2) Certificate of test indicating quality, compared to those originally specified.

(3) Cost comparisons with material originally specified. Request shall be submitted to the Engineer for evaluation at least 15 working days before installation of subject material is due, or at least 7 days before opening of bids.

b. Cost of testing of materials, whether on originally specified items or on substitutions, shall be to the account of the Contractor.

c. Results of tests shall be submitted to the Engineer

SOIL, WASTE, DRAIN AND VENT PIPES

a. Installation

(1) All sewer lines shall be pitched 6 mm per 300 mm (1/4" per foot) for soil pipes and no case flatter than 3 mm per 300 mm (1/8" per foot) for waste pipes.

(2) All sanitary waste piping buried beneath floors shall be encased in concrete at least 150 mm thick.

(3) All changes in pipe sizes on soil, waste and drain lines shall be made with reducing fittings or reducers. All changes in direction shall be made by the appropriated use of forty five degree (45º) wyes, or long sweep bends, except that sanitary tees may be used on vertical stacks. Short quarter bends or elbows may be used in soil and waste lines where the change in direction is from the horizontal to the vertical and on the discharge from the water closet.

(4) Roughing-in for pipes and fixtures shall be carried along with the building construction. Correctly located openings of proper sizes shall be provided where required in the walls and floors for the passage of pipes all items to be embedded in

b. Traps

(1) Every plumbing fixture shall be separately trapped by a vented water sealed trap as close to the fixture outlets as the conditions allow, but in no case at a distance greater than 600 millimeters. In case of the upper or the only fixture on a soil pipe extended full size through the roof, a vent shall not be required when said fixture has its center stack. Traps shall be of the same diameter as the waste pipes from the fixtures which they shall serve, all traps shall have a water seal of at least 32 millimeters with a brass thumbscrew clean out at the bottom of the seal.

c. Vent

(1) Vents shall be taken from the crown of the fixtures, except for water closet traps, in which case, the branch line shall be vented below trap and above all small waste line inlets, so connected as to prevent obstructions. Each vent pipe shall be run separately above the fixtures into the adjacent soil pipes, a distance not more than 1.50 meters. If more than this distance, the vent shall run independently through the roof.

(2) A vent line shall be wherever practicable, direct extension of a soil or waste line.

(3) Main vent risers at 4.5 meters long or more shall be connected at the foot with the main water or soil pipes below the lowest vent outlet with a forty five degree connection.

(4) All vertical soil or vent pipes shall be carried up at least 600mm above the roof of the building and the open side end

(5) Vent pipes in roof spaces shall be run as close as possible to the underside of roof with horizontal piping pitched down to stacks without forming traps.

(6) Where an end or circuit vent pipe from fixtures it shall be connected into the main vent or vent stack.

d. Joints and Connections - All joints shall be air and water tight. For jointing pipes, see Item 2.1.6.

WATER DISTRIBUTION SYSTEM

a. Installation

(1) The pipings shall be extended to all fixtures, outlets and equipment from the gate valves installed in the branch near the riser.

(2) The water supply piping at each fixture shall be provided with a shutoff valve and union, whether indicated on the drawings or not, which will permit isolation and disconnection of each item without disturbing the remainder of the system.

(3) An union shall be provided within 600 mm of each threaded end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping at locations adjacent to devices or equipment which may require removal in the future and at locations required by the drawings or specifications.

(4) All necessary provisions shall be taken in laying out piping to provide throughout for expansion and contraction. Piping shall be held free of contact with building construction so as not to transmit noise resulting from expansion.

(5) All pipes shall be cut accurately to measurement and shall be worked into place without springing or facing. Care shall be taken so as not to weaken the structural portions of the building.

(6) All service pipes, valves and fittings shall be kept a sufficient distance from other work to permit finished covering not less than 15mm from such work or from finished covering on the different service.

(7) Changes in sizes shall be made with reducing fittings.

(8) Accessible Contraction - Expansion joint shall be made where necessary. Horizontal runs of pipes over 15 m in length shall be anchored to wall or the supporting structure about midway on the run to force expansion and contraction equally towards the ends.

(9) Polypropylene (PP-R) Random (Type 3) PP-R pipes and fittings must be installed in accordance with the manufacturer's installation recommendation.

The maximum permissible support for (PP-R) spacing shall be as follows:

d	**Distance between two branches (cm)**					
(mm)	**20^0**	**30^0**	**40^0**	**50^0**	**60^0**	**70^0**
20	75	75	70	65	60	50
25	85	85	85	80	75	65
32	100	100	95	90	85	80
40	110	110	105	100	95	90
50	130	125	115	110	105	100
63	150	145	140	125	120	110
75	170	165	160	150	145	120
90	180	175	170	165	160	130
110	190	185	175	170	165	140

EXCAVATING, PIPELAYING AND BACKFILLING

a. Trenches for all underground pipe lines shall be excavated to the required depths and grades. Bell holes shall be provided so that pipe will rest on well-tamped solid ground for its entire length. Where rock is encountered, excavation shall extend to a depth 150 mm below the pipe bottom and other approved filling materials.

b. All pipes except concrete pipes and cast iron soil pipes that will run across the road shall be protected with Class B concrete casing, a minimum of 100 mm around the pipe perimeter and 250 mm below the finish grade.

c. Materials for backfilling shall be free of debris or big rocks. Backfill shall be placed in horizontal layers, properly moistened and compacted to an optimum density that will prevent excessive settlement and shrinkage.

MISCELLANEOUS

a. Cleanout shall be gas and watertight, and shall be provided with quick and easy plug removal to allow ample space for cleansing tools.

Cleanout shall be of the same size as the pipe up to and including 100mm, the location of which is extended to an easily accessible place.

b. Traps

1. Every plumbing fixture or equipment requiring connections to the drainage system shall be equipped with a trap.

2. Each trap shall be placed as near as possible to fixture. No fixture shall be double-trapped.

c. Valves

1. Valves shall be provided on all water supplies to fixtures as specified.

d. Pipe Hangers, Inserts and Supports

1. Horizontal runs of pipe shall be hung with adjustable wrought iron and malleable iron pipe hangers spaced not over 3 m apart, except hub and spigot soil pipes which shall have hangers spaced not over 1.52 m apart and located near the hub.

2. Hangers shall have short turn buckles or other approved means of adjustment.

3. Insert shall be of cast steel and shall be of type to receive a machine bolt or nut after installation.

4. Vertical runs of pipe shall be supported by wrought iron clamps or collars spaced not more than 9 m. apart.

5. Water and Vent Pipes - 65 mm and larger, band type 6.4 mm x 25 mm flat mild steel or black iron with 15 mm round rod with plates and nuts; 50 mm and smaller split ring type with 10 mm iron rods with insert plates; toggle bolts, clamps or expansion shield.

e. Pipe Sleeves

1. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through masonry or concrete.

2. Pipe sleeves shall be of sufficient diameter to provide approximately 6.4 mm clearance around the pipe or insulation.

3. Pipe sleeves in walls and partitions shall be of cast iron, wrought iron or steel pipe. Pipe sleeves in concrete beams or concrete slabs shall be wrought iron or steel pipe.

4. Pipe sleeves on footings shall be cast iron or steel and shall be not less than 100mm larger in diameter than the pipe to be installed.

5. Where pipes pass through waterproofing membrane, the sleeves shall be provided with an integral flange or clamping device to which a flashing shield can be soldered.

6. The space between the pipes and sleeves shall be made water tight by inserting a picked oakum gasket and filling the remaining space with poured lead caulking thoroughly.

f. Fixture and Equipment Supports and Fastenings

1. Where secured to concrete or filled hollow block walls, fastenings shall be brass and at least 76mm into solid concrete.

2. Inserts shall be securely anchored and the anchor shall be properly flushed with mortar.

g. Floor, Walls and Ceilings Plates:

Plates shall be large enough to completely close the hole around the pipes and shall be round with the least dimension hole 30mm larger than the diameter of the pipe.

h. Drains

All drains installed in connection with waterproofing of floors shall be equipped with a clamping device.

PLUMBING FIXTURES, FITTINGS AND ACCESSORIES

a. Materials and schedule of plumbing fixtures, fittings and accessories shall be as specified under Section Toilet Accessories and Section Plumbing Fixtures of these Specifications.

NON-POTABLE WATER TANK (CISTERN)

Reinforced Concrete Water Tank

a. Concreting works and placing of reinforcing steel bars shall be done in accordance with sections on concrete structures and reinforcing steel, respectively.

b. Piping, fittings and miscellaneous metal works.

1. Furnish and install all pipe fittings, valves, pipe supports, miscellaneous metal work and all required appurtenances as shown on the plans and as required to make the entire piping system operable.

2. All materials furnished and installed shall be new and guaranteed free from defect in design, materials and workmanship.

3. Adequate protective measures shall be provided to protect pipes, fittings, valves and all other materials from damage or injury during storage and installation.

c. Installation

1. All pipes shall be carefully placed and supported at the proper lines and grade where possible shall be sloped to permit complete draining.

2. Piping runs shown on the Drawings shall be followed as closely as possible, except for minor adjustments to avoid adverse-effect on architectural and/or structural features. If major relocations are required, they shall be subjected to the approval of the Engineer.

3. Carefully inspect all pipes and fittings before installation. Inspection of pipe shall include light tapping with a hammer to detect cracks or defects. No pipe fittings or valves which are cracked or showing defects shall be used.

4. Piping shall be properly supported by suitable anchor, brackets or hangers. Vertical pipes shall be anchored by suitable galvanized steel straps. Pipe supports shall be provided as shown on the Plans and whenever else necessary to prevent stain on joints or to facilitate taking down pipe.

d. Test for Water Tank Tightness

The completed reinforced concrete reservoir shall be tested for water-tightness by filling it up with clean water after cleaning out all dirt and debris inside the tank. The water shall be allowed to stand for a minimum of 48 hours reckoned from the time the freeboard line was reached during filling up. After the 48 hour period there shall be no drop in water level in the tank more than 40 mm, otherwise the Contractor shall empty the tank to permit close examination for evidence of any cracking or other conditions that might be responsible for the leakage. Any cracks shall be "vee'd" and sealed with rubber sealant, and any evidence of leakage through the joints shall be repaired to the satisfaction of the Engineer. Following these operations, the test for water-tightness shall be repeated.

PUMPS

General

a. All equipment shall be supplied from reputable firms engaged in the manufacturer of each particular item. The entire assembly as installed shall be given a start-up and test run to prove that all the Specifications have been met before acceptance by the Owner. The test duration shall be 24 hours. Submittal of the Certificate of Test to the Owner shall be a condition of final payment.

b. The Specifications stated herein are basic guides only. Other items not so indicated but which are obviously necessary for the proper operation of system as intended shall be supplied in accordance with accepted engineering standards.

c. The equipment shall be guaranteed for a period of at least one year of trouble free operation. The supplier of equipment shall certify to the availability of spare parts locally and service in case of system breakdowns within a period of at least three years. Manuals of operation and maintenance and lists of spare parts shall be supplied together with the equipment. Submittal of Warranty Certificate shall be a condition for final payment.

d. The supplier shall submit at least two copies of pump performance curves showing, among others, the pump rating and pump efficiency properly marked thereon.

e. Accessories to be supplied for each pump shall include one non-slam type check valve and two (2) gate valves, of size equal to the size of pump discharge and suction, rated 150 psi. Also, one pressure gauge for each set of pumps and pipe fittings necessary for complete installation shall be provided. The pressure gauge shall be 100 mm face diameter and shall be reading from 0 psi (or 0 kg/cm2) to 100 psi (or 7 kg/cm2).

f. Price quoted shall include cost of delivery of all quoted items to the jobsite. Pump and motor installation dimension drawings shall be submitted together with the quotation.

g. The brands, names and place of manufacture of pump, motor, valves, controls and all accessories where applicable shall be indicated in the quotation. Also, a description of pump impellers being offered shall be included.

h. A metal nameplate indicating in indelible letters the correct Specifications of the pump and motor shall be properly attached to the assembly at a location such that the information written thereon can be conveniently read by all concerned.

i. Separate price shall be quoted for installation work, preparation and submittal of as installed Drawings.

Variable Speed Booster System

a. Scope

Supply and installation of a pre-fabricated and tested variable speed packaged system to maintain constant water delivery pressure.

b. Pumps

The pumps shall be in-line vertical multi-stage centrifugal pumps with one external frequency converter. The unit shall be rated for a total system capacity of 250 GPM at a discharge head of 100 feet when supplied with a working suction head of 1 foot. Each pump shall be sized as indicated:

Triplex System

Pump P1 = 50 GPM (33% of Total System Flow)
Pump P2 = 100 GPM (67% of Total System Flow)
Pump P3 = 100 GPM (Stand-by Unit)

The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.

The pumps shall have the following features:

(1) The pump impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement.

(2) The suction/discharge base shall have ANSI Class 250 flange or internal pipe thread (NPT) connections as determined by the pump station manufacturer.

(3) Pump Construction

- Suction/discharge base, pump head, motor stool: Cast iron (Class 30)
- Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel
- Shaft: 316 or 431 Stainless Steel
- Impeller wear rings: 304 Stainless Steel
- Shaft journals and chamber bearings: Silicon Carbide
- O-rings: EPDM

Shaft couplings for motor flange sizes 184TC and smaller shall be made of cast iron or sintered steel. Shaft couplings for moto

(4) The shaft seal shall be a balanced o-ring cartridge type with the following features:

- Collar, Drivers, Spring: 316 Stainless Steel
- Shaft Sleeve, Gland Plate: 316 Stainless Steel
- Stationary Ring: Silicon Carbide
- Rotating Ring: Silicon Carbide
- O-rings: EPDM

The Silicon Carbide shall be imbedded with graphite.

(5) Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, shaft coupling and motor. The entire cartridge shaft seal shall be removable as a one piece component. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

c. Variable Frequency Drive

(1) The VFD shall convert incoming fixed frequency single-phase or three phase AC power into a variable frequency and voltage for controlling thespeed of three-phase AC induction motors. The VFD shall be a six-pulse input design, and the input voltage rectifier shall employ a full wave diode bridge; VFD's utilizing controlled SCR rectifiers shall not be acceptable. The output waveform shall closely approximate a sine wave. The VFD shall be of a PWM output design utilizing current IGBT inverter technology and voltage vector control of the output PWM waveform.

(2) The VFD shall include a full-wave diode bridge rectifier and maintain a displacement power factor of near unity regardless of speed and load.

(3) The VFD shall produce an output waveform capable of handling maximum motor cable distances of up to 1,000 ft. (unshielded) without tripping or derating.

(4) The VFD shall utilize an output voltage-vector switching algorithm, or equivalent, in both variable and constant torque modes. VFD's that utilize Sine-Coded PWM or Look-up tables shall not be acceptable.

(5) VFD shall automatically boost power factor at lower speeds.

(6) The VFD shall be able to provide its full rated output current continuously at 110% of rated current for 60 seconds.

(7) An empty pipe fill mode shall be available to fill an empty pipe in a short period of time, and then revert to the PID controller for stable operation.

(8) Switching of the input power to the VFD shall be possible without interlocks or damage to the VFD at a minimum interval of 2 minutes.

(9) Switching of power on the output side between the VFD and the motor shall be possible with no limitation or damage to the VFD and shall require no additional interlocks.

(10) The VFD shall have temperature controlled cooling fans for quiet operation, minimized internal losses, and greatly increased fan life.

(11) VFD shall provide full torque to the motor given input voltage fluctuations of up to +10% to -15% of the rated input voltage.

(12) The VFD shall provide internal DC link reactors to minimize power line harmonics and to provide near unity power factor. VFD's without a DC link reactor shall provide a 5% impedance line side reactor.

(13) VFD to be provided with the following protective features:

- VFD shall have input surge protection utilizing MOV's, spark gaps, and Zener diodes to withstand surges of 2.3 times line voltage for 1.3 msec.

- VFD shall include circuitry to detect phase imbalance and phase loss on the input side of the VFD.

- VFD shall include current sensors on all three-output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

- VFD shall auto-derate the output voltage and frequency to the motor in the presence of sustained ambient temperatures higher than the normal operating range, so as not to trip on an inverter temperature fault. The use of this feature shall be user-selectable and a warning will be exported during the event. Function shall reduce switching frequency before reducing motor speed.

- VFD shall auto-derate the output frequency by limiting the output current before allowing the VFD to trip on overload. Speed can be reduced, but not stopped.

- The VFD shall have the option of an integral RFI filter. VFD enclosures shall be made of metal to minimize RFI and provide immunity.

(14) VFD to be provided with the following interface features:

- VFD shall provide an alphanumeric backlit display keypad, which may be remotely mounted using standard 9-pin cable. VFD may be operated with keypad disconnected or removed entirely. Keypad may be disconnected during normal operation without the need to stop the motor or disconnect power to the VFD.

- VFD shall display all faults in plain text; VFD's, which can display only fault codes, are not acceptable.

- All VFD's shall be of the same series, and shall utilize a common control card and LCP (keypad/display unit) throughout the rating range. The control cards and keypads shall be interchangeable through the entire range of drives used on the project.

- VFD keypad shall be capable of storing drive parameter values in nonvolatile RAM uploaded to it from the VFD, and shall be capable of downloading stored values to the VFD to facilitate programming of multiple drives in similar applications, or as a means of backing up the programmed parameters.

- A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

- A start guide menu with factory preset typical parameters shall be provided on the VFD to facilitate commissioning.

- VFD shall provide full galvanic isolation with suitable potential separation from the power sources (control, signal, and power circuitry within the drive) to ensure compliance with PELV requirements and to protect PLC's and other connected equipment from power surges and spikes.

- All inputs and outputs shall be optically isolated. Isolation boards between the VFD and external control devices shall not be required.
- There shall be three programmable digital inputs for interfacing with the systems external control and safety interlock circuitry. An additional digital input is preprogrammed for start/stop.
- The VFD shall have two analog signal inputs. One dedicated for sensor input and one for external set point input.
- One programmable analog output shall be provided for indication of a drive status.
- The VFD shall provide two user programmable relays with selectable functions. Two form 'C' 230VAC/2A rated dry contact relay outputs shall be provided.
- The VFD shall store in memory the last 5 faults with time stamp and recorded data.
- The VFD shall be equipped with a standard RS-485 serial communications port for communication to the multi-pump controller. The

bus communication protocol for the VFD shall be the same as the controller protocol.

(15) VFD service conditions:

- Ambient temperature operating range, -10 to 45ºC (14 to 113□F).
- 0 to 95% relative humidity, non-condensing.
- Elevation to 1000 meters (3,300 feet) without derating.
- VFD's shall be rated for line voltage of 380 to 480VAC; with +10% to -15% variations. Line frequency variation of ± 2% shall be acceptable.
- No side clearance shall be required for cooling of the units.

d. Fixed Speed Motors

(1) Fixed Speed Motors are to be provided with the following basic features:

(2) Designed for continuous duty operation, NEMA design B with a 1.15 service factor.

(3) Totally Enclosed Fan Cooled or Open Drip Proof with Class F insulation.

(4) Nameplate shall have, as a minimum, all information as described in NEMA Standard MG 1-20.40.1.

(5) Motors shall have a NEMA C-Flange for vertical mounting.

(6) Drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump.

e. Pump System Controller

(1) The pump system controller shall be a standard product developed and supported by the pump manufacturer.

(2) The controller shall be microprocessor based capable of having software changes and updates via personal computer (notebook). The controller user interface shall have a VGA display with a minimum screen size of 3-1/2" x 4-5/8" for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment. Password protection of system settings shall be standard.

(3) The controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

(4) The controller shall display the following as status readings from a single display on the controller (this display shall be the default):

- Current value of the control parameter, (typically discharge pressure)
- Most recent existing alarm (if any)
- System status with current operating mode
- Status of each pump with current operating mode and rotational speed as a percentage (%)

5) The controller shall have as a minimum the following hardware inputs and outputs:

- Three analog inputs (4-20mA or 0-10VDC)

- Three digital inputs
- Two digital outputs
- Ethernet connection
- Field Service connection to PC for advanced programming and data Logging

(6) Pump system programming (field adjustable) shall include as a minimum the following:

- Water shortage protection (analog or digital)
- Transducer Settings (Suction and Discharge Analog supply/range)
- PI Controller (Proportional gain and Integral time) settings
- High system pressure indication and shut-down
- Low system pressure indication and shut-down
- Low suction pressure/level shutdown (via digital contact)
- Low suction pressure/level warning (via analog signal)
- Low suction pressure/level shutdown (via analog signal)
- Flow meter settings (if used, analog signal)

(7) The system controller shall be able to accept up to seven programmable set-points via a digital input, (additional input/output module may be required).

(8) The controller shall have advanced water shortage protection. When analog sensors (level or pressure) are used for water shortage protection, there shall be two indication levels. One level is for warning indication only (indication that the water level/pressure is getting lower than expected levels) and the other level is for complete system shut-down (water or level is so low that pump damage can occur). System restart after shut-down shall be manual or automatic (user selectable).

(9) The system pressure set-point shall be capable of being automatically adjusted by using an external set-point influence. The set-point influence function enables the user to adjust the control parameter (typically pressure) by measuring an additional parameter. (Example: Lower the system pressure set-point based on a flow measurement to compensate for lower friction losses at lower flow rates).

(10) The controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

(11) The pump system controller shall store up to 24 warning and alarms in memory. The time, date and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. The controller shall display the following alarm conditions:

High System Pressure	Low system pressure
Low suction pressure (warning and/or alarm)	Individual pump failure
VFD trip/failure	Loss of sensor signal (4-20 mA)
Loss of remote set-point signal (4-20mA)	System power loss

12) The pump system controller shall be mounted in a UL Type 3R rated enclosure. A self-certified NEMA enclosure rating shall not be considered equal. The entire control panel shall be UL 508 listed as an assembly. The control panel shall include a main

disconnect, circuit breakers for each pump and the control circuit and control relays for alarm functions.

Control panel options shall include, but not be limited to:

Pump Run Lights	Pump Alarm Lights
System Fault Light	Audible Alarm (80 db[A])
Surge Arrestor	Control Panel Internal Illumination
Emergency/Normal Operation Switches	Disconnect Switches Service

(13) The controller shall be capable of receiving a redundant sensor input to function as a backup to the primary sensor (typically discharge pressure).

(14) The controller shall have a pump “Test Run” feature such that pumps are switched on during periods of inactivity (system is switched to the “off” position but with electricity supply still connected). The inoperative pumps shall be switched on for a period of two to three (2-3) seconds every 24 hours, 48 hours or once per week (user selectable).

(15) The actual pump performance curves (5th order

f. Hydropneumatic Pressure Tank

A 34 gallon nominal (or as recommended by pump manufacturer) bladder- type (“bag type”) carbon steel hydropneumatic pressure tank, designed to ASME Code and stamped 200 psi working pressure shall be furnished mounted and piped at the factory. The bladder shall be made of heavy duty butyl rubber and FDA approved for potable water applications.

g. Sequence of Operation

The system controller shall operate from one to two pumps and one Variable Frequency Drive (VFD) to maintain a constant discharge pressure (system setpoint). The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. When a flow demand is detected (drop in system pressure) the VFD controlled pump shall start first. As flow demand increases, the speed of the VFD controlled pump shall be increased to maintain the system setpoint pressure. When the VFD controlled pump cannot maintain the system setpoint as flow increases (pressure starts to drop below system set-point), an additional pump will be started Direct-On-Line (DOL). The VFD controlled pump shall immediately adjust speed to maintain the system set-point.

Additional DOL pumps shall be started as flow demand increases. As flow demand decreases, the pump speed shall be reduced while system set-point pressure is maintained. The system controller shall switch off DOL operated pumps as required with decreasing flow.

The system controller shall be capable of switching pumps on and off to satisfy system demand without the use

h. Low Flow Stop Function

The system controller shall be capable of stopping pumps during periods of lowflow

or zero-flow without wasting water or adding unwanted heat to the liquid. Temperature based no flow shut-down methods that have the potential to waste water and add unwanted temperature rise to the pumping fluid are not acceptable.

Standard Low Flow Stop and Energy Saving Mode

If a low or no flow shut-down is required (periods of low or zero demand) a bladder type diaphragm tank shall be installed with a pre-charge pressure of 70% of system set-point. The tank shall be piped to the discharge manifold or system piping downstream of the pump system. When only one pump is in operation the system controller shall be capable of detecting low flow (less than 10% of pump nominal flow) without the use of additional flow sensing devices. When a low flow is detected, the system controller shall increase pump speed until the discharge pressure reaches the stop pressure (system set-point plus 50% of programmed on/off band). The pump shall remain off until the discharge pressure reaches the start pressure (system set-point minus 50% of programmed on/off band). Upon low flow shut-down a pump shall be restarted in one of the following two ways:

1) Low Flow Restart: If the drop in pressure is slow when the start pressure is reached (indicating the flow is still low), the pump shall start and the speed shall again be increased until the stop pressure is reached and the pump shall again be switched off.

(2) Normal Flow Restart: If the drop in pressure is fast (indicating the flow is greater than 10% of pump nominal flow) the pump shall start and the speed shall be increased until the system pressure reaches the system set-point.

It shall be possible to change from the standard low flow stop to the optional low flow stop (and vice-versa) via the user interface.

System Construction

(1) The suction and discharge manifolds shall be constructed of 316 stainless steel. Manifold connection sizes shall be as follows:

3 inch and smaller:	Male NPT threaded
4 inch through 8 inch:	ANSI Class 150 rotating flanges
10 inch and larger:	ANSI Class 150 flanges

(2) Pump Isolation valves shall be provided on the suction and discharge of each pump. Isolation valve sizes 2 inch and smaller shall be nickel plated brass full port ball valves. Isolation valve sizes 3 inch and larger shall be a full lug style butterfly valve. The valve disk shall be of stainless steel. The valve seat material shall be EPDM and the body shall be cast iron, coated internally and externally with fusion-bonded epoxy.

(3) A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. The head loss through the valve shall not exceed 5 psi at the pump design capacity. Check valves 1-1/2” and smaller shall have a POM composite body and poppet, a stainless steel spring with EPDM or NBR seats. Check valves 2” and larger shall have a body material of stainless steel or epoxy coated iron (fusion bonded) with an EPDM or NBR resilient seat. Spring material shall be stainless steel. Disk shall be of stainless steel or leadless bronze.

(4) For systems that require a diaphragm tank, a minimum diaphragm tank connection size of ¾" shall be provided on the discharge manifold.

(5) A pressure transducer shall be factory installed on the discharge manifold (or field installed as specified on plans). Systems with positive inlet gauge pressure shall have a factory installed pressure transducer on the suction manifold for water shortage protection. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

(6) A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2/1/2 %. The gauge shall be capable of a pressure of 30% above its maximum span without requiring recalibration.

(7) Systems with a flooded suction inlet or suction lift configuration shall have a factory installed water shortage protection device on the suction manifold.

(8) The base frame shall be constructed of corrosion resistant 304 stainless steel. Rubber vibration dampers shall be fitted between each pump and baseframe to minimize vibration.

(9) The control panel shall be mounted on a 304 stainless steel fabricated control cabinet stand attached to the system skid.

Elevator Pit Pumps

Furnish and install where shown on the plans, four (4) sets of automatic, portable, and submersible dewatering sump pump, constructed with cast iron casing, hard cast iron impeller, mounted on ball bearing supported shaft, double mechanical seal, capable of delivering 15 GPM against 25 FT. TDH driven by a 3/4 HP submersible motor, 3500 RPM, 230 Volts, single phase, 60 hertz, equipped with thermal motor protector, automatic level control, and all necessary accessories.

1001.3 Construction Requirements

DRAINAGE SYSTEM TESTS

a. The entire drainage and venting system shall have all necessary openings which can be plugged to permit the entire system to be filled with water to the level of the highest stack vent and/or vent stack above the roof.

b. The system shall hold this water for a full thirty (30) minutes during which time there shall be no drop more than 100 mm.

c. If and when the Engineer decides that additional test is needed, such as an air or smoke test on the drainage system, the Contractor shall perform such test without additional cost.

PRESSURE TESTS FOR WATER LINES

a. After the pipe have been installed, the joints completed and with joints exposed for examination, all newly installed pipe or any valve section, thereof, shall be subjected

to hydrostatic pressure one and one half (1½) the designed working pressure of the system or as specified by the Engineer.

b. The duration of each pressure test shall be at least 10 minutes unless otherwise specified by the Engineer.

c. Each section of pipeline shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. During the filling of the pipe and before applying the test pressure, all air shall be expelled from the pipeline. To accomplish this, tap shall be made if necessary, at the highest point of the pipe under test and after completion of the test, the taps shall be tightly plugged unless otherwise specified. During the test, all exposed pipes, fittings, valves, joint and couplings will be carefully examined. If found to be cracked or defective, they shall be removed and replaced by the Contractor with sound materials at his expense. The test shall then be repeated until satisfactory results are obtained.

LEAKAGE TESTS FOR WATER LINES

a. Leakage test shall be conducted after satisfactory completion of the pressure test and shall consist of an examination of all exposed joints for leakage as well as an overall leakage test of the completed pipeline.

b. The pressure to be maintained during the test shall be the designed working pressure of the system.

c. Leakage test shall be made only after a minimum of 24 hours after the pipe to be tested has been filled with water.

d. The duration of each leakage test shall be two hours unless otherwise specified by the Engineer.

e. Each section of pipe line shall be slowly filled with water and the specified test pressure, measured at the point of lowest elevation shall be applied by means of a positive displacement type pump and reservoir connected to the pipe in a manner satisfactory to the Engineer.

f. Before starting the leakage test, all air shall be expelled from the pipe. All exposed pipes, fittings, valves and joints shall be examined for leakage during the test.

g. Allowable leakage rate per 100 joints per inch of Pipe Diameter at Pressure Stipulated.

Pressure		Leakage Rate	
PSI	KG/CM^2	LITERS/HR	LITERS/2 HRS.
50	3.5	1.45	2.90
75	5.3	1.75	3.50
100	7.0	2.05	4.10
125	8.8	2.30	4.60
150	10.5	2.50	5.00
200	14.0	2.90	5.80

Defective Work

a. If the inspection or test shows any defect, such defective work or material shall be replaced and the test shall be repeated until satisfactory to the Engineer.

b. All repairs to piping shall be made with new materials at the expense of the Contractor.

c. No caulking of screwed joints or holes will be accepted.

Test Certificate

Test Certificate shall be filled up and signed by the Owner's representative.

Disinfection of Water Distribution System

a. The entire water system shall be thoroughly flushed and disinfected with chlorine before it is placed on operation.

b. Chlorination materials shall be liquid chlorine or hypochlorite, as specified and shall be introduced into the water lines in a manner approved by the Engineer.

c. The chlorine dosage shall be such as to provide not less than fifty parts per million (50 ppm) available chlorine.

d. Following a contact period of not less than sixteen (16) hours, the heavily chlorinated water shall be flushed from the system with clean water until the residual chlorine content is not greater than two tenth parts per million (0.20 ppm). All valves in water lines being sterilized shall be opened and closed several times during the 16-hour chlorinating period.

Cleaning

a. All exposed metal surfaces shall be free of grease, dirt of other foreign materials.

b. Chrome or nickel plated pipings, fittings and trimmings shall be polished upon completion.

c. All plumbing fixtures shall be properly protected from use and damage during the construction stage. The fixtures shall be cleaned to the satisfaction of the Engineer upon completion and prior to acceptance of work.

d. All equipment, pipes, valves and fittings shall be cleaned of grease and sludge which may have accumulated. Any clogging, discoloration or damage to other parts of the building due to the system shall be repaired by the Contractor.

Painting and Protection

a. All exterior of pipings to be installed in or through concrete floor fill or fill floors and underground shall be given one coat of acid resisting paint having a bituminous base.

b. Pipe hanger supports and all other iron work in concealed spaces shall be painted with one coat of asphalt.

Color Code for Exposed Pipes

a. All exposed pipings shall be adequately and durably identified by distinctive colored paints as follows:

Item	Color Code
cold water (potable) line	blue
non-potable water line	white
storm water pipe	aluminum
sewage pipe	black
waste pipe	gray
vent pipe	green

Warranty and "AS - BUILT" Plans

a. All works, equipment and fixtures shall be guaranteed by the Contractor for satisfactory service for a minimum period of one (1) year.

b. The Contractor shall submit to the Owner, in reproducible form plus three (3) sets of white prints, the complete plans of the entire system as actually built. The cost of those shall be borne by the Contractor. Submittal of "AS BUILT" Plans shall be a condition to final payment.

Responsibility

The general Contractor shall be responsible for the coordination among the different trades on the job in order to finish the work in the least possible time, in strict accordance with the Plans and Specifications.

a. Throughout the construction period open ends of all installed pipe lines shall be kept closed by temporary plugs.

b. Drainage lines shall not be used to conduct dirty construction washed water especially those with cement mixes to avoid possible clogging.

c. A temporary fire protection system shall be provided by the Contractor during the construction period. This shall be of sufficient capacity to put out any fire that may break out at any floors due to construction operations. This is in addition to temporary fire extinguisher required.

d. A temporary potable water supply shall be made available to construction workers as construction progresses.

e. A temporary human excreta disposal system shall be provided by the Contractor to serve the workers during the construction period.

1001.4 Method of Measurements

Measurement for payment of pipe fittings, valves, hose bibbs, drains, clean-outs, p-traps, excavation, backfill, sand and other miscellaneous shall be the actual number furnished, placed and accepted.

Measurement for payment of variable speed booster system and elevator pit pumps shall be the actual number of sets furnished, placed and accepted.

Measurement for payment of pipes of the type and size specified including trenching, bedding and backfill, as required, shall be the linear meter installed and accepted.

1001.5 Basis of Payments

The quantities measured as provided in Method of Measurement, shall be paid for at the contract unit price, respectively, for each of the Pay Item shown in the Bill of Quantities, which price and payment shall be full compensation for trenching, bedding and backfilling for pipelines, for furnishing and placing all materials including labor, equipment, tools and incidentals necessary to complete the work prescribed in this Section.

Payment will be made in accordance with the Bill of Quantities.

Pay Item Number	Description	Unit of Measurement
1001 (a)	PVC Pipes, 300mm dia	Lm
1001 (b)	PVC Pipes, 250mm dia.	Lm
1001 (c)	PVC Pipes, 200mm dia.	Lm
1001 (d)	PVC Pipes, 150mm dia.	Lm
1001 (e)	PVC Pipes, 100mm dia.	Lm
1001 (f)	PVC Pipes, 75mm dia.	Lm
1001 (g)	PVC Pipes, 50mm dia.	Lm
1001 (h)	PVC Pipes, 32mm dia	Lm
1001 (i)	PVC Pipes, 25mm dia	Lm
1001 (j)	PVC Pipes, 20mm dia	Lm
1001 (k)	PVC Pipes, 12.7mm dia	
1001 (l)	Cistern Tank 4.0m3,	Each
1001 (m)	Spherical Tank 4.0m3,	Each
1001 (n)	Septic Tank 2.7m x 2.0m x 1.5m,	Each
1001(o)	Oil and Grease Interceptor	
1001(p)	Concrete Trench & Grating Cover	Each
1001(q)	Catch Basin 600mm x 600mm	
1001(r)	Water Closet with Tank and standard accessories.	Set
1001(s)	Lavatory with Faucet and standard accessories.	set
1001 (t)	Roof Strainer, 100mm dia.	Each
1001 (u)	Supply and Installation of waterlines system including pipes, fittings, valves and other appurtenances to complete as specified in the drawings. (Market Hall)	lot
1001 (v)	Urinal with flush valve and standard accessories	set
1001 (w)	Floor Drain, 50mm dia.	Each

1001 (x)	Supply and Installation of waterlines system including booster pumps, controller, pipes & fittings, valves, wiring and other appurtenances to complete as specified in the drawings.	lot

PART J – MECHANICAL WORKS

ITEM 1200 – Refrigerated Truck/Van, Air Conditioning System, Pumps & Fittings

ITEM 1200 – AIR CONDITIONING & REFRIGERATION SYSTEM

1200.1 Description

This Item shall consist of furnishing and installation of air conditioning, refrigerated truck/van, ice plant and its refrigeration system inclusive of all necessary electrical connections, ductworks, grilles, pipes and condensate drains and all accessories ready for service in accordance with the approved Plans and Specifications.

1200.1.1 Submittals

1200.1.1.1 Manufacturer's Data

Submit manufacturer's data for all materials and equipment to be incorporated in the work.

1200.1.1.2 Shop Drawings

Submit shop drawings for the overall system and each major component. Drawing shall illustrate how each item of equipment will function, system schematic diagram, one line diagram and equipment layout.

1200.1.1.3 Operation and Maintenance

Submit three copies of operating and maintenance manual.

1200.2 Material Requirements

The types, sizes, capacities, quantities and power characteristics of compressor, evaporator, condenser chilled water pump and condenser water pump shall be as specified or as shown on the Plans.

1200.2.1 Refrigerant Pipes

Refrigerant pipes shall be copper tubing, type L or K or black steel pipe, Schedule 40 for size of 100mm diameter and smaller. Pipes over 100mm shall be black steel pipe Schedule 40.

Black steel pipe shall be standard seamless, lap-welded, or electric resistant welded for size 50mm diameter and larger, screw type for size 38mm diameter and smaller, fittings for copper tubing shall be cast bronze fitting designed expressly for brazing.

1200.2.2 Pipes for Cooling Water

Chilled and condenser cooling water pipes shall be black steel pipe, Schedule 40.

Pipes and fittings for size 50mm diameter and smaller shall be screwed type. Pipes and fittings for size 62mm diameter and larger shall be welded or flanged type.

1200.2.3 Pipe Insulations

Insulations shall be pre-formed fiberglass or its equivalent.

The insulating materials shall be covered with 100mm x 13mm thick polythelene film which shall be overlapped not less than 50mm. Pipe insulations shall be adequately protected at point of support by means of suitable metal shield to avoid damage from compression. Insulated pipes valves and fittings located outdoors shall be provided with metal jackets.

1200.2.4 Ductworks

Ducts shall be galvanized sheet steel of not less than the following gages:

1. No. 26 for 300mm wide and smaller
2. No. 24 for 350mm to 750mm wide
3. No. 22 for 775mm to 1500mm wide
4. No. 20 for 1525mm to 2250mm wide
5. No. 18 for 2275mm to 2500mm or higher

Joints and stiffeners of ducts using slips joints shall be as follows:

a. 300mm wide and smaller, without brasing
b. 325mm to 750mm wide, brace with 31mm x 3mm steel angles
c. 775mm to 1500mm, brace with 31mm x 3mm steel angles
d. 1525mm up, brace with 38mm x 3mm steel angles

Stiffeners shall be located not more than 1200mm from each joint.

1200.2.5 Ductwork Insulation

The application insulation materials shall be rigid board made of styropor or equivalent 25mm thick for ground and top floor, 13mm thick for intermediate floor.

Galvanized metal bands for ducts shall be secure and spaced 300mm minimum center to center and corners shall be protected with galvanized metal angles.

1200.2.6 Diffusers

The type, shape, capacity, size and location shall be as shown in the Plans.

Diffusers shall be complete with frame and gasket, equilizing deflector and volume control as indicated or specified and shall have factory-applied prime coat of paint.

Samples of supply and return air diffusers shall be submitted for approval before mass fabrication and installation.

1200.2.7 Dampers

Dampers shall be of same materials as duct, at least one gage heavier and shall have accessible location, complete with locking device for adjusting and locking damper in position.

Where necessary, splitters, butterflies and louvers damper deflecting vanes for control of air volume and direction and for balancing the system shall be provided whether or not they are indicated on the Plans.

1200.2.8 Fire Dampers

Main duct shall be provided with proper fire dampers of the fusible link actuated type.

Access door shall be provided in ductwork for renewal of fusible link and to reset damper.

1200.2.9 Equivalent Foundation

Foundation shall be provided and shall conform to the recommendation of the manufacturer of the equipment. Equipment shall be leveled on foundation by means of jacks or steel wedges. All spaces between equipment bases and concrete foundation shall be filled with cement mortar.

1200.2.10 Electrical Works

Power supply shall be provided by the Contractor at the pull box installed inside the machine room and shall furnish and install the main circuit breaker and starter with suitable ratings and capacities, conduits, wirings, fittings, devices and all other equipment and electrical connections needed to complete the electrical installation of the system. All electrical works shall comply with the latest edition of the Philippine Electrical Code, with the applicable ordinance of the local government and all the rules and requirements of the local power company.

1200.3 Construction Requirements

The air conditioning system shall be entirely automatic in operation and shall not require the presence of an attendant except for periodic inspection for lubrication. All equipment and materials shall be inspected upon delivery and shall be tested after installation. Piping shall not be buried, concealed, or insulated until it has been inspected, tested and approved. Walls, floors and other parts of the building and equipment damaged by Contractor in the performance of the work shall be replaced as shown on the Plans.

1200.3.1 Operating Tests

Refrigerating equipment shall be tested for 8-hours per day for three consecutive days or longer when so directed, under the supervisions of manufacturers qualified and authorized representative, who will make necessary adjustments and instruct designated plant operation personnel for each operation and maintenance of refrigerating equipment and controls.

Operating test of complete air conditioning system shall be 6-hours minimum for each system. Tests of air flow, temperature and humidity shall be made to demonstrate that each complies with the requirements of the Plans and Specifications.

1200.3.2 Guarantee and Service

All equipment, materials and workmanship shall be guaranteed for a period of one (1) year from the date of acceptance at any time within the period of guarantee and upon notification, the Contractor shall repair and rectify the deficiencies, including replacement of parts or entire units.

1200.3.3 Miscellaneous

The owner shall be provided with three (3) bound copies “AS BUILT” diagram, shop drawings, part lists, serial number and inventory of equipment including manufacturers operating and maintenance manuals.

All standard tools and equipment shall be furnished for proper and regular maintenance of installed equipment.

1200.4 Method of Measurement

The work under this item shall be measured either by set, lot actually placed and installed as shown on the Plans.

Compressor, condenser and evaporator shall be measured by set, grilles, diffusers and valve by piece, pipe by length, duct and insulation by square meter.

1200.5 Basis of Payment

All work performed and measured and as provided for in the Bill of Quantities shall be paid for at the Unit Bid or Contract Unit Price which payment shall constitute full compensation including labor, materials, tools and incidentals necessary to complete this item.

Payment shall be made under:

Pay Item Number	Description	Unit of Measurement
1200 (1)	ACCU/FCU - 1 , 2.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (2)	ACCU/FCU - 2 , 2.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (3)	ACCU/FCU - 3 , 2.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (4)	ACCU/FCU - 4 , 0.8 hp, 220V-240V, 60HZ, 1PH	set
1200 (5)	ACCU/FCU - 5 , 0.67 hp, 220V-240V, 60HZ, 1PH	set
1200 (6)	ACCU/FCU - 6 , 2.2 hp, 220V-240V, 60HZ, 1PH	set
1200 (7)	ACCU/FCU - 7 , 0.7 hp, 220V-240V, 60HZ, 1PH	set
1200 (8)	ACCU/FCU - 8 , 0.9 hp, 220V-240V, 60HZ, 1PH	pc
1200 (9)	ACCU/FCU - 9 , 3.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (10)	ACCU/FCU - 10 , 2.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (11)	ACCU/FCU - 11 , 1.2 hp, 220V-240V, 60HZ, 1PH	set
1200 (12)	ACCU/FCU - 12 , 1.67 hp, 220V-240V, 60HZ, 1PH	set
1200 (13)	ACCU/FCU - 13 , 1.67 hp, 220V-240V, 60HZ, 1PH	set
1200 (14)	ACCU/FCU - 14 , 2.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (15)	ACCU/FCU - 15 , 2.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (16)	ACCU/FCU - 16 , 1.5 hp, 220V-240V, 60HZ, 1PH	set
1200 (17)	ACCU/FCU - 17 , 3.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (18)	ACCU/FCU - 18 , 1.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (19)	ACCU/FCU - 19 , 3.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (20)	ACCU/FCU - 20 , 1.5 hp, 220V-240V, 60HZ, 1PH	set
1200 (21)	ACCU/FCU - 21 , 2.0 hp, 220V-240V, 60HZ, 1PH	set
1200 (22)	Supply and Installation of (30 Tons) Ice Making Plant with complete civil, structural, mechanical and electrical works as specified in the drawings.	lot
1200 (23)	Dismantle of contact freezer with sub-accumulator equipment as specified in the drawings.	lot
1200 (24)	Supply and delivery of (2) two brand new 20 footer refrigerated truck/van, (2) two brand new 10 footer refrigerated truck/van and (3) three 40 footer reefer van stationary type.	lot

ITEM 1201 - WATER PUMPING SYSTEM

1201.1 Description

This Item shall consist of furnishing and installation of water pumping system, inclusive of all pipings and pipe connections, valve, controls, electrical wirings, tanks and all accessories ready for service in accordance with the approved plans and specifications.

1201.2 Material Requirements

1201.2.1 Water Pump

The type, size, capacity, location, quantify and power characteristics shall be as specified or as shown on the Plans.

1201.2.2 Overhead Tank

The tank shall be provided with manhole, cover, drain pipes, distribution pipe outlet, overflow pipes and air vent. Suitable float switch or electrode shall be provided in the tank to stop and start the operation of the pump.

1201.2.3 Pneumatic Tank

Tank shall be designed for twice the maximum total dynamic pressure required and shall have the following accessories.

a) A suitable pressure switch to stop pump if pressure required is attained.
b) Air volume control device to maintain correct air volume inside the tank.
c) Electrode to be connected in the motor pump control to control the water level.
d) Air compressor shall be provided for tank of 3,785 liters to maintain air pressure inside the tank.

1201.2.4 Air Compressor

The air compressor shall be electric motor driven with sufficient capacity. The compressor shall be V-belt driven and both motor and compressor shall have V-sheaves on the flywheels. The compressor and motor shall be mounted on a base of structural steel with anchor clips drilled to permit securing to a foundation.

1201.2.5 Pipes and Fittings

All pipes and fittings shall be G.I. pipe Schedule 40. All pipings 100 mm and larger shall be welded or flanged while smaller sizes shall screwed.

1201.2.6 Valves

A gate valve followed by a check valve shall be placed between discharge of pump and tank to prevent back flow of water when pump stops.

1201.2.7 Foundation

Refer to sub-section 1200.2.9 – Concrete Works.

1201.2.8 Electrical Works

Refer to sub-section 1200.2.10 – Electrical Works.

1201.3 Construction Requirements

Exposed pipings shall be provided with concrete saddle or steel clamps or hangers to secure them firmly to the building structures. Pipe treads shall be lubricated by white lead, red lead, Teflon or other approved lubrication before tightening. Piping support shall be placed at 3 meters interval or less.

1201.3.1 Test

Appropriate test shall be done to demonstrate that the system complies with the requirements of the Plans and specifications.

1201.3.2 Guarantee and Service

Refer to sub-section 1200.3.2 – Electrical Works.

1201.3.3 Miscellaneous

Refer to sub-section 1200.3.3 – Air Conditioning System.

1201.4 Method of Measurement

The work under this Item shall be measured either by set, length and piece actually placed and installed as indicated on the Plans. Equipment shall be measured by set, pipes by length, valves and fittings including pipes by length.

1201.5 Basis of Payment

All work performed and measured and as provided for in this Bill of Quantities shall be paid for at the unit bid or Contract Unit Price which payment shall constitute full compensation including all materials, labor equipment, tools and incidentals necessary to complete this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
1201 (a)	Booster Pump 25GPM vs. 30m Head (1.0hp)	Set
1201 (b)	Hydro Pneumatic Tank, 205 Gallons Water Tank (including roughing-ins and fittings)	Set
1201 (c)	Fire Hydrant Assembly, 100mm dia. Valves, Pressure Gauge	Set
1201 (d)	Stand Pipe (50mm dia.) (including connections, gate valves and fitting)	Assy
1201 (e)	PVC Pipe, 150mm dia. Class 100 (Water lines) Depth ≤ 2.0m	Lm

Pay Item Number	Description	Unit of Measurement
1201 (f)	PVC Pipe, 100mm dia. Class 100 (Water lines) Depth ≤ 2.0m	Lm
1201(g)	PVC Pipe, 75mm dia. Class 100 (Water lines) Depth ≤ 2.0m	Lm
1201(h)	PVC Pipe, 50mm dia. Class 100 (Water lines) Depth ≤ 2.0m	Lm
1201(i)	PVC Pipes, 200mm dia.(Sewer Line)	Lm
1201(j)	PVC Pipes, 150mm dia.(Sewer Line)	Lm

ITEM 1202 – SEWAGE TREATMENT PLANT

1202.1 Description

This Item shall consist of furnishing and installation of Sewage Treatment Plant, inclusive of all pipings and pipe connections, valve, controls, electrical wirings, tanks and all accessories ready for service in accordance with the approved plans and specifications.

1202.2 Material Requirements

This Specification sets out the detailed scope of works and requirements for the design, construction, installation, testing, commissioning, and bringing into operation the Sewage Treatment Plant.

The intent of this Specification is to provide guidance to the Contractor to design, construct, install, test, commission, and bring into operation the Sewage Treatment Plant conceived for the project.

1202.2.1 ASSUMPTIONS

The design of the STP shall be based on the following assumptions;

Domestic sewage and other organic wastes containing BOD equal or less than 500 mg/l will discharge directly to the proposed Sewage Treatment Plant (STP).

1202.2.2 DESIGN CRITERIA

The following are the conditions or design criteria under which the sewage treatment facilities shall be designed:

Process: The Contractor's Proposed Sewage Treatment process shall comply with all the requirements of this specification and approval of the Owner. It consists of physic-chemical and biological treatment processes for the degradation and removal of pollutants present in the waste stream.

Influent Characteristics:

Sewage Flow Rate

	Phase 1
Average Daily Flow, m3/day	200
Peak Hour Flow, m3/hr	20.0

Sewage Characteristics:

a. Ph : 6 to 9
b. 5-day 20°C Biochemical Oxygen Demand (BOD) : 500 mg/L
c. Chemical Oxygen Demand (COD) : 1000 mg/L
d. Total Suspended Solids (TSS) : 200 mg/L
e. Surfactants : 50 mg/L
f. Oil and Grease : 50 mg/L
g. Color : 100 PCU

Effluent Characteristics

The effluent shall conform to Class C, Inland Water Effluent Standards as specified in Table 2A – Effluent Standard: Conventional and Other pollutants in Protected Waters Category I & II and in Inland Water Class C, DENR Administrative Order No.08, series of 2016 as shown in Table 1.

Sewage Treatment Plant Area

The maximum volume allocation for the Proposed Sewage Treatment Plant (STP) is approximately 130 cu.m. ($m^{3)}$.

Contents of Proposals

All proposals shall include but not limited to the following items:

Catalogs/brochures showing the Technical data of equipment, such as weights, physical dimensions and performance characteristics.

Plant layout showing the arrangement and dimensions of all concrete/steel tanks and equipment mounting.

Process flow diagram of Sewage Treatment Plant.

Control and instrumentation diagrams of proposed Sewage Treatment Plant.

Testing and commissioning procedures, as well as, operation and maintenance manuals for the start-up, operation, and maintenance of STP.

Complete list of chemicals to be used in the proposed Sewage Treatment Plant. Chemicals needed for the Sewage Treatment Plant must be available in the local market.

A full breakdown of plant operating and maintenance cost table on a monthly basis; assuming that the plant is treating 100%, 75%, 50% and 25% of the design flows, and also expressed as a cost per cubic meter of effluent treated.

Equipment part list indicating the source of supply and recommended spare parts.

Details of proposed construction installation and commissioning schedule within the framework of the Owner's schedule as in this document.

Company profile showing the Contractor's background and experience including a list of past and present Sewage Treatment projects done in the last five years.

Compliance with DENR-EMB

The complete system shall meet the requirement of the Department of Environment and Natural Resources- Environmental Management Bureau (DENR-EMB) as shown in Table 1 on the quality of the effluent and all other requirements. The contractor shall obtain permit to construct and the final permit to operate the Sewage Treatment Plant.

Schedule of Operation

Contractors are advised to consider in their proposal the commissioning, operation and maintenance starting from the acceptance of the works.

1202.2.3 SEWAGE TREATMENT PLANT COMPONENTS

The proposed sewage treatment process shall consist of physic-chemical and biological treatment facilities. Physical treatment processes consists of screening, oil separator and pre-aeration/equalization and equalization tank. The biological treatment processes composed of a contact reactor. Aeration tank and settling tank/clarifier. Chlorine disinfection is the cheapest and most effective disinfection method. Waste activated is further treated in a separate sludge digestion tank. Sludge cakes produced will be hauled and disposed offsite.

Physical Treatment

Screening

Raw sewage will be collected through a sewer system that converged at the sewage treatment plant. Sewage flows by gravity to a bar screen chamber where large objects such as rags, paper, plastics, metals and the like will be removed. These objects, if not removed, may damage the pumps, hang over weirs and block valves, nozzles, channels, pipelines and appurtenances, thus creating serious plant operation and maintenance problems.

Bar screen clear opening between bars should be no less than 25.4 mm (one inch) for manually clean screens. It should be placed on a slope of 30 to 45 degrees from the horizontal. The bar screens shall be protected by guard railing and deck gratings, with adequate provisions for removal or opening to facilitate raking.

Oil-Water Separator

Fiberglass underflow baffles shall be installed to trap floating oil and grease which will be scraped from the surface and disposed together with other solids.

Equalization Tank

Influent flows through a collection tank in which shall be utilized as Equalization Tank, wherein incoming sewage with different characteristics is mixed and homogenized. Two

submersible lift pumps, one duty and the other as stand-by, (with flow control valves to control transfer of sewage), shall be installed in the equalization tank. The PLC shall control the transfer of influent wastewater from the Equalization Tank to the Contact Reactor.

Biological Treatment

Equalized wastewater overflows to the Contact Reactor wherein organic pollutants are completely mixed with the return-activated sludge (RAS). Complete mixing would mean better contact between the biomass and the organic pollutants preventing the occurrence of “sludgebulking” which is the most common problem encountered in conventional activated sludge process.

Contact Reactor

Equalized wastewater overflows to the Contact Reactor wherein organic pollutants are completely mixed with the return-activated sludge (RAS). Complete mixing would mean better contact between the biomass and the organic pollutants preventing the occurrence of “sludge-bulking" which is the most common problem encountered in conventional activated sludge process.

Aeration

Completely mixed wastewater from the contact reactor overflows ti the aeration tank wherein aerobic and facultative bacterial culture is maintained in complete suspension. The tanks are equipped with turbine diffusers with blower to provide the required air flow for aerobic bacterial growth and activity. A mixed liquor suspended solids (MLSS) concentration of 4,000 mg/l shall be maintained for the biodegration of the estimated 250 kilograms per day BOD load. The Food-to-Mass (F/M) ratio therefore is 0.35 kilograms of BOD per kilogram of MLSS daily which is within the range of typical values. The turbine diffusers serve dual purpose. First, it supplies oxygen for aerobic bacterial growth and second, they serve as mixers regime so that the biomass is maintained in active suspension.

Clarifier

From the aeration tank, the mixed liquor shall overflow to the clarifier for the separation of sludge (bioflocs) from the clear water (supernatants). Settled sludge at the hopper is recycled back to the aeration tank in order to maintain the MLSS level. Excess sludge is wasted in the sludge disgestion tank for further treatment.

Disinfection

Chlorine Contact Chamber

Decanted sewage from the clarifier shall be disinfected in the chlorine contact chamber. The chlorine contact chamber shall be provided with baffles to avoid short-circuiting of flows and designed for at least 30 minutes retention time. Enteric organisms associated with various waterbone disease contained in the sewage shall be removed.

High Test Hypochlorite (HTH) chemicals shall be used. HTH shall be diluted to 1% solution and diffuse to the chlorine contact chamber over a 24-hour period. Treated effluent from the chlorine contact chamber shall be discharged to the nearest water body.

The contractor shall furnish and install chlorine contact tank, chlorine diffusion equipment, HTH batch mixing tank, and dosing pump.

Flow Measurement

The Effluent sewage shall be provided with measuring devices such as electronic transducers that can be read/accessed from the programmable logic.

Sludge Digestion

Waste activated sludge is further treated in a separate sludge digestion tank where the endogenous phase of the microorganisms occur. In the endogenous phase, the microorganisms are forced to metabolize their own protoplasm without replacement because the concentrations of available food is at a minimum, disintegrates and the contents of the cell enter the growth medium. Many of the components of which the cell consisted are frequently utilized for further cell growth. This phenomenon is referred to as “cryptic growth”. This means

Monitoring Devices (Optional)

pH and DO probe with indicators shall be installed at the equalization tank and aeration tanks for monitoring purposes.

SEWAGE TREATMENT PLANT EQUIPMENT

General

Under this section, mechanical equipment will include the furnishing, installation, and testing under operational conditions, of all items required by the STP. Insofar as possible and practicable, equipment items will be standard units of reputable manufacturers regularly engaged in the design, fabrication and testing of their product from the United States of America and/or Japan. These specifications stipulate that the contractor shall engage the services of competent personnel to test the installed equipment and to acquaint and train the treatment plant personnel on operation and maintenance procedures.

Unless otherwise specified, contractors shall provide two sets of electro-mechanical equipment with one set normally operating and the second set serving as stand-by.

Equipment

Lift Pumps

Furnish and install two (2) sets of Submersible Sewage Pumps with adequate capacity to handle the daily sewage flow. Each lift pump shall have the capacity equivalent to average flow.

Pump casing, shaft, impeller, bearing, housing, pump pedestal, and motor pedestal will be fabricated of materials suitable to handle wastewater and resistant to corrosive environment. Lift pumps shall originate from U.S. or Japan and should be factory assembled.

Bar Screen

The influent box shall be furnished with a removable stainless steel bar screen and the necessary fasteners for connecting to the plant influent box.

Aeration System

Furnish and install a complete aeration system designed to provide adequate aeration for the daily design sewage flow. The aeration equipment shall consist of removable components or sub-assemblies made of corrosion-resistant material for easy maintenance and shall be equipped with a regulating valve for adjusting or shutting off air flow.

Sludge Return System

The plant shall be provided with a return loop of activated sludge from the settling tanks to the aeration tanks by means of a non-clog centrifugal pump. The system shall be designed for maximum case of maintenance.

Air Supply system (Air Blower)

The air requirement of the plant shall be supplied thru three (3) rotary positive displacement blowers of identical capacities. The capacity of each blower shall be fifty percent (50%) of the total air requirement at the ultimate design flow.

Each blower shall be provided with an inlet filter, silencer regulator to vary the air output, a weighted type air relief valve and shut-off valve. Blower shall originate from U.S. or Japan.

Chlorination

Furnish and install an automatic chlorinator capable of delivering the required dosage of solution in a variable sewage flow condition. The equipment shall be equipped with discharge tubing, motor, sensor/transmitters, chlorine solution tanks and chlorine residual analyzers for chlorine residual monitoring.

Test Kit

Furnish with the plant a portable test kit to include the necessary equipment and chemical reagents to determine dissolved oxygen, settleable solids, relative stability and hydrogen ion concentration (pH). The kit shall be provided with instructions/manual for performing the analysis. The equipment and reagents shall be completely contained in a portable container with a hinged cover and carrying handle.

Ventilation System for Facility

Furnish, install and test ventilating equipment (fresh air and exhaust air fans) for the underground sewage treatment plant including fans, ductworks, dampers, hangers, controls and other incidental materials to make the system operational and served its purpose of providing adequate air change and recirculation in the plant area as per indoor air quality standard.

Motors

General Requirements

a. Motor types required for project: Refer to other parts of Specifications.

b. Motors shall be furnished with driven equipment to assure proper coordination of motor and control characteristics with requirements of driven equipment. Contractor is responsible for proper correlation of horsepower, starting torque, other characteristics of electrical equipment with requirement of driven equipment.

c. All necessary accessories essential to the proper operation of the motor and the driven equipment shall be provided.

d. Conform to NEMA Standard No. MGI entitled “Motor and Generators, Induction Motors, Induction Machines in General Motors or approved equal.

e. Conform to ANSI Standard No. C50.2 – 1955 Altering – current Induction Motors, Induction Machines in General and Universal Motors or approved equal.

f. Torque and speed characteristics: suited to the requirements of driven equipment, including gear reducers if specified.

g. Maximum speed: 1750 rpm unless specified otherwise.

h. Horsepower

1. Motor hp rating specified shall be nameplate rating without consideration of motor service factor.

2. Nameplate hp shall be not less than hp required by driven equipment operated at maximum conditions specified.

i. Duty: continuous

j. Service Factor: 1.15

k. Accessories: Lifting tugs as required

l. Motors: specified as 460V, 3-Phase or 230 V, single phase may be designed for single and dual voltage in accordance with manufacturer’s standard for horsepower and speed required.

m. Frequency: 60Hz

Enclosures

Totally enclosed fan-cooled (TEFC) suitable for 40° ambient duty.

All motor unit shall originate from U.S and or Japan.

PIPES, VALVES, AND FITTINGS

Specifications

Where American Standards are specified, or other approved national or local standards may be acceptable, provided copies of the applicable standards specifications are forwarded to the Engineer for his written approval.

Deviation from Piping Specifications

If pipe wall thickness specified herein is not available, use next heavier wall thickness.

General: Specific deviations from the requirement of this Specification may be requested by the Contractor. Such requests may be accompanied by complete design analysis which demonstrate equivalent performance characteristics and compliance with the requirements of the plumbing or other applicable codes. All deviations shall be subject to review and approval by the Engineer.

Submit to the Engineer, for approval, design computations based upon design conditions for piping as stated on the installation drawings.

Piping

Air Distribution Piping

a. For sewage piping; Cast Iron (CI) pipes, extra heavy, conforming to ASTM A74-72.
b. For sludge piping; Centrifugally cast-iron pressure pipes (CCI) seamless, conforming with ISO-13-1978 Class LA.

Valves

Type: Gate, check, globe, and angle valve shall be designed for a minimum hydraulic working pressure of 125 psi.

a. Packed valves shall be back seating, with wing caps
b. Type permitting repacking under pressure when wide open
c. Non-directional

Body Material: Cast Iron

Pressure Class: 862 Kpa (125 psig) or higher.

Bonnet type: 22mm (7/8”) OD and larger: Bolted

Ends: Flanged

Provide special tools required for repacking disassembling valves.

Valves shall bear manufacturer’s logo size and rating integrally cast on, indicating manufacturer, pressure and temperature rating.

Stem arrangements: Outside screw and yoke brass seat and steam, union bonnets. Noncorrosive stem finish on all valve handling sewage.

Gate Valve Discs: solid or flexible single disc wedge type.

Flexible Couplings

Flexible Connectors shall be installed near equipment beside valves installed inside valve boxes and where pipelines leave underground structures to facilitate disassembly of equipment valves and sections of piping.

1202.3 Construction Requirements

1202.3.1 STRUCTURAL SYSTEM

References:

a. American Water Works Association AWWA D100
b. National Structural Code of the Philippines 2010
c. Uniform Building Code 1994
d. ACI 318-11 Building Code Requirements for Structural Concrete and Commentary
e. ACI 350-91 Manual of Concrete Practice Environmental Engineering Structures
f. ACI 224-89 Control of Cracking in Concrete Structures
g. Other ACI Codes, as applicable.

Basic Design Loads

Dead Load:

a. Dead Load
b. Live Load on Roof
c. Hydrostatic Load
d. Lateral Soil Pressure
e. Seismic Load

Basic Design Conditions (where applicable)

Empty reservoir subjected to lateral soil pressure including all surcharge loads during construction and services.

Full reservoir without external passive soil pressure during hydro testing.

Additional load combination specific to environmental structures in compliance with durability requirements per ACI 350-91;

UI = 1.3(1.7DL + 1.7LL + 1.7H)

Special design· requirements include but are not necessary limited to the following:

a. Crack control requirements per ACI 224-89
b. Minimum thickness of walls as per ACI 350-91
c. Maximum spacing of reinforcements as per ACI 350-91

Material Specifications:

a. Concrete : fc'=24.1 MPa, minimum

b. Reinforcing Bars: fy= 414 MPa, minimum
: conforming to PNS 49/ ASTM A615
: deformed, weldable

1202.3.2 ELECTRICAL SYSTEM

Motor Controllers

Applications

a. For motors above 40 hp: combination circuit breaker, reduced-voltage, close-circuit transition magnetic starter, Y-delta, NEMA 1A enclosures.

b. For 1/6 hp thru 40 hp motor: combinations circuit breaker and cross-the-line magnetic starter, NEMA 1A enclosure.

c. Motors below 1/6 hp, 230V, 1 phase: manual type with protections, NEMA 1.

Starters

a. Type
(1) Magnetic - 400V, 30 and 230V, 1 phase provide separate control wiring at 24V.

(2) Manual- 230V, 1 phase.

b. All starters shall be assembled in the Motor Control Center specified in 8.2.
c. Size and rating: UL approved or listed and NEMA standards.
d. Overload relays: One (1) per phase with heaters.
e. Auxiliary Contacts: Provide minimum of two (2) normally open contacts per starter. Provide additional contacts as required by controls.

Circuit Breakers; Provide each starter with molded case breaker complete with thermal magnetic trip and external operating handle.

Pushbutton and Auxiliary ·Controls

a. Type: Heavy duty control stations, star-stop pilot lights.

b. Enclosure: NEMA type 1A for indoor use with dust protecting gaskets, Rust proof metal with baked enamel finish, NEMA type 3R for outdoor use.

Motor Control Center (MCC)

The Contractor shall supply and install the Motor Control Center to be used at the pump house.

Wiring shall conform to NEMA class II type B.

Enclosure bus shall be NEMA type 1A and shall be provided with door- interlocked mechanism. Control units shall be mounted on front only.

Horizontal bus shall be rated not less than 600 amperes with vertical busses rate not less than 300 amperes.

Busses shall be braced for short circuit current of 42, 00 rms. Symmetrical amperes minimum at 400 V.

The enclosures shall be finished with baked light gray enamel over lead primer and rust inhibitor.

Combination circuit breaker and starter shall be as specified under item 8.1, Motor Controller, this Section.

Control transformer shall be connected to emergency supply (dual power supply source).

Control Wiring

All wiring in connection with the control system shall be provided under this Section.

The term, "wiring" shall be construed to include furnishing of wires, conduits, miscellaneous materials, and labor as required for mounting and connecting the electrical control devices.

Control wiring shall be installed in accordance with applicable requirements of Philippine Electrical Code.

All wires between equipment of devices shall be installed in conduit or other approved raceway.

Conduit: UL approved or approved equivalent, mild steel hot dipped galvanized with interior coat of enamel. Conduits shall conform to the requirements of Section 2 151 of the Philippine Electrical Code, such approved PNS 14 polyvinyl chloride.

Conductor

e. Construction: Plain annealed copper strands #18 AWG minimum complying with IPCEA Standards. Shielded if required.

b. Insulation: colored THWN or THW, 600 V complying with the NEC.

c. Establish consistent color code throughout building in so far as practicable. Identifying conductor by means of tape or printed tags or equals markers at equipment and junctions boxes.

d. Use no splices except as approved.

e. Pull wires into conduit using powdered soapstone or commercial wire lubrications; do not use soap solution.

Step-down transformers: Provide step-down transformers as required by control system. Power supplies from distribution boards to transformers shall be provided by the Electrical Contractors.

1202.3.3 MISCELLANEOUS METAL WORKS

Miscellaneous metalwork including pipe handrails, grating supports, ladders, rung, seat angles, guards, stop gates and guides, weir plates, launders and trough, pipe hangers and supports, anchors and appurtenances, shall be stainless steel 316.

1202.3.4 GENERAL PROVISIONS

General Conditions

All particle under this Part shall be subject to the requirements of the Department of Environment and Natural Resources and Environmental Management Bureau.

The term Contractor in these Specifications shall mean the Contractor for the Sewage Treatment Plant.

General Description

The work to be done shall consist of the design and construction, complete in all details, of the Sewage Treatment Plant Works, at the subject premises, and all work and materials incidental to the work that are expressly stated to be done by others .

All work shall be in accordance with the governing Codes and Regulations and with these Specifications, except where same shall conflict with existing codes, etc., in which latter shall then govern.

The requirements with regards to materials and workmanship specify the required standards for the furnishing of all labor, materials and appliances necessary for the complete installation of the work specified herein and indicated on the drawings. These specifications are intended to provide a broad outline of the required installation, but are not intended to include all details of design and construction.

The Contractor shall adopt his proprietary technique to guarantee the safety and performance of the system in accordance with the concepts and criteria set by these Specifications. The Contractor must be experienced in Sewage Treatment Plant works.

No consideration will be granted for any alleged misunderstanding on the quality of materials to be furnished or work to be done, it being understood that the submission of a proposal is an Agreement to all items and conditions referred to immediately place an order as soon as the project is awarded to him. Any exceptions, omission or substitutions shall be presented in writing with the Contractor’s Bid.

The Contractor, before commencing work, shall examine the proposed location of the STP and all adjoining areas on which this work is in any way dependent for perfect workmanship according to the intent of these specifications and shall report to the Owner's representative any condition which will prevent the Contractor from performing first class work. No waiver of responsibility for defective work will be considered unless notice has been filed at the time the Contractor submits his proposal.

Work Included

Under this Part of the Specifications, provide all materials and equipment and perform all the work necessary for the complete execution of all Sewage Treatment Plant (STP) works as herein specified, except as otherwise but not be limited to the following principal items of work:

Furnishing, delivery to the project site and installation of complete Sewage Treatment Plant including all equipment, valves, and piping, motor and controls and all accessories necessary to complete the system.

Preparation of installation drawings and design calculations of the above STP including selection of mechanical equipment capacities, design of tank dimensions, piping and all accessories to comply with the concepts and criteria set by these Specifications.

Electrical Controls of the above systems including motor control center, remote control switches, motor controllers and starters, wires and cables, conduits and other required accessories.

Sanitary sewer connection of effluent pipe from STP to the site storm drainage system.

Corrosion protection and painting of all equipment and piping including all exposed and embedded materials

Complete testing and commissioning of the entire Sewage Treatment Plant, including supply of all instruments for operating and testing the various systems and submission of reports.

Full instruction after completing the job to the maintenance personnel regarding operation and maintenance of the entire installation. Provide complete printed/typewritten instruction booklets (hardbound) covering maintenance, operation and adjustments of each piece of equipment and list of spare parts for each piece of equipment.

If anything has been omitted in any item of work or materials usually furnished which are necessary for the completion of the STP Work as outlined herein before, then such items must be and are hereby included in this Division of the Work.

Acquisition of Authority to Construct and Permit to Operate from DENR and Building Permit.

The Contractor shall prepare all plans, applications, permits, etc., and shall complete all tests, forms, etc., required by all rules, regulations, etc. of all the Government Authorities having jurisdiction and such shall be completed by personnel of proper caliber, in particular engineers, where so required.

Codes, Inspections, Permits and Fees

The work under this Contract is to be installed according to the latest applicable codes, ordinances and requirements of the following:

a. National Plumbing Code of the Philippines
b. Sanitation Code of the Philippines
c. Department of Health
d. Effluent Regulation of 1990 – Environmental Management Bureau (EMB) formerly National Pollution Control Commission (NPCC).
e. Rules and Regulations of the EMB for Domestic and Industrial Wastewater Disposal (Section 6g of Presidential Decree No. 984, otherwise known as the National Pollution Control Decree of 1976).

The Contractor's bid shall be deemed to include all costs to comply with the various code, inspections, permits and fees.

Nothing contained in this Specification shall be construed as to conflict with National and Local Ordinances or Laws governing the installation of Sewage Treatment Plant Work

and all such laws and ordinances are hereby made part of this Specification. The Contractor is required to meet the requirements hereof.

Codes and Standards of following organizations other than mentioned above are referenced in this Specification. The Contractor's price shall be deemed to include compliance with the following:

a. American National Standards Institute (ANSI)
b. American Society for Testing and Materials (ASTM)
c. American Water Works Association (AWWA)
d. International Organization for Standardization (ISO)
e. National Electric Manufacturers Association (NEMA)
f. Underwriters' Laboratories (UL)
g. Uniform Plumbing Code by JAPMO
g. U.S. Federal Specifications (FS)

All construction permits and fees required for this work shall be obtained by and at the expense of the Contractor. The Contractor shall furnish the Architect, the Engineer and the Owner final certificates of inspection and approval from the proper government authorities after the completion of the work.

Approval from authorities of all plans for construction shall be secured by the Contractor.

Record Drawings

The Contractor shall, during the progress of work keep record of all deviations of the actual installation from that shown in the approved Installation Drawings.

Upon completion of work, the Contractor shall submit two (2) copies of the as-built drawings, signed and dry-sealed by the Contractor’s registered sanitary engineer, indicating the work as actually and finally installed, including new information not originally shown in the approved Installation Drawings, to the Engineer for approval as to conformance with these Specifications and compliance with pertinent Code provisions. The Contractor shall also submit two (2) sets of operating and maintenance instructions, equipment and parts lists for approval.

After such approvals, the contractor shall submit the as-built originals (sepia) and two (2) sets of prints to the Owner, a well three (3) sets of operating and maintenance instructions, equipment and part lists, including addresses of manufacturers or suppliers of major equipment and materials.

Approval of the as-built drawings by the Engineer shall be a requirement for final acceptance of the completed works and for final payment.

The contractor shall prepare and submit for approval the following:

a. Dimensional layout drawings of the Sewage Treatment Plant and its auxiliary equipment, pumping and piping systems, concrete tanks, control system and other systems which are complete in nature, or which require close coordination with other work of this trade and/or the work of other trades.

b. Calculation of sewage treatment processes, equipment sizing and selections, and other processes involved in the preparation of proposed construction of the Sewage treatment Plant.

c. Dimensional drawings of all concrete tanks and other structures required in the review of structural design.

d. Electrical control components to include MCC's, starters, breakers, wires, etc.

e. Complete control schematic and wiring diagrams for all equipment.

f. Manufacturer's catalog sheets, marked as necessary to indicate materials or equipment being furnished for the following:

(1) Pumps, blowers and other STP equipment complete with ratings and dimensions.
(2) Controls, magnetic starters, pressure switches, valves, etc.
(3) Valves: Gate, check and pressure reducing valves
(4) Pipes and fittings.
(5) Flexible couplings
(6) Riser supports, hangers and sleeves

g. Marked sets of piping drawings showing mark number and exact location of hangers, anchors, guides and sway braces, and approximate location of random hangers.

h. Details of all anchors, guides and sway braces.

i. List of miscellaneous materials proposed, including pipe, fittings, valves, etc. and manhole accessories, identifying manufacturer and type.

j. Field test reports

k. Such other drawings as the Engineer may require.

All drawings should be signed and dry sealed by the Contractor's Registered Sanitary Engineer, Structural Engineer and other Professional Engineers concerned.

All drawings, etc., shall .be submitted sufficiently m advance of field requirements to allow ample time for checking and no extension of the contract time will be granted this Contractor, by reason of his failure in this respect.

All submittals shall be complete and shall contain all required information and details.

Coordination

Coordinate schedule of installation with works of other trades.

Systems provided shall be complete and operable, and shall include required accessories, fastenings and supports.

All equipment shall be installed in strict accordance with manufacturer's recommendation.

Guarantee

The Contractor shall guarantee the Sewage Treatment Plant's complete and successful operation against defects on the equipment and defects in workmanship for a period of two (2) years from date of completion of the Contract certified by the Architect. Said warranty shall include repair works and labor.

All equipment furnished and installed shall be new and free of defects in design materials and workmanship. The Contractor shall replace, without additional cost to the Owner, any defective material or equipment within two (2) years after final acceptance of the plant.

Replacement of defective components, labor to trouble-shoot, and repair of the systems shall be furnished by the Contractors at no charge to the Owner during the guarantee period.

The Contractor shall indemnify and save harmless the Owner and the Engineer from and against all liability for damages arising from injuries or disabilities to persons or damage to property occasioned by any act or omissions of Contractor or any of his Sub-Contractors, including any and all expenses, legal or otherwise which may be incurred by the Owner or the engineer, in the defense of any claim, action or suit.

Approval, Substitutions, etc.

Wherever herein after the words “For Approval”, or “Approved” (make type, size, arrangement, etc.) are used, especially in regard to manufactures specialties, etc. or whenever it is desired to substitute a different make or type of apparatus for that specified, all information pertinent to the adequacy and adaptability of the proposed apparatus, shall be submitted and their approval secured before submitting the bid. No approvals or substitutions on specified items will be entertained unless requested by the Owner after the Contract Award or during construction.

Workmanship

The work throughout shall be executed in the best and most through manner to the satisfaction of the Architect and the Engineer who will jointly interpret the meaning of the Drawings and Specifications and shall have power to reject any work and materials which in their judgment are not in full accordance therewith.

The Contractor shall assume full responsibility for the design, construction, installation, testing, commissioning and hand-over of Sewage Treatment Plant and guarantee its satisfactory performance as described in this Section.

Table 1: Effluent standards for NPI: Conventional and other Pollutants in protected Waters and Category I & II and in Inland Water Class C (DAO No.08)

Parameter	Unit	Protected Waters Category I (Class AA & SA	Protected Waters Category II (Class AB & SB	Inland Waters (Class C)	Marine Waters (Class D)	Coastal Waters (Class SC)	Class SD & other Coastal Waters Not Classified
Color	PCU	(b)	100	150 (c)	-	(c)	(c)
Temp. (Max rise in deg. Celsius in RBW	^{0}C nse	(b)	3	3	3	3	3
Ph (range)	-	(b)	6.0-9.0	6.5-9.0	6.0-9.0	6.0-9.0	5.0-9.0
COD	mg/L	(b)	60	100	200	200	200

Parameter	Unit	Protected Waters Category I (Class AA & SA	Protected Waters Category II (Class AB & SB	Inland Waters (Class C)	Marine Waters (Class D)	Coastal Waters (Class SC)	Class SD & other Coastal Waters Not Classified
Settle able solids (1-hour)	mg/L	(b)	0.3	0.5	-	-	-
5-Day 20 deg ^{0}C BOD	mg/L	(b)	30	50	120	100	120
Total Dissolved Solids	mg/L	(b)	1,000	-	1,500(h)	-	-
Surfactants (MBAS)	mg/L	(b)	2	5	-	10	-
Oil/Grease (Petroleum Ether Extract)	mg/L	(b)	5	5	-	10	15
Phenolic Substances as Phnols	mg/L	(b)	0.05	0.1	-	0.5(i)	1
Total Coliforms		(b)	3000	10,000	(j)	-	-

NPI (New/Proposed Industry or Wastewater Treatment Plants to be constructed.)

Notes for table 1:

1. In cases where the background level of Total Dissolved Solids (TDS) in fresh water rivers, lakes reservoirs and similar bodies of water is higher than the Water Quality Criteria, the discharge should not increase the level of TDS in the receiving body of water by more than ten percent of the background level.

2. The COD limits in Table 1 generally apply to domestic waste-water treatment plant effluent. For industrial discharges, the effluent standards for COD should be on a case to case basis considering the COD-BOD ratio after treatment. In the interim period that this ratio is not yet established by each discharger, the BOD requirements shall be enforced.

3. There are no effluent standards for chloride except for industries using brine and discharging into inland waters, in which case the chloride content should not exceed 500 mg/L.

4. The effluent standards apply to industrial manufacturing plants and municipal treatment plants discharging more than thirty (30) cubic meters per day.

Legend for Table 1:

(a) Except as otherwise indicated, all limiting values in Table 1 are 90” percentage values. This is applicable only when the discharger undertakes daily monitoring of its

effluent quality, otherwise, the numerical value in the tables represent maximum values not to be exceeded once a year.

(b) Discharge of sewage and/or trade effluents are prohibited or not allowed.

(c) Discharging shall not cause abnormal discoloration in the receiving water outside of the mixing zone.

(d) For the waste waters with initial BOD concentration over 1000 mg/L but less than 3000 mg/L, the limit may be exceeded up to a maximum of 200 mg/L or a treatment reduction of ninety (90) percent, whichever is stricter. Applicable to both old and new industries.

(e) The parameters Total Suspended Solids (TSS) should not increase the TSS of receiving water by more than (30) percent during the dry season.

(f) Not more than 30 mg/L increase (dry season).

(g) Not more than 60 mg/L increase (dry season).

(h) If effluent is the sole source of supply for irrigation, the maximum limits are 1500 mg/L and 1000 mg/L, respectively, for old industries and new industries.

(i) Not present in concentration to affect fish flavor or taste or training. If effluent is used to irrigate vegetable and fruit crops which may be eaten raw, Fecal Coliforms should be less than 500 MPN/10O mL

1202.4 Method of Measurement

Measurement of sewage treatment plant shall be the actual number of units installed, complete in place and accepted.

1202.5 Basis of Payment

All work performed and measured and as provided for in this Bill of Quantities shall be paid for at the unit bid or Contract Unit Price which payment shall constitute full compensation including all materials, labor equipment, tools and incidentals necessary to complete this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
1202 (a)	Supply and Installation of 150cu.m. Sewage Treatment Plant / Waste Water Treatment Plant - including Bar S, Air Blower, Influent Pump (EQT Pump), Effluent (CCT) Pump, Decanter Pump, Sludge Transfer Pump, Sludge Digester Pump, Return Sludge, Hypochlorinator, Fine Bubble Diffuser, Coarse Bubble Diffuser, Interconnecting Works, Electrical Works, Flow Meter, Ventilation System and Civil Works.	Lot