

METHOD OF MEASUREMENT

Aggregate Base Course will be measured by the cubic meter (m³). The quantity to be paid for shall be the design volume compacted in-place as shown on the Plans, and accepted in the completed base course. No allowance shall be given for materials placed outside the design limits shown on the cross-sections. Trial sections shall not be measured separately but shall be included in the quantity of aggregate base course.

ITEM 11 : PORTLAND CEMENT CONCRETE PAVEMENT

SCOPE OF WORK

The works include the furnishing of all labor, materials and equipment required for the construction of gravel base course and concrete pavement. The works shall be in accordance with the lines and grades shown on the Drawings and in conformity with the Specifications.

MATERIAL REQUIREMENTS

Cement

Portland cement shall conform to the requirements of the Section "Reinforced Concrete".

Fine Aggregate

The fine aggregate shall be well-graded from coarse to fine and shall conform to the requirements of the Section "Reinforced Concrete".

Coarse Aggregate

Coarse aggregate shall conform to the requirements of the Section "Reinforced Concrete".

Water

Clean, fresh, potable water shall be used for the mixing of all concrete and mortar and shall be from a source approved by the Engineer. Sea water or brackish water shall not be used.

Admixture

Admixture shall only be used with the written permission of the Engineer. If air-entraining agents, water reducing agents, set retarders or strength accelerators are permitted to be used, they shall not be used in greater dosages than those recommended by the manufacturer, or as permitted by the Engineer. The cost shall be considered as already in the Contractor's unit cost bid for concrete.

TIE BARS AND SLIP BARS

Tie bars shall be deformed bars conforming to the requirements specified in AASHTO M 31 or M 42, except that rail steel shall not be used for tie bars that are to be bent and re-straightened during construction, sizes as indicated on the Drawings. The deformed bars shall be Grade 40 and shall be shipped in standard bundles, tagged and marked in accordance with the Code of Standard practice of the Concrete Reinforcement Steel Institute.

Slip bars shall be smooth round steel bars conforming to the requirements specified in AASHTO M 31 or plain M 42.

Joint Filler

Poured filler for joint shall conform to the requirements of AASHTO M173.

EXECUTION

Concrete Class

The concrete for pavement shall satisfy the following requirements:

Minimum 28-day comprehensive strength	:	24 MPa
Minimum Flexural Strength	:	3.8 MPa
Maximum Aggregate size	:	25 mm
Maximum water cement ratio	:	0.52

Proportioning, Consistency and Mixing of Concrete

The proportioning, consistency and mixing of concrete shall conform to the requirements of the Section "Reinforced Concrete".

Preparation

The base shall be watered and thoroughly moistened prior to placing of the concrete.

Formwork Construction

Formwork shall comply with the requirements of the Section "Reinforced Concrete". Forms shall be of steel, of an approved section and shall be straight and of a depth equal to thickness of the pavement at the edge. The base of the forms shall be of sufficient width to provide necessary stability in all directions. The flange braces must extend outward on the base not less than 2/3 the height of the form.

All forms shall be rigidly supported on a bed of thoroughly compacted material during the entire operation of placing and finishing the concrete. They shall be set with their faces vertical so as to produce a surface complying with the required tolerance.

Adjacent lanes may be used in lieu of forms for supporting finishing equipment provided that proper protection is afforded to the concrete of the adjacent lanes to prevent damage, and provided further that the surface of the concrete carrying the finishing equipment does not vary by more than 3mm in each meter length. Adjacent lanes in lieu of forms may not be used until the concrete is at least seven (7) days old. Flanged wheels of the finishing equipment shall not be operated on the concrete surface. The inside edge of supporting wheels of the finishing machine shall not operate closer than 100mm from the edge of the concrete lane.

Alternative to placing forms, slip-forming may be used. Slip-form paving equipment shall be equipped with the traveling side forms of sufficient dimensions, shape and strength to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section. No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation shall not exceed 20mm from the proper alignment established by the Engineer.

Joints

All joints, longitudinal, transverse, etc., shall be constructed as shown on the Drawings and shall be clean and free of all foreign material after completion of shoulder work prior to acceptance of the work and in accordance with the following provisions:

Longitudinal and Transverse Contact Joints:

Longitudinal contact joints are joints formed between lanes that are poured separately. Transverse contact joints are joints formed between segments of a lane that are poured separately. Transverse contact joints shall be formed perpendicular to pavement centerline at the end of each day of concrete placing, or where concreting has been stopped for 30 minutes or longer but not nearer than 1.5 meters from sawed contraction joints. All contact joints shall have faces perpendicular to the surface of the pavement. Tie bars of the size, length and spacing shown on the Drawings shall be placed across longitudinal and transverse contact joints.

Placing Concrete

The concrete shall be deposited and spread in order that segregation will not occur and place a uniform layer of concrete whose thickness is approximately 20 mm greater than that required for the finished pavement is placed. Rakes shall not be used for handling concrete.

In order to prevent the introduction into the concrete of earth and other foreign materials, the men whose duties require them to work in the concrete, shall in general, confine their movements to the area already covered with fresh concrete. Whenever it becomes necessary for these men to step out of the concrete, their footwear shall be washed or otherwise thoroughly cleaned before returning to the concrete. Repeated carelessness with regard to this detail will be deemed sufficient cause for removing and replacing such worker.

During the operation of striking off the concrete, a uniform ridge of concrete at least 70 mm in height shall be maintained ahead of the strike-off screed for its entire length. Except when making a construction joint, the finishing machine shall at no time be operated beyond that point where this surplus can be maintained in front of the strike-off screed.

After the first operation of the finishing machine, additional concrete shall be added to all low places and honeycombed spots and the concrete rescreeded. In any rescreeding, a uniform head of concrete shall be maintained ahead of the strike-off for its entire length. Honeycombed spots shall not be eliminated by tamping or grouting.

Workers on the job shall have mobile footbridges at their disposal so that they need not walk on the wet concrete.

In conjunction with the placing and spreading, the concrete shall be thoroughly spaded and vibrated along the forms, bulkhead, and joints.

The internal vibrators shall be of pneumatic, gas-driven, or electric type, and shall operate at a frequency of not less than 3,200 pulsations per minute.

Whenever the placing of the concrete is stopped or suspended for any reason, for a period of 30 minutes or longer, a suitable bulkhead shall be placed so as to produce a vertical transverse joint. If an emergency stop occurs within 2.5 meters of the contraction or an expansion joint the concrete shall be removed back to the joint. When the placing of the concrete is resumed, the bulkhead shall be removed and a new concrete placed and

vibrated evenly and solidly against the face of previously deposited concrete. Any concrete in excess of the amount needed to complete a given section or that has been deposited outside the forms shall not be used in the work.

The Contractor shall provide suitable equipment for protecting the fresh concrete in case of rain, such as screens which will cause the rain water to run off beyond the edges of the paving, rain proof tarpaulins or other methods approved by the Engineer. The equipment shall be sufficient to shelter from rain all areas equal to that paved in two hours of work.

Finishing Concrete

The concrete shall be compacted and finished by a mechanical, self-propelled finishing machine of approved type, having two independently operated screeds. If a machine possessing only one screed is approved, the screed will not be less than 450 mm wide and shall be equipped with compensating springs to minimize the effect of the momentum of the screed on the side forms. The number of driving wheels, the weight of the machine and the power of the motor shall be so coordinated as to prevent slippage. The top of the forms and the surface of the finishing machine wheels shall be kept free from concrete or dirt.

The machine shall at all times be in first-class mechanical condition and shall be capable of compacting and finishing the concrete as herein described. Any machine which causes displacement of the side forms from the line or grade to which they have been properly set, or causes undue delay due to mechanical difficulties, shall be removed from the work and replaced by a machine meeting the Specifications.

The finishing machine shall be operated over each section of pavement two or more times and at such intervals as will produce the desired results. Generally, two passes of the finishing machine are considered the maximum desirable.

The concrete shall be vibrated, compacted, and finished by a vibratory finishing machine. The vibratory machine shall meet the requirements for ordinary finishing, and shall be one of the following type:

1. The machine shall have two independently operated screeds; the front screed shall be equipped with vibratory units with a frequency of not less than 3,500 pulsations per minute. There shall be not less than one vibratory unit for each 2.5 meters length or portion thereof, of vibratory screed surface. The front screed shall not be less than 300mm wide and shall be equipped with a "bull nose" front edge built on a radius of not less than 50mm. This type of vibratory finishing machine shall be operated in such manner that each section of pavement will receive at least one vibratory pass, but not more than two passes, unless otherwise directed, or ;
2. The machine shall be equipped with an independently operated vibratory "pan" (or pans) and two (2) independently operated screeds, the "pan" shall be mounted in a manner that will permit it to come in contact with the forms and will permit vibration of the full width of lane simultaneously.

There shall be not less than one vibratory unit for each 2 m. length or portion thereof, of vibrating pan surface. The vibratory units in any individual pan shall be synchronized and have a frequency of not less than 3,500 pulsations per minute. The front screed shall be capable of operating in a position that will strike off the concrete at a sufficient height above the top of the forms to allow for proper compaction with the vibrating pan. This type of vibratory finishing machine shall be operated in such manner that each section of pavement will receive at least one vibratory pass but not more than two passes, unless otherwise directed.

After the final pass of the finishing machine and when the concrete has started to dry, the surface of the pavement shall be finished with an approved longitudinal float. The float may be operated either manually or by mechanical means. The float may be either of wood or metal shall be straight and smooth and light in weight so as not to displace or sink into the concrete surface.

To be effective, the float shall be at least 300mm wide and 3m long. When manually operated, the float shall be moved from edge to edge with a wiping motion and advance one (1) meter or more.

The succeeding trip shall overlap the previous trip. A light smoothing lute at least 3 meters long may be used provided approved by the Engineer.

The surface of the pavement shall be tested by the Contractor, before the final belting, with an approved standard straightedge 3 meter in length. Irregularities so detected shall be corrected immediately. Special attention shall be given to the concrete adjacent to transverse joints to insure that the edges thereof are not above the grade specified or the adjacent concrete below grade. All depressions or projections shall be corrected before any initial set has developed in the concrete.

After the concrete has been brought to the required grade, contour and smoothness, it shall be finished by passing over the concrete a drag of one or two burlap clothes, which give the surface the required roughness. The vehicles used to carry these cloths may be independent of the concrete-laying machine or may be incorporated with it and may be operated either by hand or mechanically.

Hand finishing will be permitted only on variable width sections of the pavement and other places where the use of the finishing machine would be impractical. Hand finishing shall be accomplished by means of the hand-operated strike-off template of either steel or steel-shod wood construction. The striking template shall be operated forward with a combined longitudinal and transverse motion and shall be so manipulated that neither end will be raised off the side forms. A similar tamper shall be used for tamping the concrete.

As soon as the concrete has attained its initial set, the edges of the pavement, the longitudinal joints, the construction dummy and expansion joints not sawn shall be carefully finished with an edging tool having radius of at least 5mm. The tools, the special accessories for cutting impressed joints and methods of workmanship shall be such as will produce a joint whose edges are of the same quality of concrete as the other portion of the pavement. Methods and workmanship which make use of excess mortar or grout in this area shall be eliminated. Unnecessary tool marks shall be eliminated during work, and the edges left smooth and true to line.

Striking Forms

Forms shall remain in place at least 12 hours after the concrete has been placed. When working conditions are such that the early strength gain of the concrete is delayed, the forms shall remain in place for a longer period, as directed by the Engineer. Bars or heavy load shall not be used against the concrete when still in the forms. Any damage to concrete resulting from form removal shall be repaired promptly by the Contractor as directed by the Engineer without any additional payment to the Contractor.

Curing Concrete

Unless otherwise ordered by the Engineer, curing of concrete shall be done by any method specified in the Section "Reinforced Concrete".

Cleaning and Sealing Joints

After completion of the required curing and before opening of the pavement to traffic, all joints shall be thoroughly cleaned of all concrete aggregate fragments or other materials.

After removal of side forms, the ends at transverse expansion joints at the edges of the pavement shall be carefully cleaned of any concrete within the expansion spaces for the entire depth of slab, care being taken not to injure the ends of the joints. Expansion and contraction joints shall then be poured with a hot joint sealer to the depth as indicated on the Drawings. Joint sealer shall be poured using approved hand pouring pots, with liquid at a temperature not less than that recommended by the approved manufacturer.

Opening to Traffic

The pavement shall be closed to traffic, including the vehicles of the Contractor, for a period of 10 days after the concrete is placed or longer if in the opinion of the Engineer, the weather conditions make it necessary to extend this time. The Contractor shall furnish, place and maintain satisfactory barricades and lights as directed, to exclude all traffic from the pavement.

Any damage to the pavement due to traffic shall be repaired or replaced at the expense of the Contractor. Paving mixers, mechanical concrete spreaders and finishers and other heavy paving equipment shall not be operated on completed concrete lanes in order to construct alternate lanes until after the regular curing period is completed. Even then, planks shall be laid on the finished pavement or other precautions taken to prevent damage to the concrete pavement.

Pavement Smoothness, Thickness and Tolerance

Portland cement concrete pavement shall be constructed to the designed level and transverse slope shown on the Drawing. The allowable tolerance shall be as listed hereunder.

- | | | |
|----|--|---------|
| 1. | Permitted variation from design thickness of layer | + - 5mm |
| 2. | Permitted variation from design level of surface | + - 5mm |

The thickness of the pavement will be determined by measurement of cores from the completed pavement in accordance with AASHTO T 148.

The completed pavement shall be accepted on a lot basis. A lot shall be considered as 2,500 sq.m of pavement. The last unit in each slab constitutes a lot in itself when its length is at least $\frac{1}{2}$ of the normal lot length. If the length of the last unit is shorter than $\frac{1}{2}$ of the normal lot length, it shall be included in the previous lot.

Other areas such as intersections, entrances, crossovers, ramp, etc., will be grouped together to form a lot. Small irregular areas may be included with other unit areas to form a lot.

ITEM 12 : DRAINAGE WORKS

SCOPE OF WORK

The works shall consist of excavation, backfilling and construction of lateral drains, construction of manholes, reconnection to existing lateral and other related works in accordance with the dimensions, size, elevation and grade as shown on the drawing and shall conform with the Specification.

At least thirty (30) days before the start of any construction related to drainage works, the Contractor shall submit to the Engineer for his approval, shop drawings of the drainage work he intends to construct. The shop drawings shall include the materials and the general method of installation he intends to employ.

MATERIAL REQUIREMENTS

BACK FILL

Fill shall be in accordance with Item "Reclamation and Fill".

GRAVEL BEDDING

Gravel Bedding/gravel base shall be in accordance with the specifications of Crushed Course Aggregates in "Reinforced Concrete".

SAND BEDDING

Sand bedding shall be in accordance with Item "Reinforced Concrete (Fine Aggregates)".

CONCRETE

Mixing/Casting and steel reinforcements shall be in accordance with Item "Reinforced Concrete" while the dimensions shall be as shown on the Drawings.

CEMENT MORTAR

Cement mortar shall consist of one part Portland cement to two parts of fine aggregate with water added as necessary to obtain the required consistency.

REINFORCED CONCRETE PIPE

The fabrication of reinforced concrete pipes shall conform to the Specifications of ASTM C 76 while the testing requirements shall conform to ASTM C 497. The Engineer reserves the right to inspect and test the pipe delivered for intended purpose. Defects that are discovered after acceptance of delivery of the pipe but before installation shall be a cause for rejection.

Standard reinforcement details and concrete strength shall be in accordance with DPWH "Standard Two Meter Concrete Pipe Culvert".

STEEL GRATING

The fabrication of grating shall conform to requirements of Steel and Metal Works" and "Zinc Coatings on Iron and Steel"

All steel grades and dimensions shall conform with the approved plans.

EXECUTION

EARTHWORKS

All earthworks for concrete pipe culvert shall conform to the lines, grades and elevations shown on the drawings or as directed by the Engineer.

The lateral drain shall be excavated to the depth, grade and width established by the Engineer. The bedding surface shall provide a firm foundation of uniform density throughout the entire length. Soft, spongy, or otherwise unstable material encountered that will not provide a firm foundation for the concrete drainage shall be removed to the full width of the trenches and replaced by suitable material to a depth of not less than 30 cm. 100mm thick gravel bedding shall be used as foundation or otherwise as specified.

PIPE LAYING

The pipe shall be tested for water-tightness of joints before backfilling the trench. Unsatisfactory work shall be corrected without additional cost to the PPA. The collar shall have set sufficiently prior to backfilling.

Methods of installation and typical bedding for pipe conduits if not included in the plans, shall conformed to DPWH "Standard Two Meter Reinforced Concrete Culvert".

LATERAL DRAIN

Concrete cover and the steel gratings shall be set to the required elevations as shown on the drawings to fit the adjoining surfaces and shall be installed after the adjoining concrete is struck off and finished, and the fit on the frames shall be such that there is no rocking.

All completed structures shall be thoroughly cleaned of any accumulations of silts, debris or foreign matter of any kind, until finally accepted and put into service.

CATCH BASIN INLETS, MANHOLES AND OUTLETS

Lid frames shall be set to the required elevations as shown on the drawings to fit the adjoining surfaces. Lids shall be installed after the adjoining concrete is struck off and finished, and the fit on the frames shall be such that there is no rocking.

Where reconstruction of existing catch basin inlets, manholes, outlets, or similar structures are indicated, the work shall be in accordance to the details and elevations as shown on the drawings, including re-installation of existing metal frames, grates and lids, or replacing of concrete covers instead of grates that may have been lost or found lacking. All completed structures shall be thoroughly cleaned of any accumulations of silts, debris or foreign matter of any kind, until finally accepted and put into service.

FIELD DENSITY TEST

Field Density tests to determine the percent of compaction of the fill material shall be conducted until a field density of at least 95 percent of the maximum dry density in accordance with AASHTO T180, Method D has been achieved. In place density determination shall be made in accordance with AASHTO T191.

CLEARING AND DISPOSAL

Dumping or disposal of un-used excavated materials shall be coordinated to PMO. If the excavated materials are determined for disposal, the contractor will provide all necessary works and expenses for its completion in concurrence by the Engineer.

ITEM 13 : MOORING AND FENDERING SYSTEM

SCOPE OF WORK

1. The work includes furnishing of all labor, materials and equipment to complete the installation of mooring bollards and fenders in piers/wharves.
2. The work shall include the supply, transport, handling, storage and installation of fenders systems in the newly constructed piers.
3. The Contractor shall furnish and install the necessary fittings as shown on the drawings and/or specified.

Supplementary parts necessary to complete and install each item of works shall be included whether or not shown or specified. The Contractor shall furnish to relevant trades all anchors, fastenings, inserts, fittings, fixtures or the like to be installed on or required for securing the works.

The Contractor shall submit shop drawings of all fitting works prior to placing orders and commencement of any fabrication.

MATERIAL REQUIREMENTS

MOORING SYSTEM

Designated load capacity of mooring bollards shall be as shown in the drawings, and shall be referred to as the maximum load capacity. The mooring bollards shall be at rupture stage upon reaching the maximum load capacity.

Mooring bollards shall be of the dimensions, weights, capacities and designs as shown in the drawings and shall be fabricated by approved manufacturer with cast steel conforming to the requirements indicated in the plan/drawings, or approved equivalent.

The size of the bolts, nuts and washers shall be in accordance with the specifications provided in the plans/drawings. The anchor plate shall be connected to the holding down bolt as shown in the plans/drawings. All bolts, nuts, washers etc., that are exposed shall be hot-dip galvanized.

Samples of the bolts, nuts, washers and anchor plates shall be submitted to the Engineer for approval before being used in the Works.

The upper part of bollards and base plates which are not embedded in concrete shall be painted. The surface of bollards shall be cleaned thoroughly by wire brush 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 120m micron thickness in accordance with JIS K5623 or the approved standard.

Base Steel:

Chemical composition and mechanical properties of base metal to be used for fabrication of mooring bollard and its accessories shall comply with ASTM A36 and other required standard stated therein.

Concrete Foundation :

Concrete foundation for mooring bollards shall conform to the requirements of the Section concerning "Reinforced Concrete".

Visual Inspection :

All mooring bollards delivered to Site shall be inspected by the Engineer for any signs of flaws or defect inimical to usage.

Mill Test Certificates:

Two (2) copies of mill test reports shall be submitted certifying that materials meet the specified standards.

Test Inspection:

Inspection of all materials and methods of fabrication shall be carried out by the Contractor. However, the Engineer reserves the right to inspect all facilities at any time during the manufacture to ensure that the materials and workmanship are in accordance with Specifications and the best of workmanship.

FENDER SYSTEM

The rubber fenders should comply with the performance requirements specified in the table provided on the plan/drawings of Rubber Dock Fenders (RDF).

PHYSICAL PROPERTIES OF MATERIALS

The rubber for the fenders shall be of high quality natural rubber, synthetic rubber or mixed rubber blended with carbon black used in the rubber industry and shall have sufficient resilience and anti-ageing, weathering, abrasion, wear and oil resistant properties. The rubber dock fenders shall be free from bubbles, cracks and other harmful defects.

The physical properties of the rubber compound used for the fenders shall comply with the following requirements:

Physical Properties and Test Method

Test Item		Properties	Test Method	
Physical Test	Before Aging	Tensile Strength	Test piece: Dumbell No. 3	ASTM D412
		Elongation		ASTM D1456
		Hardness	Spring Type hardness test (Type A)	ASTM D2240
	After Aging	Tensile Strength	Aging by air heating: 70±1°C x 96 hours.	ASTM D412
		Elongation		ASTM D1456
		Hardness		ASTM D2240
	Compression Test		Heat treatment: 70±1°C x 22 hours.	ASTM D395

Note: Equivalent Standards are acceptable.

FITTINGS AND ANCHORAGE

Anchor bolts and connecting hardware shall be fabricated using type of steel specified and to the required shapes and sizes shown on the approved plan/drawings.

TESTING, SAMPLING, INSPECTION, ACCEPTANCE, MARKING AND PACKAGING

Testing

All rubber dock fenders shall be tested for performance. It shall pass the required energy absorption and reaction force at a certain deflection as indicated in the plan.

The Contractor shall be required to submit test certificates showing compliance to the above requirements. The test certificates shall be certified by an independent testing institute / organization recognized by the Authority.

The standard performance testing methodology shall be Method B, to wit:

1. Fender temperature shall be stabilized at 23 degrees plus or minus 5 degrees centigrade for at least 24 hours before compression testing.
2. Break-in of fender by deflecting 3 times to rated deflection.
3. Removed load from the RDF and allow recovering for a minimum of 1 hour.
4. Deflect RDF at speed of 2-8 cm/min once to rated deflection.

The testing apparatus shall be calibrated and certified within plus or minus 1% in accordance with ISO or equivalent JIS or ASTM requirements. Calibration shall be traceable to a national/international standard and shall be performed annually by an accredited third party organization. The RDF performance testing center shall be subjected to accreditation by PPA and notation and /or certification by DPWH-BRS prior to acceptance.

Inspection

All fenders of each type shall be inspected for compliance to specified dimensions and all fenders shall be inspected by the Engineer for any sign of flaw or defect inimical to its use.

All anchor bolts and fittings shall be inspected. The material used for the fabrication of bolts and fittings shall be covered by the manufacturer's certified mill certificate and shall be verified by the Authority.

All RDF items/units shall be clearly numbered and marked indicated the following:

Acceptance Tolerance

The acceptance tolerance shall be based on the following:

1. Fender Dimension

Length	:	-2% to +4%
Width	:	-2% to +4%
Height	:	-2% to +4%
Thickness	:	-2% to +8%
2. Anchor Bolt Holes in Fender

Diameter of the Hole	:	+2.0mm
Pitch of the Hole	:	+4.0mm
3. Acceptance tolerance for all fenders supplied shall be as follows:

E = Energy absorption,	E ≥ Specified E but not less than 10% of the specified E
R = Reaction force,	R ≤ Specified R but not more than 10% of the specified R

Marking

All fender units shall be clearly numbered and marked. Each fender shall have the following markings.

1. Fender type and manufacturer's name or trade mark
2. Production serial number
3. Date of manufacture or its abbreviation
4. Main dimensions
5. Project identification as follows:

Name of Port/Project: _____

Year supplied _____

Packaging

The fenders shall be packaged on wooden crate or wrapped individually with Polypropylene sheets except when shipped containerized. The bolts and fittings should be placed in crates and suitably treated for protection when transported by sea and stored in port areas.

EXECUTION

MOORING / FENDERING SYSTEM

All units shall be installed at the locations shown on the drawings and as directed by the Engineer.

ITEM 14 : STEEL AND METAL WORKS**GENERAL**

General Requirements contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

SCOPE OF WORK

The work includes the furnishing of all labor, materials, equipment and other incidentals necessary for the fabrication and installation of structural steel and miscellaneous metal works as specified in relevant items of these specifications and as indicated on the drawings.

SUBMITTAL

1. Before placing orders for materials for the steel and metal works, the Contractor shall submit to the Engineer for approval shop drawings for all steelwork. All project shop drawings shall show the dimension of all parts, method of construction, bolts, welding sectional areas and other details.
2. The detail of connections shown on the shop drawings shall be such as to minimize formation of pockets to hold condensation, water or dirt. A minimum gap between abutting angles and the like shall be provided wherever possible to eliminate any traps and facilitate maintenance painting.
3. No materials shall be ordered nor fabrication commenced until the shop drawings are approved by the Engineer.

STORAGE OF MATERIALS

Structural materials, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. Materials shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion.

MATERIAL REQUIREMENTS

1. Unless specified herein all steel structures and metals shall conform with the requirements of "Steel and Metal Works." Connections where details are not specified or indicated herein, shall be designed in accordance with the American Institute of Steel Construction (AISC), Manual of Steel Construction, latest edition.
2. Structural steel works consisting of channels, gusset plates and other structural steel shape shall be as indicated on the drawings and shall be structural carbon steel conforming to ASTM A 36. Shapes shall be as given in AISC, Manual of Steel Construction.
3. High strength structural bolts, shall conform to ASTM A 325, Types 1 or 2. Nuts shall conform to ASTM A 560, Grade A, heavy hex style, except nuts 38 mm (1-1/2 inch) may be provided in hex style. Washers shall conform to ANSI B 18.22.1, Type B.
4. Electrodes for arc welding shall be E70 series conforming to American Welding Society Specifications A5.1.
5. Tests are required under the ASTM Standards for steel to be used in the Works and shall be carried out in the presence of the Engineer and at least four (4) days notice must be given to him of the dates proposed for such tests. Four (4) calendar days notice on which fabricated steelwork will be ready for inspection in the Contractor's yard.

6. Standard bolt shall conform to ASTM A 307 Carbon Steel Externally Threaded Standard Fasteners.

EXECUTION

QUALIFICATION

Qualification of steel fabricators, erectors and welders shall comply with the requirements.

FABRICATION REQUIREMENTS

1. **Workmanship**

Fabrication shall be performed within the permissible tolerance by the approved fabricator. All workmanship shall be of the best quality with respect to internationally recognized standards of practice.

2. **Cutting**

Low-carbon structural steel may be cut by machine-guided torch instead of by shears or saw. Harmful notches, burrs, irregularities, etc., shall not be developed at the cut surface.

3. **Contact Faces**

Contact surfaces between bases or other elements bearing directly upon bearing plates shall be ground or milled as necessary for full effective bearing. Edges for welding shall likewise be properly prepared.

4. **Bolt Holes**

Bolt holes shall be according to engineering practice and as specified in these specifications. Gas burning of holes will not be permitted.

5. **High Strength Bolt Assembly Preparation**

Surfaces of high strength bolted parts in contact with bolt heads and nuts shall not have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

Where the surface of a high strength bolted part has a slope of more than 1:20, a beveled washer shall be used to compensate for lack of parallelism.

High strength bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials.

When assembled, all joint surfaces including those adjacent to washers shall be free of scale except tight mill scale, and shall be free from dirt, loose scale, burrs, and other defects that would prevent solid seating of parts.

Contact surfaces of friction-type joints shall be free from oil, paint, lacquer or galvanizing.

6. **Welding**

All welding shall be done only by welders certified as to their ability to perform in accordance with accepted testing requirement.

Welding of parts shall be in accordance with structural standards and the Standard Code for Arc and Gas Welding in Building Construction of AWS, and shall only be done where shown, specified, or permitted by the Engineer.

Damage to galvanized areas by welding shall be thoroughly cleaned with wire brushing and all traces of welding flux and loose or cracked zinc coating shall be removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight. As an alternative to the above, the Contractor may submit for approval the use of a galvanizing rod or galvanizing solder to repair damaged areas.

The welding machine shall be a stable welder, and have suitable functions for the dimension of materials to be welded. The auxiliary tools used for welding shall perform sufficiently and adequately.

The welding machine used for field welding shall be of readily adjustable for electric current.

7. Shop Assembly

Structural units furnished shall be assembled in the shop. An inspection shall be made to determine that the fabrication and the matching of the component parts are correct.

Jigs shall be used for the assembly of units as much as possible to maintain appropriate position of mutual materials.

Approval of the Engineer shall be required when drilling temporary bolt holes or welding temporary support to the assembled structure.

The tolerances shall not exceed those allowed by codes and each unit assembled shall be closely checked to insure that all necessary clearances have been provided and that binding does not occur in any moving part.

In order to maintain accurate finished dimensions and shape, appropriate reverse strain or restraint shall be provided as required. Assembly and disassembly work shall be performed in the presence of the Engineer, unless waived in writing by the Engineer any errors or defects disclosed shall be immediately remedied by the Contractor.

Before disassembly for shipment, component parts of the structures shall be match marked to facilitate erection in the field.

FABRICATION TOLERANCES

1. Dimensional Tolerances for Structural Work

Dimensions shall be measured by means of an approved calibrated steel tape at the time of inspection. Unevenness of plate work shall not exceed the limitation of the standard mill practice as specified in the American Institute of Steel Construction, "Manual of Steel Construction".

2. Camber

Reverse camber in any structural steel members in excess of 1/1,000 of the span length shall cause rejection. The minimum dead load camber for any structural steel member shall be as allowed by Code, or otherwise specified.

INSPECTION AND TEST OF WELDING

1. Inspection of Welding

Inspection of welding shall be executed for the following work phases.

a. Before Welding

Scum, angle of bevel, root clearance, cleaning of surface to be welded, quality of end tab, drying of welding rod.

b. During Welding

Welding procedure, diameter of coil and wire, type of flux, welding current and voltage, welding speed, welding rod position, length of arc, melting, cleaning of slag of each level under surface chapping, supervision of welding rod.

c. After Execution of Welding

Assurance of bead surface, existence of harmful defects, treatment of crater, quality of slag removal, size of fillet, dimension of extra fill of butt welding, treatment of end tab.

2. Testing of Welding

Twenty percent (20%) of welds contributing in the overall strength of the structure and which will be inaccessible for the inspection in service shall be tested.

Welding shall be tested by ultrasonic test to the extent specified herein or as directed by the Engineer.

Where partial inspection is required, the ultrasonic test shall be located at random on the welds so as to indicate typical welding quality.

If ten percent (10%) of the random ultrasonic tested indicate unacceptable defect, the remaining eighty percent (80%) of the welding shall be tested. Repair welding required shall be ultrasonic tested after the repairs are made.

CORRECTIONS

In lieu of the rejection of an entire piece or member containing welding which is unsatisfactory or which indicates inferior workmanship, corrective measures may be permitted by the Engineer whose specific approval shall be obtained for making each correction. Defective or unsound welds or base steel shall be corrected either by removing and replacing the entire weld, or as follows.

1. Excessive convexity or overlap shall be reduced by grinding.
2. Undercuts, lack of weld shall be repaired with necessary reinforcement of weld after removal of any foreign materials such as slag, dust, oil, etc.
3. Any defects such as slag inclusions, incomplete fusion, or inadequate joint penetration, shall be completely removed, cleaned and re-welded.
4. Cracks in welds or base steel, shall be removed to sound steel throughout their length and 5cm beyond each end of the crack, followed by welding. The extent of the crack, depth and length, shall be ascertained by the use of acid etching, magnetic particle

inspection or other equally positive means.

The removal of welded steel shall be done by chipping, grinding, oxygen cutting, oxygen gouging, or air carbon arc gouging and in such a manner that the remaining welded steel or base steel is not nicked or undercut. Defective portions of the welding shall be removed without substantial removal of the base steel.

INSTALLATION

1. Installation Program

a. Prerequisite Condition

Prior to executing steel fabrication and field installation, the Contractor shall prepare a comprehensive installation program including engineering supervision organization, fabrication procedures, field installation procedures, material application, machinery applications, inspection procedure, scope and standard of quality judgment, and submit to the Engineer for approval.

b. Special Technical Engineering

Special technical engineering different from contract specifications can be applied upon receiving approval of the Engineer.

2. Installation Requirement

a. Setting of Anchor Bolt and Others

- a. 1. Anchor bolts shall be set in accurate position by using templates.
- a. 2. The setting method shall be proposed to the Engineer for his approval before setting starts.
- a. 3. The threads of bolt shall be cured with an appropriate method against rust and/or any damage before tightening.
- a. 4. Non-shrink mortar shall be placed under base plates, well cured to obtain the sufficient strength before bearing loads are applied to base plates.

b. Temporary Bracing

- b. 1. Temporary bracing shall be installed as necessary to stay assemblies and assume loads against forces due to transport, erection operations or other work.
- b. 2. Temporary bracing shall be maintained in place until permanent work is properly connected and other construction installed as necessary for support, bracing or staying of permanent work.
- b. 3. Extent and quality of temporary bracing shall be as necessary against wind and other loads, including seismic loads not less than those for which the permanent structure is designed to resist.

c. Adequacy of Temporary Connections

During erection, temporary connection work shall be securely made by bolting and/or

welding for all dead load, wind and erection stresses.

d. Alignment

No permanent bolting or welding shall be done until the alignment of all parts with respect to each other shall be true within the respective tolerances required.

e. Field Welding

e. 1. Any shop paint or surfaces adjacent to joints where field welding is to be executed shall be wire brushed to remove paint/primer.

e. 2. Field welding shall conform to the requirements specified herein, except as approved by the Engineer.

f. High Strength Bolts

Final tightening of high strength bolts shall be done by using manufacturer's power operated equipment without any overstress to the threads.

g. Correction of Errors

g. 1. Corrections of minor misfits by use of drift pins, and reaming, chipping or cutting will be permitted and shall be provided as part of erection work.

g. 2. Any errors to be corrected or adjusted, preventing proper assembly, shall be immediately reported to the Engineer, and such corrections or adjustments shall be made as necessary and approved by the Engineer.

g. 3. Cutting or alterations other than as approved will not be permitted.

h. Erection

h. 1. Erection and installation shall be as per approved shop drawings.

h. 2. Each structural unit shall be accurately aligned by the use of steel shims, or other approved methods so that no binding in any moving parts or distortion of any members occurs before it is finally fastened in place.

h. 3. Operations, procedures of erection and bracing shall not cause any damage to works previously placed nor make overstress to any of the building parts or components. Damage caused by such operations shall be repaired as directed by the Engineer at no extra cost to the Employer.

GALVANIZING

PREPARATION

All mild steel parts exposed to weather shall be hot-dipped galvanized after fabrication in accordance with the requirements of ASTM A 123 or ASTM A 153. Prior to galvanizing, the surfaces shall be cleaned of dirt, weld splatter, grease, slag, oil, paint or other deleterious matters. The steel surfaces shall be chemically de-scaled and cleaned with the same abrasive blast or other suitable method as approved by the Engineer.

COATING

The zinc coating shall consist of uniform layers of commercially pure zinc free from abrasions, cracks blisters, chemical spots or other imperfections, and shall adhere firmly to the surface of the steel. The weight of zinc coating per square meter of actual surface shall not be less than 550 grams. Any surface damaged subsequent to galvanizing shall be given two coats of approved zinc rich paints.

PAINTING

This work shall consist of the preparation of the metal surfaces, the application, protection and drying of the painted surfaces, and supplying of all tools, tackle, scaffolding, labor and materials necessary for the entire work. Painting shall be applied in the field or shop as approved by the Engineer.

Unless otherwise specified or approved, all painting work for structural steel shall comply with the requirements of this Section.

SHOP PAINTING

All structural steel shall be given a shop primer after fabrication and cleaning before delivery to the site.

All steel work shall be thoroughly dried and cleaned of all loose mill scale, rust and foreign matters by means of sand blasting or other suitable methods approved by the Engineer before shop painting shall be applied. Each individual piece shall be painted prior to assembly. Portions where field welding or field contact with concrete is required shall not be painted.

Except for galvanized surfaces and items to be encased in concrete, clean ferrous metal surfaces shall be given one coat of Amerlock 400 Epoxy Primer at 100 Microns or approved equal. Additional coat shall be applied to surfaces that will be concealed or inaccessible for finish painting by Amerlock 400, Top Coat at 150 Microns with color or equivalent.

FIELD PAINTING

After erection, the Contractor shall thoroughly prepare and clean the entire surface of all structural steel from all dirt, grease, rust or other foreign matters. The entire surface of all members shall then be field painted.

MATERIALS

1. Structural Steel Work

- a. After surface preparation, steelwork shall be given one coat of approved prefabricating primer.
- b. Before final assembly of steelwork at the fabricator's shop, two shop coats of special red lead primer shall be applied to the surface of sections to be in permanent contact, meeting faces and all other concealed surfaces. After final assembly, but before delivery to the project site, the steelwork shall likewise be given two shop coats of special red lead primer.

2. Galvanized Steelwork

All galvanized steelwork shall be treated with zinc chromate two-pack etch primer followed by one coat of non-etch zinc chromate primer.

3. Miscellaneous Metal Work

Unless otherwise specified in other Sections of the Specifications or shown on the drawing, miscellaneous metal works such as ladders, structural steel ladder rungs, etc. shall be given two shop coats of epoxy primer and two coats of epoxy enamel.

CONSTRUCTION METHODS

1. Cleaning of Surfaces

Surfaces of metal to be painted shall be thoroughly cleaned; removing rust, loose mill scale, dirt, oil or grease, and other foreign substances. Unless cleaning is to be done by sand blasting, all weld areas, before cleaning is started, shall be neutralized with a proper chemical, after which they shall be thoroughly rinsed with water.

Three methods of cleaning are provided herein. The particular method to be used shall be as directed by the Engineer.

2. Hand Cleaning

The removal of rust, scale, and dirt shall be done by the use of metal brushes, scrapers, chisels, hammers or other effective means. Oil and grease shall be removed by the use of gasoline or benzene.

Bristle or wood fiber brushes shall be used for removing loose dirt.

3. Sandblasting

All steel shall be cleaned by sandblasting. The sandblasting shall remove all loose mill scale and other substances. Special attention shall be given to cleaning of corners and re-entrant angles. Before painting, sand adhering to the steel in corners and elsewhere shall be removed. The cleaning shall be approved by the Engineer prior to any painting which shall be done as soon as possible before rust forms.

4. Flame Cleaning

All metal, except surface inside boxed members and other surfaces which shall be inaccessible to the flame cleaning operation after the member is assembled, shall be flame cleaned in accordance with the following operations.

- a. Oil, grease, and similar adherent matter shall be removed by washing with a suitable solvent. Excess solvent shall be wiped from the work before processing with subsequent operations.
- b. The surface to be painted shall be cleaned and dehydrated (free from occluded moisture) by the passage of oxyacetylene flames which have an oxygen to acetylene ratio of at least 1.0. The oxyacetylene flames shall be applied to the surfaces of the steel in such a manner and at such speed that the surfaces are dehydrated; dirt, rust loose scale in the form of blisters or scabs, and similar foreign matters are freed by the rapid, intense heating by the flames. The number arrangement and manipulation of the flames shall be such that all parts of the surfaces to be painted are adequately cleaned and dehydrated.
- c. Promptly after the application of the flames, the surfaces of the steel shall be wire brushed, hand scraped wherever necessary, and then swept and dusted to remove all free materials and foreign particles.

- d. Paint shall be applied promptly after the steel has been cleaned and while the temperature of the steel is still above that of the surrounding atmosphere.

5. Weather Conditions

a. Exterior Coatings

Coatings to surface shall not be applied during foggy or rainy weather, or under the following surface temperature conditions: below 4°C, or over 35°C, unless approved by the Engineer.

b. Interior Coatings

Coatings shall be applied when surfaces to be painted are dry and the following surface temperatures can be maintained: between 18 to 35°C during the application.

6. Application

- a. Paint shall be factory tinted and mixed. All paint shall be field mixed before applying in order to keep the pigments in uniform suspension.

b. Field Painting

When the erection work is complete, including all bolting and straightening of bent metal, all adhering rust, scale, dirt, grease or other foreign materials shall be removed as specified above.

As soon as the Engineer has examined and approved each steel and metal works structures, all field bolts, all welds, and any surfaces from which the top or first coat of paint has become worn off, or has otherwise come defective shall be cleaned and thoroughly covered with one coat of paint.

Surfaces to be bolted and surfaces which shall be in contact with concrete, shall not be painted. Surfaces which shall be inaccessible after erection shall be painted with such field coats as are required. When the paint applied for retouching the shop coat has thoroughly dried, and the field cleaning has been satisfactorily completed, such field coats as are required shall be applied. In no case shall a succeeding coat be applied until the previous coat is dry throughout the full thickness of the paint film. All small cracks and cavities which were not sealed in a watertight manner by the first field coat shall be filled with a pasty mixture of red lead and linseed oil before the second coat is applied.

The following provision shall apply to the application of both coats. To secure a maximum coating on edges of plates or shapes, bolt heads and other parts subjected to special wear and attack, the edges shall first be striped with a longitudinal motion and the bolt heads with a rotary motion of the brush, followed immediately by the general painting of the whole surface, including the edges and bolt heads.

The application of the second field coat shall be deferred until adjoining concrete work has been placed and finished. If concreting operations have damaged the paint, the surface shall be re-cleaned and repainted.

c. General Manners

Painting shall be done in a neat and workmanlike manner. Paint may be applied with hand brushes or by spraying, except aluminum paint which preferably shall be applied by spraying. By either method the coating of paint applied shall be smoothly and uniformly spread so that no excess paint shall collect at any point. If the work done by spraying is not satisfactory to the Engineer hand brushing shall be required.

d. Brushing

When brushes are used, the paint shall be so manipulated under the brush as to produce a smooth, uniform, even coating in close contact with the metal or with previously applied paint, and shall be worked into all corners and crevices.

e. Spraying

Power spraying equipment shall be used to apply the paint in a fine spray. Without the addition of any paint, the sprayed area shall be immediately followed by brushing, when necessary, to secure uniform coverage and to eliminate wrinkling, blistering and air holes.

f. Removal of Paint

If the painting is unsatisfactory to the Engineer the paint shall be removed and the metal thoroughly cleaned and repainted.

ITEM 15 : ZINC (HOT-DIP GALVANIZED) COATINGS ON IRON AND STEEL

SCOPE OF WORK

This specification covers the requirements for zinc coating (galvanizing) by the hot-dip process on iron and steel products made from rolled pressed and forged shapes, casting, plates, bars and strips.

This specification covers both fabricated and un-fabricated products, for example, assembled steel products, structural steel fabrications, large tubes already bent or welded before galvanizing, and wire work fabricated from uncoated steel wire. It also covers steel forgings and iron castings incorporated into pieces fabricated before galvanizing or which are too large to be centrifuged (or otherwise handled to remove excess galvanizing bath metal).

MATERIAL REQUIREMENTS

STEEL OR IRON

The specification, grade or designation, and type and degree of surface contamination of the iron or steel in articles to be galvanized shall be supplied by the purchaser to the hot-dip galvanizer prior to galvanizing.

The presence in steels and weld metal, in certain percentages, of some elements such as silicon, carbon and phosphorus tends to accelerate the growth of the zinc-iron alloy layer so that the coating may have a matte finish with a little or no outer zinc layer.

EXECUTION

FABRICATION

The design and fabrication of the product to be galvanized shall be in accordance to the plans and specifications. ASTM Practices A 143, A 384 and A 385 provide guidance for steel fabrication for optimum hot-dip galvanizing and shall be complied with in both design and fabrication.

CASTINGS

The composition of heat treatment of iron and steel castings shall conform to specifications designated by the purchaser. Some types of castings have been known to show potential problems being embrittled during normal thermal cycle of hot-dip galvanizing. The requirements for malleable iron castings to be galvanized are stipulated in ASTM specification A 47.

ZINC

The zinc used in the galvanizing bath shall conform to ASTM Specification B 6. If a zinc alloy is used as the primary feed to the galvanizing bath, then the base material used to make that alloy shall conform to ASTM Specification B 6.

BATH COMPOSITION

The molten metal in the working volume of the galvanizing bath shall contain not less than an average value of 98.0% zinc by weight.

COATING PROPERTIES

Table 1 – Minimum Average Coating Thickness Grade by Material Category

Material Category	All Specimens Tested Steel Thickness Range (Measured), mm (in.)				
	< 1/16 (<1.6)	1/16 to < 1/8 (1.6 to < 3.2)	1/8 to < 3/16 (3.2 to 4.8)	> 3/16 to < 1/4 (> 4.8 to < 6.4)	≥ 1/4 (≥ 6.4)
Structural Shapes & Plate	45	65	75	85	100
Strip and Bar	45	65	75	85	100
Pipe and Tubing	45	45	75	75	75
Wire	35	50	60	65	80

COATING THICKNESS

The average thickness of coating for all specimens tested shall conform to the requirements of Table 1 for the categories and thickness of the material being galvanized. Minimum average thickness of coating for any individual specimen is one coating grade less than that required in Table 1. Where products consisting of various material thicknesses or categories are galvanized, the coating thickness grades of each thickness range and material category of material shall be shown in Table 1. The specification of coating thickness heavier than those required by Table 1 shall be subject to mutual agreement between the galvanizer and Engineer.

For articles whose surface area is greater than 100,000 mm² (160 in.²) (multi-specimen articles), each test article in the sample must meet the appropriate minimum average coating thickness grade requirements of Table 1. Each specimen coating thickness grade comprising that overall average for each test article shall average not less than one coating grade below that required in Table 1.

For articles whose surface area is equal to or less than 100,000 mm² (160 in.²) (single-specimen articles), the average of all test articles in the sample must meet the appropriate minimum average coating thickness grade requirements of Table 1. For each test article, its specimen coating thickness shall not be less than one coating grade below that required in Table 1.

No individual measurement or cluster of measurements at the same general location on a test specimen shall be cause for rejection under this specification provided that when those measurements are averaged with the other dispersed measurements to determine the specimen coating thickness grade for that specimen, the requirements of the above specifications as appropriate are met.

The coating thickness grades in Table 1 represent the minimum value obtainable with a high level of confidence for the ranges typically found in each material category. While most coating thicknesses will be in excess of those values, some materials in each category may be less reactive (for example, because of chemistry or surface condition) than other materials of the steel category spectrum. Therefore, some articles may have a coating grade at or close to the minimum requirements shown in Table 1. In such cases, the precision and accuracy of the coating thickness measuring technique should be taken into consideration when rejecting such articles for coating thickness below that is required by this specification.

FINISH

The coating shall be continuous (except as provided below), and as reasonably smooth and uniform in thickness as the weight size and shape of the item. Except for local excess coating thickness which would interfere with the use of the product or make it dangerous to handle (edge tears or spikes), rejection for non-uniform coating shall be made only for plainly visible excess coating not related to design factors such as holes, joints, or special drainage problems. Since surface smoothness is a relative term, minor roughness that does not interfere with the intended use of the product, or roughness that is related to the as-received (un-galvanized) surface condition, steel chemistry to zinc shall not be grounds for rejection.

Surfaces that remain uncoated after galvanizing may be renovated in accordance with the methods in ASTM Practice A 780 provided that the following conditions are met:

1. Each area subject to renovation shall be 25mm (1 in.) or less in its narrowest dimension.
2. The total area subject to renovation on each article shall be no more than $\frac{1}{2}$ of 1% of the accessible surface area to be coated on that article, or 22,500mm² (36 in.²) per ton of piece weight, whichever is less. Inaccessible surface areas are those which cannot be reached for appropriate surface preparation and application of repair materials as described in ASTM Practice A 780.
3. The thickness of renovation shall be that is required by the thickness grade for the appropriate material category and thickness range in Table 1 in accordance with the coating thickness requirements, except that for renovation using zinc paints, the thickness of renovation shall be 50% higher than that required by table 1, but not greater than 0.0254mm (4.0 mils).
4. When areas requiring renovation exceed the criteria previously provide, or are inaccessible for repair, the coating shall be rejected.

THREADED COMPONENTS IN ASSEMBLIES

The zinc coating on external threads shall not be subjected to a cutting, rolling or finishing tool operation, unless specifically authorized by the purchaser. Internal threads may be tapped or retapped after galvanizing. Coatings shall conform to the requirements of ASTM Specification A 153/A 153 M.

APPEARANCE

Upon shipment from the galvanizing facility, galvanized articles shall be free from uncoated areas, blisters, flux deposits and gross dross inclusions. Lumps, projections, globules or heavy deposits of zinc which will interfere with the intended use of the material will not be permitted. Plain holes of 12.5mm (1/2 in.) diameter or more shall be clean and reasonably free from excess zinc. Marks in the zinc coating caused by tongs or other items used in handling the article during the galvanizing operation shall not be cause for rejection unless such marks have exposed the base metal, and the bare metal areas exceed the criteria provided in number 1 and 2 of Subsection "Finish".

Whenever dross is present in a form other than finely dispersed pimples in the coating and is present in such amount as to be susceptible to mechanical damage, it will be considered as "gross".

ADHERENCE

The zinc coating shall withstand handling consistent with the nature and thickness of the coating and the normal use of the article, without peeling or flaking. Although some material may be formed after galvanizing, in general the zinc coating on the articles covered by this specification is too heavy to permit severe bonding without damaging the coating.

SAMPLING

A lot is a unit of production or shipment from which a sample may be taken for testing. Unless otherwise agreed upon between the galvanizer and the purchaser, or established within this specification, the lot shall be as follows:

1. For testing at a galvanizer's facility, a lot is one or more articles of the same type and size comprising a single order or a single delivery load, whichever is smaller, or any number of articles identified as a lot by the galvanizer, when these have been galvanized within a single production shift and in the same bath.
2. For test by the purchaser after delivery, the lot consists of the single order or the single delivery load, whichever is smaller, unless the lot identify, established in accordance with the above, is maintained and clearly indicated in the shipment by the galvanizer.

The method of selection and number of test specimens shall be agreed upon between the galvanizer and the purchaser. Otherwise, the test specimens shall be selected random from each lot. In this case, the minimum number of specimens from each lot shall be as follows:

Number of Pieces in Lot	Number of Specimens
3 or less	All
4 to 500	3
501 to 1,200	5
1,201 to 3,200	8
3,201 to 10,000	13
10,001 and over	20

A test specimen which fails to conform to any requirement of this specifications shall not be used to determine the conformance to other requirements.

TEST REQUIREMENTS

Magnetic Thickness Measurements:

The thickness of the coating shall be determined by magnetic thickness gauge measurements in accordance with ASTM Practice E 376. For each specimen, five or more measurements shall be made at points widely dispersed throughout the volume occupied by the specimen so as to represent as much as practical, the entire surface area of the test specimen. The average of the five or more measurements thus made for each specimen is the specimen coating thickness.

For articles whose surface area is greater than 100,000 mm² (160 in²), in the average of the three specimen coating thickness grades comprising each test article is the average coating thickness for that test article. A specimen must be evaluated for each steel category and material thickness within the requirements for each specimen of the test article

For articles whose surface area is equal to or less than 100,000 mm² (160 in²), the average of all specimen coating thickness grades is the average coating thickness for the sample.

The use of magnetic measurement method is appropriate for larger articles, and may be appropriate for smaller articles when such is practical using ASTM Practice E 376.

Stripping Method

The average weight of coating may be determined by stripping a test article, a specimen removed from a test article, or group of test articles in the case of very small items such as nails, etc., in accordance with Test method ASTM A 90/A 90m. The weight of coating per unit area thus determined is converted to equivalent coating thickness values in accordance with Table 2, Coating Thickness Grade (rounding up or down as appropriate). The thickness of coating thus obtained is the test article coating thickness, or in the case of a specimen removed from a test article, is the specimen average coating thickness.

Table 2 – Coating Thickness Grade ^A

Coating Grade	mils	oz/ft ²	μm	g/m ²
35	1.4	0.8	35	245
40	1.4	1.0	45	320
50	2.0	1.2	50	355
55	2.2	1.3	55	390
60	2.4	1.4	60	425
65	2.6	1.5	65	460
75	3.0	1.7	75	530
80	3.1	1.9	80	565
85	3.3	2.0	85	600
100	3.9	2.3	100	705

^A Conversions in Table 2 are based on the metric thickness value equivalents from the next earlier version, using conversion factors consistent with Table X 2.1 in Specification A 653/A 653M, rounded to the nearest 5 μm (0.0002 in.). The conversion factors used are: mils = μm x 0.03937; oz/ft² = μm x 0.002316; g/m² = μm x 7.067.

Weighing Before or After Galvanizing

The average of coating may be determined by weighing articles before and after galvanizing, subtracting the first weigh from the second and dividing the result by the surface area. The first weigh shall be determined after pickling and drying, and the second after cooling to ambient temperature. The weight of coating per unit area thus determined is converted to equivalent coating thickness values according to Table 2 (rounding up or down as appropriate). The thickness of coating thus obtained is the test article coating thickness.

Microscopy

The thickness of coating may be determined by cross-sectional and optical measurement in accordance with ASTM Test Method B 487. The thickness thus determined is a point value. No less than five such measurements shall be made at locations on the test article which are as widely dispersed as practical, so as to be representative of the whole surface of the test article. The average of no less than five such measurement is the specimen coating thickness.

Adhesion

Determine adhesion of the zinc coating to the surface of the base metal by cutting or prying with the point of a stout knife, applied with considerable pressure in a manner tending to remove a portion of the coating. The adhesion shall be considered inadequate if the coating flakes off in the form of a layer of the coating so as to expose the base metal in advance of the knife point. Do not use testing carried out at edges or corners (points of lowest coating adhesion) to determine adhesion of the coating. Likewise, do not use removal of small particles of the coating by paring or whittling to determine failure.

Embrittlement

Test for embrittlement may be made in accordance with ASTM Practice A 143

The galvanized article should withstand a degree of bending substantially the same as the ungalvanized article. Flaking or spalling of the galvanized coating is not be constructed as an embrittlement failure.

Inspection, Rejection and Retest

The material shall be inspected at the galvanizer's plant prior to shipment. However, by agreement the purchaser may make the tests which govern the acceptance or rejection of the materials in his own laboratory or elsewhere.

When inspection of materials to determine conformity with the visual requirements of Subsection "Finish" warrants rejection of a lot, the galvanizer may sort the lot and submit it once again for acceptance after he has removed any nonconforming articles and replace them with conforming articles.

Materials have been rejected for reasons other than embrittlement may be stripped and regalvanized, and again submitted for inspection and test at which time they shall conform to the requirements of this inspection.

Transport and Storage

Galvanized components shall, wherever possible, be transported and stored under dry, well-ventilated conditions to prevent the formation of wet storage staining.

Either zinc phosphate or chromate passivation treatment after galvanizing may be used to minimize the wet storage staining which may occur on articles unable to be stored in dry, well-ventilated conditions.

Provided the coating thickness complies with the requirements of Subsection "Coating Thickness", no further remedial action is required to the stained areas.

ITEM 16 : SECURITY FENCE

DESCRIPTION

This item shall consist of furnishing, construction and installation of security fence components in any combinations in accordance with this specification, lines, grades and cross-sections shown on the Plans, or as directed by the Engineer.

MATERIALS REQUIREMENT

Materials shall conform to the respective specifications and other requirements specified below

CONCRETE HOLLOW BLOCKS (CHB)

CHB shall be of standard manufacture, machine vibrated with fine and even texture and well-defined edges and conforming to the requirements of ASTM C 129. Unless otherwise specified on the Drawings, It shall have a minimum compressive strength of 4.14 MPa (600 psi). CHB shall be non-load bearing uniform and essentially smooth as normally achieves by standard molding methods and shall be free from any cracks, flaws or other defects.

BEDDING MORTAR

Mortar shall be composed of 1 part of Portland cement, 3 parts of sand and ½ part of lime. It shall have a compressive strength of [14 MPa (2,000 psi)] at 28 days and shall comply with property specifications for type N mortar set forth in ASTM Specification C 270 and as modified herein, proportioned and tested in an approved laboratory at the expense of the Contractor. When tested for water retention, the mortar shall have a flow after suction, of 75 percent or more when mixed to an initial flow of 125 to 140 percent. When tested for compressive strength, mortar shall be mixed to a flow of 100 to 115 percent. Aggregate for mortar shall conform to ASTM C 144.

PLASTER

Plaster shall comply with the same specification as those for bedding mortar and will include the use of synthetic fibrous reinforcement of type and dosage recommended by the manufacturer.

REINFORCING STEEL BARS AND RODS

Minimum yield strength of reinforcement shall conform to the specifications in Section of Reinforced Concrete.

CONCRETE

Minimum compressive strength of concrete shall conform to the specifications in Section of Reinforced Concrete.

BARBED WIRE AND STEEL/GI PIPE POST

The materials to be used shall conform to the specifications indicated on the drawings and shall be approved by the Engineer prior to installation.

CYCLONE WIRE MESH

Cyclone Wire Mesh shall conform to the requirements of ASTM A 121, Class I.

CONSTRUCTION REQUIREMENT

The Contractor shall perform such clearing and grubbing as may be necessary to construct the fence to required grade and alignment. Fence shall generally follow the contour of the ground. Grading shall be performed where necessary to provide a neat appearance.

The post shall be erected vertically in position inside the formwork of the foundation block prior to the placing of concrete shall be adequately supported by bracing to prevent movement of the post during the placing and setting of the concrete. The post shall be erected to the height and location shown on the Plans, or as ordered by the Engineer.

Masonry shall be laid plumb, true to line, with level courses accurately spaced. Bond pattern shall be kept plumb throughout. Corners and reveals shall be plumb and true. Vertical joints shall be shoved tight. Each unit shall be adjusted to final position while mortar is still soft and plastic. Any unit that is disturbed after mortar has stiffened shall be removed and relaid with fresh mortar. Courses shall be so spaced that backing masonry will level off, flush with the face work at all joints where ties occur. Chases and rake-out joints shall be kept free from mortar or other debris.

Anchorage to concrete. Anchorage to abutting columns shall be provided only where indicated. Details shall be as indicated including anchorage to underside of beams and slabs

Cutting and fitting, including that required to accommodate the work of others shall be done by masonry mechanics. Wherever possible, full units of the proper size shall be used in lieu of cut units. Cut edges shall be clean, true and sharp. Openings shall be carefully cut, formed or otherwise neatly made for recessed items and for electrical, plumbing, or other mechanical installations so that wall plates, cover plates, or escutcheons required by the installation will completely conceal the openings and will have bottoms in alignment with lower edge of masonry joints. Webs of hollow masonry units shall be cut to the minimum required for the installation. Reinforced masonry lintels shall be provided as indicated above openings over 300mm wide, for pipes, ducts and cable trays, unless steel sleeves are used.

Spaces around built-in items shall be filled with mortar. Openings around flush-mounted electrical outlet boxes in wet locations shall be pointed flush with mortar including flush joints above the boxes. Anchors, ties, accessories, flashing, pipe sleeves and other items required to be built-in shall be built-in as the masonry work progresses. Anchors, ties, and joint reinforcement shall be fully embedded in mortar.

Unfinished work shall be stepped back for jointing with new work. Toothing may be resorted to only when specifically approved. Before laying new work, loose mortar shall be removed and the exposed joint shall be thoroughly cleaned.

Mortar shall be accurately measured in laboratory-established proportions and mixed with as much water as may be necessary to produce the wettest workable consistency possible. Mortar shall be placed in final position within one hour after mixing. Mortar not used or that has started to set within this time interval shall be discarded.

Joints in exposed-to-view except control joints, joints to be pointed or caulked or sealed, and openings around flush-mounted electrical outlet boxes in wet locations shall be tooled slightly concave with the mortar thoroughly compacted and pressed against the edges of the units. Tooling shall be done when the mortar has been thumbprint hard. The tooled joint shall be finished to uniformly straight and true lines and surfaces, smooth and free of tool marks.

Details of reinforcement shall be as indicated in the drawings. Reinforcing shall not be bent or straightened in a manner injurious to the steel. Bars with kinks or bends not shown on the drawings shall not be used. Placement of reinforcement shall be inspected and approved prior to placing

grout. One piece vertical bars extending from floor to floor or roof above shall be provided. Vertical bars shall be spliced only where indicated.

a. **Positioning Bars**

Vertical bars shall be positioned accurately at the centerline of the wall. A minimum clearance between the bars and masonry units of 12mm and between parallel bars of one diameter of the reinforcement shall be maintained. Vertical reinforcing shall be held in place using metal supports, centering clips, spacers, ties or caging devices located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement.

b. **Splices**

Splices shall be located only as indicated. Splices shall be staggered in adjacent bars at least 600mm. Bars shall be lapped a minimum of 40 diameters of the reinforcement.

Welding shall be done in accordance with Standard Code and under supervision of Engineer.

PAINTING AND CLEANING

If required in the contract, paint shall be in accordance to the specification indicated in the plans and coordinated with the end user.

Mortar daubs or splashing, before setting or hardening, shall be completely removed from masonry unit surfaces that will be exposed or painted. Before completion of the work, all defects in joints or masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Masonry surfaces shall not be cleaned, other than removing excess surface mortar until mortar in joints has hardened. Masonry hardened surfaces shall be left clean, free of mortar daubs, dirt, stain and discoloration, including scum from cleaning operations and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

ITEM 17 : PILING WORKS (PRE-STRESSED CONCRETE PILES)

SCOPE OF WORK

This section covers the minimum requirements for the fabrication, hauling, spotting, driving and finishing of all foundation piles to be used in wharves/piers/platforms/pile anchor.

The Contractor may however, adopt, in addition to this minimum requirements additional provisions as may be necessary to insure the successful prosecution of the work related to foundation piling.

METHOD STATEMENT

Before the commencement of any piling works, the Contractor shall submit (allowing sufficient time for consideration) to the Engineer for approval a Safety Policy and a Method Statement which shall include the following information:

1. Program of Works detailing sequence and timing of individual portions of works.
2. Maximum proposed lead at any stage of driving between a pile and its neighbor and the limitations of same if hard driving is encountered.
3. Contingency plan in the event of encountering obstructions or reaching driving refusal to minimize disruption/delay especially when using pitch and drive methods.

MATERIAL REQUIREMENTS

TYPE OF FOUNDATION PILES

Pre-stressed concrete foundation piles to be used shall be in accordance with the design as shown on the Drawings and called for in the proposal.

PRE-STRESSED CONCRETE PILES

Pre-stressed concrete piles shall be constructed in accordance with the standard practice employed for the particular system specified and as directed by the Engineer subject to the following clauses.

1. Pre-stressed concrete piles shall be of readymade products of approved fabricator regularly engaged in the production of pre-stressed concrete piles.
2. If an alternative system of pre-stressing to that shown in the Drawings is proposed by the Contractor, full details, procedures and explanations shall be submitted in writing to the Engineer for his approval. When approved for the work, the provisions of this Specification and such other provisions as he may require shall be fully satisfied.
3. Concrete strength, high tension wires/strands, reinforcing bars to be used for pre-stressed concrete work shall be as specified in the Drawings.
4. The Contractor shall submit the casting method including pre-stressing, application of stress and casting schedule and shall obtain the approval of the Engineer before commencement of fabrication of the piles.
5. The Contractor shall arrange for the Engineer to have free access to the place of manufacture of the piles.

6. Piles shall be cast on a horizontal platform in approved steel moulds and details of the formwork and methods of concreting shall be as specified. The concreting of each pile shall be completed on one continuous operation and no interruption shall be permitted.

The pile butt must be formed truly square to the axis of the pile. Provision for standard splicing shall be provided unless otherwise ordered by the Engineer.

7. Anchorages shall be made from steel of a suitable quality to withstand permanently the forces imposed upon them, and shall in general be in accordance with the normal practice of the proprietors of the pre-stressing system in use.
8. Application of stress, grouting of pre-stressing cables, protection of pre-stressing cable anchorages and other necessary steps to complete the pre-stressing process shall conform to the standard practice of the pre-stressing system in use or as directed by the Engineer.
9. When the stress has been transferred to the pile, the pile shall exhibit no curvature in its length on any face greater than 3 millimeters deviation along a chord of 15 meters (1 in 500).
10. Pre-cast pre-stressed units shall be lifted only by lifting holes/hook as indicated in the Drawings, or when not provided can be lifted by slings placed securely at corresponding points. Units shall be kept in the upright position at all times and shock shall be avoided. Any unit considered by the Engineer to have become sub-standard in any way shall be rejected and replaced by an acceptable unit.
11. Each pre-stressed member is to be uniquely and permanently marked to show its type, date of casting, length of pile and any control markings as ordered by the Engineer
12. Forms shall conform to the geometry of the pile with the provision of chamfer as shown on the Drawings.
13. Not less than five (5) cylindrical specimens shall be made for each casting batch of which at least two (2) shall be reserved for 28-day test, one (1) for 7-day, one (1) for 14-day, and one (1) test prior to lifting of pre-stressed concrete piles from the casting bed. Lifting of piles shall only be done if the result of the compressive strength has reached at least 60% of the specified compressive strength.
14. Wires/strands specifications shall be in accordance with ASTM A 416.

EXECUTION

HANDLING OF PILES

All piles shall be carefully lifted at the location of the lifting points as indicated in the Drawings. Other practical and convenient methods may be used subject to the approval of the Engineer.

DRIVING OF PILES

A hydraulic or diesel pile hammer shall be used for driving the pre-stressed concrete piles.

The required weight of ram for the hydraulic or diesel pile hammer, ranges from 3.5 to 4.5 tons.

Piles driven shall be held firmly in position in axial alignment with the hammer by means of leads of adequate length. Approved cushions shall be provided to the pile butts.

PILE SPLICING

General Provision

1. The alignment of piles shall be plumb and the length of upper and lower segment shall be in accordance in the approved plans.
2. The splice shall be embedded at least 4m from the design depth elevation.

Surface Preparation

Concrete piles to be bonded must be thoroughly cleaned, free of dirt, paint, grease, oil, curing compound and other contaminants. The concrete surface must be dry. Clean the dowels with steel brush to removed rust and other impurities. Blow compressed air to the dowel holes.

Pile Splicing Epoxy

Piling splicing epoxy is a two components, low viscosity, rapid cure, chemical resistant epoxy with high physical strength.

Preparation and Application of Epoxy Mortar

Mixing and ratio of pile splicing epoxy and dry silica sand, application and curing of epoxy mortar shall refer to product manual.

Compressive Strength

The compressive strength of epoxy mortar (Pile Splicing Epoxy + Dry Silica Sand) shall be at least 1.2 times the design compressive strength of pile or 6,000psi.

Mechanical Properties of Epoxy

Cured state at 27° C (80° F) for 24 hours

Mechanical Properties	Specification (Test Methods)
Ultimate Tensile Strength	ASTM D 638
Ultimate Flexural Strength	ASTM D 790
Hardness	ASTM D 2240
Compressive Strength at 1 hour cure	ASTM D 695
Compressive Strength with Silica Sand	ASTM D 695

PILE CHIPPING

Each pile shall be chipped-off to required elevation as indicated in the drawing. The contractor shall ensure that no damaged/cracked on the main pile will occurred after each chipping. Reinforcement from driven piles (dowels and strand) shall not be cut and will be incorporated to the construction of deck. Splicing of dowels are allowed in case of pile cutting due to early refusal.

BEARING POWER OF PILES

Each pile shall be driven to attain not less than the required minimum bearing power shown in the pile schedule, as determined by the Hiley's Formula as follows:

$$\text{For Diesel Pile Hammer : } R = \frac{1}{6} \times \frac{2WH}{S + 2.54}$$

$$\text{For Hydraulic Pile Hammer : } R = \frac{1}{3} \times \frac{2WH}{S + 2.54}$$

where : R = allowable bearing capacity of pile (tf)

 W = weight of ram (tf)

 H = fall of ram (cm)

 S = set (cm)

INTERRUPTED DRIVING

When driving is stopped before final penetration is reached and/or refusal is attained, the record of pile penetration shall be taken only after a minimum of 30 cm. (12 in.) total penetration has been obtained on resumption of driving.

ALIGNMENT TOLERANCE

Piles driven shall be within the allowable tolerance in alignment of 10 cm. (4 in.) in any direction.

DAMAGED AND MISDRIVEN PILES

1. Piles shall not be more than 10 cm. (4 in.) out of place at cut-off level. All vertical piles shall not be more than 2% out of plumb.
2. Any pile damaged by improper driving or driven out of its proper location, or driven out of elevation fixed on the plans, shall be corrected correspondingly at the Contractor's expense by any of the following methods:
 - a. Withdrawal of the pile and replacement by a new pile.
 - b. Driving a second pile adjacent to the defective one.
 - c. Splicing an additional length.

The method to be adopted in each case shall be at the discretion of the Engineer.

OBSTRUCTION

Where boulders or other obstructions make it impossible to drive certain piles in the location shown and to the required bearing strata, the Engineer may order additional pile or piles driven at other suitable location.

RECORDS

The Contractor shall keep records of each pile driven and shall furnish the Engineer two (2) signed typewritten/computerized copies. The records shall show the number of blows per 0.50 m. of initial penetration taken from the free fall elevation of the pile down to penetration depth of 5.0 m., the penetration under the last 10 blows, and the calculated safe load according to the Hiley's Formula as stated in bearing power of piles.

TESTING OF MATERIALS

The requirements regarding testing of concrete and reinforcement used in reinforced concrete piles shall be in accordance with "Reinforced Concrete".

However, the Engineer may conduct the necessary testing at the approved fabricator's casting yard whenever he considers necessary. Tests shall be carried out at the Contractor's expense.

High Tensile Strand shall be tested according to the latest ASTM Standard and PPA Circular

STORAGE AND HANDLING OF PILES

When raising or transporting piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Pile materials damaged in handling or driving shall be removed from the site and replaced by the Contractor at his expense.

Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

ITEM 18 : ELECTRICAL WORKS

SCOPE OF WORK

The work to be done shall consist of fabricating, trenching, furnishing, delivering and installing electrical materials/fixtures completed in accordance with all the details of the electrical works as shown on the drawings including materials, labor, tools and equipment and all incidental works as found necessary.

Refer to electrical plans/drawings for location and extent of work involved.

GENERAL REQUIREMENTS

- a) All works shall be done in accordance with the requirements of the publications and agencies having jurisdiction, as well as the requirements of the approved standards.
 1. National Fire Protection Association - (NFPA)
 2. National Electrical Manufacturer Association - (NEMA)
 3. Underwriter Laboratories, Inc. - (UL)
 4. Philippine Electrical Code - (PEC)
 - Philippine National Standard - (PNS)
 - Light Emitting Diode - (LED)
 5. Federation Specification: - (MCCB)
 - Molded Case Circuit Breaker
 6. American National Standard Institute - (ANSI)
 7. American Society for Testing and Materials - (ASTM)
 8. Illuminating Engineering Society - (IES)
- b) The electrical power of the Port lighting system will be connected to the Main Disconnected Panel (MDP) for the lamp post. While the supply voltage should be 230 volts, three phase (3Ø), and 60 hertz.
- c) The Contractor shall employ a licensed Electrical Engineer or Master electrician to perform and supervise the conduct of continuous inspection of all electrical works.
- d) The Contractor shall first obtain approval from the Authority before procurement, fabrication or delivery of electrical materials to the site. Partial submittals will not be acceptable and will be returned without review. Submittals shall include the Manufacturer's Name, Trade Name, Place of Manufacture, Catalog Model or Number, Nameplate Data, Size, Layout Dimensions, Capacity, Project Specification and Paragraph Reference, Technical Society Publication References and other information necessary to establish contract compliance of each item to be furnished.
- e) All excavations fill and backfill and concrete works involved herein, shall be carried to the required elevations and shall conform to the provisions of specification under Earthwork and Concrete Construction of this tender document.
- f) The materials and equipment to be furnished shall be standard products of reputable manufacturer engaged in the reproduction of such materials and equipment.

- g) All permits and electrical fees required for this work shall be obtained at the expense of the Contractor. The Contractor shall furnish the Engineer-in-Charge, the final Certificates of Inspections and approval from the proper government authorities after the completion of work. The Contractor shall prepare all as-built plans and all other paper works as required by the enforcing authorities.
- h) The Contractor shall furnish and install electrical materials as shown in the drawings. A licensed Electrical Engineer or Master Electrician is required to implement the installation of the electrical system. A licensed electrical contractor shall oversee/conduct the installation of the main circuit breaker.
- i) Electrical installation shall conform to the requirements of Philippine Electrical Code (PEC) and the other approved standards.
- j) The contractor shall install all electrical works with the supervision of the qualified Registered Electrical Engineer (REE) or Master Electrician. All electrical installation applications regardless of capacity and voltage whether new, addition or revision shall be accompanied by electrical plans signed and sealed by a duly licensed Professional Electrical Engineer (PEE).

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.

PRODUCTS

WIRES AND CABLES

The conductor material to be furnished and installed shall be copper wire Heat-Resistant Thermoplastic (THHN/THWN-2). All conductors shall be rated 600 volts insulation and shall be standard for all sizes.

CONDUIT AND FITTINGS

Underground PVC conduit shall be polyvinyl chloride with concrete covered. It shall be manufactured to schedule 40 outside diameter. All fittings and bends shall be solvent bonded using manufacturers recommended product.

FLOODLIGHT FIXTURE 200 WATT LED OR EQUIVALENT

Specifications:

Floodlight Fixture

Rated: 200 watt LED floodlight fixture or equivalent

Input Voltage: AC 100-277/ 50-60 HZ

Lumens: 26000-28000

Color Temperature: Warm White / Daylight

Optional

CRI: Ra>70

PF: > 0.95

IP Grade: IP 66 / IP 65

Beam Angle: 120 degrees

Drive Brand: Meanwell

LED Chip Brand: Philips

Minimum: 5pcs

CONCRETE DUCT BANK AND HANDHOLE

The contractor shall construct concrete duct bank and handhole as shown in the approved plans.

PANEL BOARD

Panel board shall conform as shown in the approved plans.

SINGLE ANGLE BAR FLOODLIGHT STEEL TAPERED LAMP POST

Lamp Post shall be 10.0 m ht. single angle bar floodlight post, furnished installed and tested as shown on the approved plans. The post/s shall be dimensioned for a wind velocity of 185 km/hr. It shall be locally fabricated or manufactured. The post shall be Hot -Dipped Galvanized, prime-coated with red lead and shall be painted at site with the final coating preferably aluminum paint to be approved by the Engineer.

EXECUTION

INSTALLATION

Lamp Post shall be installed as shown on the approved plans.
Attached NEMA -3R weatherproof lamp post switch as shown in the plan.

Pole Setting: Depth as shown on the approved plans.

Construction of reinforced lamp post foundation shall be in accordance with the shape and dimensions as shown on the approved plans.

Excavations / backfilling required before /after installation of lamp post with the trench shall conform to the provisions of Earthwork and Concrete construction.

WORKMANSHIP

The work throughout shall be executed in the best and most thorough manner under the direction of and at the satisfaction of the Registered Electrical Engineer or Master Electrician, who will interpret the intent meaning of the drawings and specification and shall have the power to reject any work and materials which in his judgment, are not in full accordance therewith.

TESTING OPERATIONS

When the electrical installation is completed, the Contractor shall test the installed electrical materials and equipment in the presence of Registered Electrical Engineer or Master Electrician. The system shall be free from any defects, shorts or grounds. The Contractor at no extra cost shall furnish all necessary instruments and personnel required for the testing.

GUARANTEE

Upon completion and before final acceptance of the work, the Contractor shall furnish the Engineer a written guarantee stating that all works executed are free from defects on materials and workmanship. The guarantee shall be for a period of one year from the date of the final acceptance. Any work that becomes defective during the said period shall be corrected / replaced by the Contractor at his own expense in a manner satisfactory to the Authority.

ITEM 19 : ELECTRICAL WORKS

GENERAL

APPLICATION

This Item applies to all "Electrical Works" of this project except as specified otherwise in each individual section.

SCOPE OF WORK INCLUDED

The work to be done under this Item shall include the furnishing of all tools, labor, supervision, equipment, fixtures and all necessary materials, each complete and in proper working condition unless one or other is specifically excluded or stated otherwise in this specifications but not limited to the following items of works.

- a. All works and material for a complete lighting and power systems including cables and conduits, circuit breakers, panel board and connection to all lighting fixtures and power outlets, motor appliances, switches, supports and accessories.
- b. All excavation works, backfilling, dewatering, removal of surplus earth, preparation of formworks and pouring of concrete envelopes as indicated on the drawings or as required to complete the installation.
- c. All steel support for conduits, wires, panel board, boxes, lighting fixtures, etc. as indicated or as required completing the installation.
- d. A complete grounding system as required by the governing codes.
- e. A complete testing of all electrical systems.
- f. All items incidentals to and or required for the proper completion such as painting of boxes, conduits and the likes.
- g. Coordination with other trade Contractors.
- h. Coordination with other companies/offices including handling of all materials related to material testing and application of electrical permits.
- i. Preparation of necessary shop drawings required for the proper execution of the works subject to the approval of the Engineer.

WORK INCLUDED UNDER ELECTRICAL WORKS

The work includes the furnishing of the following:

1. Supply, deliver and install of all motors, pumps and their associated control equipment.
 - a. All electrical system installation consists of motor and branch circuit breakers.
 - b. All motor controllers as indicated to be supplied with equipment.
 - c. Structural foundation of the above.

SUBMITTALS

Obtain approval before procurement, fabrication or delivery of items to the job site. Partial submittals will not be entertained and will be returned without review. Submittals shall include the manufacturer's name, trade name, place of manufacturer, catalogue model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference and technical society publication references, and other information necessary to establish contract compliance of each item to be furnished.

1. Shop Drawings

In addition to the requirements of the contract clauses, shop drawings shall meet the following requirements:

- a. Drawings shall be a minimum of 210 mm x 297 mm in size or in A3 size, except as specified otherwise.
- b. Drawings shall include wiring diagrams and installation details indicating the proposed location layout and arrangement, control panels, accessories, and other items that must be shown to assure a coordinated installation.
- c. Wiring diagrams shall identify circuit termination and the internal wiring for each item of equipment and its interconnection.
- d. Drawings shall indicate adequate clearances for operation, maintenance and replacement of equipment devices. If the layout is disapproved, revise the layout and resubmit.

2. Manufacturer's Data

Submittal for each manufactured item shall be current descriptive literature of catalogued products.

3. Publication Compliance

Where equipment or materials are specified to conform to industry and technical society publications of organizations such as American National Standard Institute (ANSI), American Society for Testing and Materials (ASTM) and Underwriters Laboratories, Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In each of the publications referred to herein, consider the advisory provisions to be mandatory as though the word "shall" had been substituted for "should" wherever it appears. Interpret reference in these publications to the authority having jurisdiction, or words of similar meaning, to mean the Engineer. In lieu of the label or testing, submit a certificate from an approved independent testing organization, adequately equipped and component to perform such services, organization's test methods and not the item conforms to the specified organizations publications. The edition or the revised version of such codes and standards current at the date twenty eight (28) days prior to date of bid submission shall apply. During Contract execution, any changes in such codes and standards shall be applied after approval by the Owner.

CERTIFICATES OF COMPLIANCE

Submit manufacturer's certifications as required on products, materials, finish and equipment indicated in the Technical Sections. Certifications shall be documents prepared specially for the contract. Pre-printed certifications and copies of previously submitted documents are not acceptable. The manufacturer's certification shall name the appropriate products, equipment or materials and the publication specified as controlling the quality of the item. Certification shall not contain statement to imply that the item does not meet requirements specified such as "Good As", "Achieves the same end use and results as materials formulated in accordance with referenced

publications" or "Equal or exceeds the service and performance of the specified materials". Certifications shall simply state that the item conforms to the requirements specified; and shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official, authorized to sign certificates of compliance.

OPERATION AND MAINTENANCE MANUALS

Submit as required for systems and equipment indicated in the Technical Sections. Furnish three (3) copies, bound in hardback binders or an approved equivalent. Furnish one complete manual prior to performance of system or equipment tests, and furnish the remaining manual prior to contract completion. Inscribe the following identification on the cover: the word "Operation and Maintenance Manual", the name and location of the system equipment, building, name of Contractor and contract number. Include in the manual the names, addresses and telephone numbers of each sub-Contractor installing the system or equivalent and the local representatives for the system or equipment. Include a table of contents and assemble the manual to conform to the table of contents with the tab sheets placed before instruction covering the subject. The instructions shall be legible and easily read with large sheets of drawings folded in the manual shall include the following:

- a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.
- b. A control sequence describing start-up, operation and shut-down.
- c. Description of the function of each principal item of equipment.
- d. Installation and maintenance manual.
- e. Safety precaution
- f. Diagrams and illustrations
- g. Testing methods
- h. Performance data
- i. Lubrication schedule including type, grade, temperature range and frequency

List qualified permanent servicing organization for support of the equipment, including addresses and certified qualifications.

POSTED OPERATING INSTRUCTIONS

Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel. The operating instructions shall include diagrams, control diagrams and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Attach or post the operating instructions adjacent to each principal system and equipment including start-up, proper adjustment, operating, lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and other items of instruction recommended by the manufacturer of each system for operating instruction exposed to the weather. Operating instructions shall not fade when exposed to the weather and shall be secured to prevent easy removal or peeling.

INSTRUCTIONS TO PERSONNEL

Where indicated in the technical sections, furnish the services of competent instructors to give full instructions to personnel in the adjustment, operation and maintenance of systems and equipment,

including safety precautionary measures. Each Contractor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work, instructions shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Engineer for regular operation. The number of man-days (8 hours) of instruction shall be as specified in each individual section.

DELIVERY AND STORAGE

Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B, Appendix 1, titled "Equipment Storage and Maintenance during Construction". Replace damaged or defective items with new one.

CATALOGUE PRODUCTS/SERVICE AVAILABILITY

Materials and equipment shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for two (2) years prior to bid opening. The two (2) year period shall include applications of equipment and materials under similar circumstances and of similar size. The two (2) year period shall be satisfactory completed by a manufacturer's catalogue or brochures. Products having less than two (2) year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6,000 hours, exclusive of the manufacturer's factory or laboratory tests is furnished. The equipment items shall be supported by service organization, which are reasonable convenient to the equipment on a regular and emergency basis during the warranty period of the contract.

MANUFACTURER'S RECOMMENDATIONS

Where installation procedures or any parts thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendation prior to installation. Installation of the items shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

MATERIALS/SUBSTITUTION/TESTS

All materials to be installed shall be brand new and shall conform to specifications except as otherwise noted on the drawings. All materials where not specified shall be of the best of their respective kind. Samples of said material including its manufacturer's data shall be submitted for approval. Necessary tests on the installations shall be made by the Contractor in the presence of the Engineer. These tests shall include but not limited to ground test, performance test, phase sequence test, etc. Records of approved tests result shall be relayed to the Engineer in writing. This Contractor shall within ten (10) days after the award of the contract, submit a list of materials he proposes to use. All materials installed without prior approval shall be at the risk of the Contractor.

COORDINATION/GUARANTEES/SUSPENSION OR DELAY

The Contractor shall be familiar with the specifications of the other trades and coordinate with them thoroughly so that he can arrange his work and dispose his materials without interfering the work of other Contractors. The Contractor shall guarantee that the electrical systems shall be free from all defects of workmanship and of materials, and that it will remain so for a period of one year from the date of acceptance by the Engineer. Any remedy to correct defects deemed to be caused by such shall be made at the expense of the Contractor. The Contractor shall not suspend or delay the work without justifiable cause. Subsequent delays shall be deemed as a sufficient cause for penalties or termination of contract in which the Engineer shall have the right to take-over the work and all materials on the site and make arrangements necessary to complete the work. It shall be the sole responsibility of the Contractor to ensure that the Electrical sub-contractor conducts coordination of his activities to other trades.

SLEEVES / INSERTS / CUTTING / PATCHING/BACKFILL

The Contractor shall provide all openings, sleeves, also inserts in walls, floors, and beams as required for his work. All unused openings shall be grouted in. The Contractor shall do all patching requirements necessary and these shall be done so as to exactly match the surrounding area without the evidence of alteration or patching. The Contractor shall provide all necessary backfill on all excavation works of his doing.

TEMPORARY LIGHT AND POWER

The Contractor shall make all arrangements and pay for the provisions of the necessary electrical power of the type and capacity required for the performance of the work of all trades engaged in the construction of the building.

CODES, INSPECTION, PERMITS AND FEES

The work under this contract is to be installed according to the requirements of the latest edition of the Philippine Electrical Code, the rules and regulations of the local authorities of San Ricardo Port, and the requirements of local Electric Cooperative of Southern Leyte.

All necessary permits and electrical fees required for this work shall be obtained by and at the expense of the Contractor. The contractor shall furnish the Engineers and the Owner final certificate of electrical inspection and approval from the proper government authorities after completion of the work. The Contractor shall prepare all as-built and all forms and documents required by the approving authorities.

Power service application including drawings for the work shall be obtained by and at the expense of the Contractor. The Contractor shall comply with all requirements of the utility company regarding service applications.

ELECTRICAL CHARACTERISTICS

The electrical characteristics for this project shall be 230VAC, 3-wire, 3Ø, 60Hz or as per system requirements as shown in the plans.

MATERIAL REQUIREMENTS

NAMEPLATES

Provide laminated plastic nameplates for each panel board, equipment enclosure, relay, switch, and device. Each nameplate inscription shall identify the function and when applicable, the position. Nameplate shall be melamine plastic, 3.2mm thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the black core. Minimum size of nameplates shall be 25mm x 38mm. Lettering shall be a minimum of 6mm, high normal block style.

EXECUTION

NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet metal screws or two rivets.

PAINTING OF EQUIPMENT

1. Factory Applied

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.30.

2. Field Applied

Paint electrical equipment as required to match finish or to meet safety criteria.

ITEM 20 : BACKGROUND MUSIC / PUBLIC ADDRESS SYSTEM**GENERAL**

Electrical Works applies for this Item, with the additions and modifications specified herein.

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. The edition or the revised version of such codes and standards current at the date twenty-eight (28) days prior to date of bid submission shall apply. During Contract execution, any changes in such codes and standards shall be applied after approval by the Owner. 1. Electronic Industries Alliance (EIA) EIA ANSI/EIA-310-D (1992) Racks, Panels, and Associated Equipment

2. Institute of Electrical and Electronics Engineers (IEEE)
IEEE C62.41 (1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

3. National Fire Protection Association (NFPA)

NFPA 70 (2007) National Electrical Code
NFPA 72 (2002) National Fire Alarm Code

4. Underwriters Laboratories (UL)
UL 1449 (2006) Transient Voltage Surge Suppressors

SUBMITTALS

The following shall be submitted.

1. Shop Drawings**a. Detail Drawings**

Detail drawings as specified.

2. Product Data**a. Spare Parts**

Spare parts data for each different item of material and equipment specified.

3. Test Reports**a. Approved Test Procedures**

Test plan and test procedures for the acceptance tests. The test plan and test procedures shall explain in detail, step by step actions and expected results to demonstrate compliance with the requirements specified. The procedure shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance.

b. Acceptance Tests

Test reports in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The reports shall include the manufacturer, model number, and serial number of test equipment used in each test. Each report shall indicate the final position of controls and operating mode of the system.

4. Certificates

a. Components

Copies of current approvals or listings issued by UL, or other nationally recognized testing laboratory for all components.

5. Operation and Maintenance Data

a. Public Address System

SYSTEM DESCRIPTION

The public address system shall consist of an audio distribution network to include amplifiers, mixers, microphones, speakers, cabling, and ancillary components required to meet the required system configuration and operation.

1. Multi-Channel System with Paging

The system shall include microphones, microphone outlet receptacles, microphone inputs with preamplifiers, inputs for film sound, compact disc, magnetic tape, telephone, and program sources, single all channel paging, control for each input, power amplifying equipment, and accessories required to output the public address and paging audio signals through selected portions of the audio distribution network as indicated. The paging signal shall replace by zones channel all channels of the radio system output, when the paging function is activated.

2. Single-Channel System

The system shall control and amplify an audio program for distribution within the areas indicated. Components of the system shall include a mixer-preamplifier, mixer-amplifier, mike input expander, power amplifier, microphone, speaker system, compact disc, cassette/DVD player, AM-FM tuner, cabling and other associated hardware.

3. System Performance

The system shall provide even sound distribution throughout the designated area, plus or minus 3 dB for the 1/1 octave band centered at 4000 Hz. The system shall provide uniform frequency response throughout the designated area, plus or minus 3 dB as measured with 1/3-octave bands of pink noise at locations across the designated area selected by the Engineer. The system shall be capable of delivering 75 dB average program level with additional 10 dB peaking margin sound pressure level (SPL) in the area at an acoustic distortion level below 5 percent total harmonic distortion (THD). Unless otherwise specified the sound pressure reference level is 20 micro Pascal (0.00002 Newton per square meter).

4. Detail Drawings

The Contractor shall submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves,

catalogue cuts, and installation instructions. Note that the contract drawings show layouts based on typical speakers. The Contractor shall check the layout based on the actual speakers to be installed and make necessary revisions in the detail drawings. Detail drawings shall also contain complete point to point wiring, schematic diagrams and other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

5. Spare Parts

The Contractor shall submit spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

DELIVERY AND STORAGE

Equipment placed in storage until installation shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with the details of the work and working conditions, shall verify dimensions in the field, and shall advise the Engineers of any discrepancies before performing the work.

MATERIAL REQUIREMENTS

STANDARD PRODUCTS

Material and equipment to be provided shall be the standard products of a manufacturer regularly engaged in the manufacture of such products, and shall essentially duplicate material and equipment that have been in satisfactory use at least 2 years. All components used in the system shall be commercial designs that comply with the requirements specified. Equipment shall be supported by a service organization that is within miles of the site.

1. Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2. Nameplates

Each major component of equipment shall have the manufacturer's name, address, model and catalogue number, and serial number on a plate secured to the equipment.

MIXER-PREAMPLIFIER (Optional)

Mixer-preamplifier shall as a minimum conform to the following specifications:

Rated Output:	18 dB
Frequency Response:	Plus or Minus 1 dB, 20 - 20,000 Hz
Distortion:	Less than 0.5 percent, 20 - 20,000 Hz

Signal to noise:	Microphone - 60 dB
Auxiliary:	70 dB
Inputs:	5-independent balanced low-impedance transformer-isolated
Input Sensitivity:	Microphone - 0.003 volts Auxiliary 0.125 volts Magnetic Cartridge - 0.0005 volts
Input Channel Isolation:	80 dB minimum
Tone Controls:	Plus or Minus 10 dB range at 50 and 15,000 Hz
Power Requirement:	220-240 Vac 60 Hz

POWER AMPLIFIERS

The power amplifier shall be provide with a nameplate indicating power rating to satisfy design, coverage, SPL requirements and reserve capacity requirements. Listed for Protective Signal Service and supervised in accordance with NFPA 72.

Power amplifiers as a minimum conform to the following specifications:

Rated power output:	60, 125, 250 watts RMS
Frequency Response:	Plus or Minus 3 dB, 20-20,000 Hz
Distortion:	Less than 2 percent at RPO, 600-13,000 Hz
Input Impedance:	50 k ohm unbalanced
Output Impedance:	Balanced 4 and 8 ohms
Output voltage:	25 and 70.7 volts
Power Requirement:	220-240 VAC, 60 Hz

MIXER AMPLIFIER (Optional)

Mixer amplifier shall as a minimum conform to the following specifications:

Rated Power Output (RPO):	35, 60, 125 watts RMS
Frequency Response:	Plus or Minus 3 dB, 20-20,000 Hz
Distortion:	Less than 1% at RPO, 60 - 13,000 Hz
Inputs:	2 microphones (high impedance or low-impedance unbalanced 2 Aux. (high-impedance)
Output Impedance:	Balanced 4 and 8 ohms
Output Voltage:	25 and 70.7 volts
Power Requirement:	220-240 VAC, 60 Hz

MICROPHONE INPUT MODULES

Microphone input modules shall as a minimum conform to the following specifications:

Rated Outputs:	0.25 volts into 10,000 ohms 1.0 volts into 10,000 ohms
Frequency Response:	Plus or Minus 2 dB, 20 - 20,000 Hz
Distortion:	Less than 0.5 percent 20 - 20,000 Hz
Inputs:	4 transformer - coupled balanced 150 ohm
Input Sensitivity:	0.003 volts
Input Channel Isolation:	70 dB minimum

MICROPHONES**1. Desk Microphone**

Microphones shall as a minimum conform to the following specifications:

Element:	Dynamic
Pattern:	Cardioid (Unidirectional)
Frequency Response:	50 - 12,000 Hz
Impedance:	Low impedance microphone (150-400 ohms)
Front to back Ratio:	20 dB
Selector switches:	Selector switches for zone shall be integral microphone or Separate console adjacent to microphone

2. Gooseneck Microphone

Gooseneck microphone shall meet the minimum requirements of the desk microphone. Microphone shall have push to talk button. Gooseneck tube length shall be [305] [406] mm.

3. Microphone Jack

Each outlet for microphones shall consist of a standard outlet box, flush-mounted, and fitted with a three-pole, polarized, locking-type, female microphone jack and a corrosion resistant-steel device plate.

LOUDSPEAKERS**1. Cone Speaker**

The cone speaker shall as a minimum conform to the following specifications:

Application:	Wall baffle, Ceiling
Frequency range:	60 to 12,000 Hz

Power Rating:	Normal - 7 watts Peak - 10 watts
Voice Coil Impedance:	8 ohms
Line Matching Transformer Type:	25/ 70.7 volt line
Capacity:	4 watts
Magnet:	10 ounces or greater
Primary Taps:	0.5, 1, 2 and 4 watts
Primary Impedance:	25 volts - 1250, 625, and 312 ohms 70.7 volts - 10k, 5k, and 2.5k ohms
Frequency Response:	30 - 20,000 Hz
Insertion Loss:	Less than 1 dB

2. Horn Speaker

The horn speaker shall as a minimum conform to the following specifications:

Application:	Indoor, Outdoor, and Weatherproof
Frequency Response:	400 - 14,000 Hz
Power Taps:	70 volt line - .9, 1.8, 3.8, 7.5, and 15 watts
Impedance:	5000, 2500, 1300, 670, 330, 90, & 45 ohms
Power Rating:	Normal - 7 watts Peak - 15 watts
Dispersion:	110 degrees

3. Dual Horn Speaker (Optional)

The dual horn speaker shall meet the minimum requirements of horn speaker except the dispersion shall be 100 degrees.

4. High Output Speaker Enclosures (Optional)

High Output speaker enclosures shall be of the tuned-port design for precise balancing and tuning of the speaker. The enclosures shall be constructed throughout of 19.1 mm high density board, with screwed and glued joints, durably braced, and padded with fibreglass where acoustically required. Speaker enclosures shall have a 25, 45 degree vertical dispersion and 90, 120 degrees horizontal dispersion. The effective length of throw shall be a minimum of 15, 40, and 60 m.

5. Wall Baffle Speaker Enclosures (Optional)

The wall baffle speaker shall be of particle board construction covered with walnut laminate and complete with black cloth grille. Baffle shall feature 9.5 degree slope to provide directional sound

dispersion offset in the direction of radiation. Wall baffle enclosure shall come equipped with a wall mounting bracket designed to assure a rigid mounting to any flat surfaces.

6. Ceiling Speaker Enclosures

Ceiling speaker enclosure shall be constructed of heavy gauge cold steel with interior undercoating and 38 mm thick high density fibreglass 24 kg per cubic meter. The unit shall be round, square and designed for recessed, surface installations which will be accomplished via standard screw torsion spring flange mounting. Recessed models shall have a rust-preventive, textured black coating and the surface mount unit finished in textured white. Enclosure shall include four triple compound conduit knockouts.

SPEAKER SWITCHING PANEL

1. Selector Switches

Zone control shall be provided for the paging function. The speaker switching panel shall contain at least double-pole, 4, 3 position push button selector switches and shall be rack-mounted, desk mounted, selector switches built in microphone to activate priority relays. Selector switches labelling shall be provided to identify the zones.

2. System Power supply

Power supply shall be provided for priority relays and controls, rack mounted and sized for a capacity equal to 200 percent of the as-built control system, and shall operate at 24 Vdc. Input and output shall be protected to permit Class 2 wiring in accordance with NFPA 70.

AM/FM EQUIPMENT (Optional)

1. AM/FM Tuner

AM/FM tuner shall be rack-mounted and shall as a minimum conform to the following characteristics:

Tuning Range:	AM - 540 to 1605 kHz FM - 88 to 108 MHz
Selectivity:	60 dB on FM 40 dB on AM
Sensitivity:	FM - 1.5 micro volts AM - 2.0 micro volts
Capture Ratio:	1.0 dB
Readout/selection:	Digital
Other features:	Phased Lock Loop (PLL)
Power Requirement:	220-240 Vac, 60Hz

2. AM/FM Antenna

The AM/FM antenna shall be roof-mounted, either combined or suitable for both AM and FM reception or separate AM and FM antennas and shall cover all frequency bands specified for radio tuners. The antenna system shall be coordinated with the TV system and other systems

with antenna communication. The system shall be furnished complete with a transformer, insulators, crossover insulator, cable of proper length, lightning arresters, coupling transformer and divider network at the radio tuners.

COMPACT DISC/DVD PLAYER

Player shall have three beam laser pickup, dual Digital-to-Analog converters, random access and random mode programmable playback. [Player shall have capability to play a minimum of 5, 6 discs automatically. Player shall as a minimum conform to the following:

Frequency:	10 - 20,000 Hz Plus or Minus 1 dB
Signal-to-Noise:	Minimum of 100 dB
Dynamic Range:	Minimum of 96 dB
Total Harmonic Distortion:	Maximum of 0.005% at 1 KHZ
Channel Separation:	Minimum 100 dB at 1 KHZ
Quantization:	Minimum of 18 Bits Linear per channel
Conversion Rate:	Minimum 8 x Oversampling
Disc Size:	5 inch
Power Requirement:	220-240 Vac, 60Hz

CASSETTE TAPE EQUIPMENT (Optional)

The [dual] cassette tape play deck shall as a minimum conform to the following specifications:

Frequency Response:	Plus or minus 3 dB, 20 - 20,000 Hz
Wow and Flutter:	Less than 0.09 percent WRMS
Signal-to-Noise:	74 dB
Noise Reduction system:	Dolby [B] [C] [S] [HX PRO]
Play Head:	Hard Parmalloy
Operation:	Automatic Reverse
Power Requirement:	220-240 Vac, 60 Hz

PRIORITY RELAYS AND CONTROLS

Priority relays and controls required to accomplish operations specified shall be provided. Relays shall be completely enclosed with a plastic dust cover for maximum protection against foreign matter, and shall be plug-in type. Relays shall be provided with a diode wired across the relay coil for transient suppression and shall be installed utilizing factory prewired, rack mounted receptacle strips. Coil shall be maximum 24 volts dc.

SWITCHES AND CONTROLS

1. Radio System Control Switch

The loudspeaker in each room, or group of speakers in a room, shall be provided with a flush program channel selector rotating-switch knob. The switch shall be mounted at location and height above the floor and in accordance with Section 7.5 INTERIOR WIRING SYSTEM. A volume control shall be installed with a switch at each station and shall be of the auto transformer type and set so that the maximum volume is sufficient for the area while not disturbing adjacent areas. If music is turned down or off, the paging signal shall override controls except speakers designated for music only. Each device plate shall be satin finished, corrosion-resisting steel permanently marked to indicate the channel selected.

2. Remote Loudspeaker ON/OFF Switches

Remote switches shall be key-operated, toggle switch 2-pole, wall mounted, single gang type with engraved switch plates finished to match the approved finish of electrical wall switches. Low-voltage priority override relays shall be provided as part of the switches with all wiring to the racks to allow override of the ON/OFF switches for priority announcements.

3. Remote Loudspeaker Volume Controls

Remote volume controls shall be an auto transformer type with detected 3 dB steps and an OFF position. The controls shall be wall mounted in single gang outlet boxes and furnished with engraved switching plates finished to match approved finish of electrical wall switches. Insertion loss of the controls shall not exceed 0.6 dB and the power-handling capacities of the control shall be 10, 35, 75 watts. Low voltage priority override relays shall be furnished as part of these controls with all wiring to the racks to allow override of the volume controls for priority announcements.

EQUIPMENT RACKS

Equipment shall be mounted on 482.6 mm racks in accordance with EIA ANSI/EIA-310-D and located as shown on drawings. Ventilated rear panels, solid side panels, and solid top panels shall be provided. Equipment racks shall be provided with lockable front panels that limit access to equipment. The lockable front shall not cover items that require operator access such as AM/FM tuner, CD/DVD player, or tape player. Rack cooling shall be through [perforations or louvers in front panels to ensure adequate ventilation of equipment] [top rack mounted fan. The racks and panels shall be factory finished with uniform baked enamel over rust inhibiting primer.

CABLES

1. Speaker Cable

Cables shall be of the gauge required depending upon the cable run length. In no case shall cable be used which is smaller than 18 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm. Cables shall be jacketed with PVC, Fluor polymer compound. The jacket thickness shall be 0.5 mm minimum.

2. Microphone Cable

Cable conductor shall be stranded copper 20 AWG. Insulation on the conductors shall be polyvinyl chloride (PVC) or an equivalent synthetic thermoplastic not less than 0.2 mm. Cable shall be shielded 100% of aluminum polyester foil with a bare 22 gauge stranded soft copper drain conductor. Cables shall be jacketed with PVC, Fluor polymer compound. The jacket thickness shall be 0.5 mm minimum.

3. Antenna Cable

Antenna coaxial cable shall have 75 ohm plus or minus 2 ohm. Attenuation of the coaxial cable span between the antenna and amplifier shall not exceed 2.5 dB at 108 MHz

TERMINALS

Terminals shall be solderless, tool-crimped pressure or type.

SURGE PROTECTION

1. Power Line Surge Protection

Major components of the system such as power amplifiers, mixer preamplifiers, and tuners, shall have a device, whether internal or external, which provides protection against voltage spikes and current surges originating from commercial power sources per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line to neutral) and 350 Volt ac (neutral to ground). Surge protection device shall be UL listed and labelled as having been tested in accordance with UL 1449.

2. Signal Surge Protection

Major components of the system shall have internal protection circuits which protect the component from mismatched loads, direct current, and shorted output lines. Communication cables/conductors shall have surge protection installed at each point where it exits or enters a building.

TELEPHONE INTERFACE MODULE (Optional)

Telephone Interface Module shall provide one way all call paging access from telephone to PA system. Paging shall be accomplished by the building telephone system instruments interconnected to the PA system via an interface module to allow telephone dial up access to the paging amplifier. Interface module shall produce an alert tone in the associated speakers on activation. Telephone interface module shall as a minimum conform to the following specifications:

Impedance:	600 ohms
Frequency response:	100Hz to 10Khz
70V Input Impedance:	200K ohms
Output level:	400mV rms
Input Power Requirement:	12-24Vdc (from power supply)
Access requirement:	Electronic (analog) or IA2 line key (line card required) PABX loop or ground-start trunk port, or dedicated single-line phone.

EXECUTION

INSTALLATION

Equipment shall be installed as indicated and specified, and in accordance with the manufacturer's recommendations except where otherwise indicated. Equipment mounted out of doors or subject to inclement conditions shall be weatherproofed. The antenna shall be supported at least 1.5 m clear above the roof by means of self supported or guyed mast.

1. Equipment Racks

Racks shall be mounted side by side and bolted together. Items of the same function shall be grouped together, either vertically or side by side. Controls shall be symmetrically arranged at a height as shown. CD/DVD, Cassette & Tuner shall be at a height above the floor as shown.

Audio input and interconnections shall be made with approved shielded cable and plug connectors; output connections may be screw terminal type. All connections to power supplies shall utilize standard male plug and female receptacle connectors with the female receptacle being the source side of the connection. Inputs, outputs, interconnections, test points, and relays shall be accessible at the rear of the equipment rack for maintenance and testing. Each item shall be removable from the rack without disturbing other items or connections. Empty space in equipment racks shall be covered by blank panels so that the entire front of the rack is occupied by panels.

2. Wiring

Wiring shall be installed in rigid steel conduit, intermediate metal conduit, cable trays, or electric metallic tubing as specified in Item INTERIOR WIRING SYSTEM. Wiring for microphone, grounding, line level, and speaker and power cables shall be isolated from each other by physical isolation and metallic shielding. Shielding shall be terminated at only one end.

GROUNDING

All grounding practices shall comply with NFPA 70. The antenna mast shall be separately grounded. Equipment shall be grounded to the serving panel board ground bus through a green grounding conductor. Metallic conduits serving the equipment shall be isolated on the equipment end with an insulating bushing to prevent noise from being transferred to the circuit. Equipment racks shall be grounded to the panel board ground bus utilizing a #8 conductor. Grounding conductor shall be terminated to the rack using connector suitable for that purpose.

ACCEPTANCE TESTS

After installation has been completed, the Contractor shall conduct acceptance tests, utilizing the approved test procedures, to demonstrate that equipment operates in accordance with specification requirements. The Contractor shall notify the Engineer 14 days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written Engineer approval of the test plans as specified. The acceptance 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.

TRAINING

The Contractor shall conduct a training course for members of the operating and maintenance staff as designated by the Engineer. The training course will be given at the installation during normal working hours for a total of hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance manuals, as well as demonstrations of routine maintenance operations. The Engineer shall be notified at least 14 days prior to the start of the training course.

ITEM 21 : FIRE DETECTION AND ALARM SYSTEM

GENERAL

"Electrical Works" applies for this Item with additions and modifications specified herein.

REFERENCES

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. The edition or the revised version of such codes and standards current at the date twenty eight (28) days prior to date of bid submission shall apply. During Contract execution, any changes in such codes and standards shall be applied after approval by the Owner.

1. Factory Mutual Engineering and Research Corporation (FM)
FM P7825 (2005) Approval Guide Fire Protection
2. National Fire Protection Association (NFPA)
NFPA 70 (2005) National Electrical Code
NFPA 72 (2002) National Fire Alarm Code
NFPA 90A (2002) Installation of Air Conditioning and Ventilating Systems
NFPA 101 (2002) Life Safety Code
3. Institute of Integrated Electrical Engineers (IIEE) PEC (2000) Philippine Electrical Code
4. Underwriters Laboratories Inc. (UL)
UL 268 (1996; Rev thru Oct 2003) Smoke Detectors for Fire Alarm Signalling Systems
UL 514A (2004) Metallic Outlet Boxes
UL 514B (2004) Fittings for Conduit and Outlet Boxes
UL 864 (2003; Rev Thru Oct 2003) Control Units and Accessories for Fire alarm Systems
UL 464 (2003; Rev Thru Oct 2003) Audible Signal Appliances
UL 1242 (2000; Rev thru May 2003) Intermediate Metal Conduit
UL 1971 (2000; Rev thru May 2004) Safety Signaling Devices for the Hearing Impaired
UL 521 (1999; Rev thru Oct 2002) Heat Detectors for Fire Protective Signaling Systems

DESCRIPTION OF WORK

The work includes providing new interior fire alarm system including material, tools, equipment, installation, and testing necessary for and incidental to the provision of a complete and usable standard system conforming to the applicable requirements of PEC, NFPA 70, NFPA 72, NFPA 90A, and NFPA 101, and this specification. Materials and equipment to be furnished under this contract shall be essentially the current design products of manufacturers regularly engaged in production of such equipment and shall be listed by the Underwriters' Laboratories, Inc. in the UL FPED, or approved by Factory Mutual System and listed in FM P7825.

SUBMITTALS

Submit the following.

1. Shop Drawings

- a. System layout**
- b. System wiring diagrams**
- c. Conductor wire marker schedule**

2. Product Data

- a. Control panel and modules**
- b. Batteries**
- c. Battery charger**
- d. Manual pull stations**
- e. Smoke detectors**
- f. Duct smoke detectors (Optional)**
- g. Audio/Visual/Alarm horns**
- h. Graphic annunciator panel**
- i. Wiring**
- j. Conduit**
- k. Outlet boxes**
- l. Fittings for conduit and outlet boxes**

Data which describe more than one type of item shall be clearly marked to indicate which type the Contractor intends to provide.

Submit one original for each item and clear, legible, first generation photocopies for the remainder of the specified copies. Incomplete or illegible photocopies will not be accepted. Partial submittals will not be accepted.

3. Test Reports

4. Preliminary testing

5. Final acceptance testing

Submit for all inspections and tests specified under paragraph entitled "Field Quality Control."

6. Certificates

- a. Qualifications of installer
- b. Qualifications of system technician

7. Operation and Maintenance Data

- a. Fire alarm system

8. Closeout Submittals

- a. System as-built drawings

QUALITY ASSURANCE

1. Qualifications of Installer

The Contractor or installer shall have satisfactorily installed fire alarm systems of the same type and design as specified herein. Prior to commencing fire alarm system work, submit data showing that the Contractor or installer has satisfactorily installed three fire alarm systems of the same type and design as specified herein within the past three years. For each system installed, submit the following:

- a. A detailed summary of the type and design of the system;
- b. The contract name or number, completion date of the project and total cost of the system;
- c. The name and telephone number of the facility or installation for which the work was performed;

2. Manufacturer's Representative

Provide the services of a representative or technician from the manufacturer of the system, experienced in the installation and operation of the type of system being provided, to supervise installation, adjustment, preliminary testing, and final testing of the system and to provide instruction to Owner representative.

3. Qualifications of System Technician

Installation drawings, shop drawings and as-built drawings shall be prepared by, or under the supervision of, a qualified technician. Qualified technician shall be an individual who is experienced with the types of work specified herein. Contractor shall submit data showing the name and certification of the technician at or prior to submittal of drawings.

4. Drawing Requirements

- a. System Layout

Submit shop drawings of the system layout showing locations of initiating devices and alarm horns. Show wire color coding, wire counts, and device wiring order.

- b. System Wiring Diagrams

Submit complete wiring diagrams of the system showing points of connection and terminals used for all electrical connections in the system. Show all modules and lamps in the control panel.

c. System As-Built Drawings

Upon completion, and before final acceptance of the work, furnish to the Engineer 4 complete sets of as-built drawings, including complete as-built circuit diagrams, of each the system. The as built drawings shall be as the contract drawings and with title block similar to contract drawings.

MAINTENANCE

1. Spare Parts

Furnish the following spare parts:

- a. Five (5) complete sets of system keys
- b. One (1) of each type of audible and visual alarm device installed
- c. Two (2) of each type of fuse required by the system
- d. One (1) spare zone modules for modular type control panels in addition to those installed in the panel
- e. Two (2) of each type of heat detector installed
- f. Two (2) of each type of smoke detector base and head installed

2. Manuals

Submit operation and maintenance data manuals. The manual shall include: circuit drawings; wiring and control diagrams; installation instructions; maintenance instructions; safety precautions, diagrams, and illustrations; test procedures; performance data; and parts list.

MATERIAL REQUIREMENTS

SYSTEM DESIGN

1. Operation

Provide a complete, electrically supervised, zoned, annunciated, fire alarm system as described herein, and as shown on the drawings. Provide separate circuits from the control panel to each zone of initiating devices as specified herein.

a. Fire Alarm Signal Initiation

Operation shall be such that actuation of any:

- 1) Manual station
- 2) Smoke detector

Shall cause all of the following actions:

- a) All building evacuation alarm devices Audio/visual alarm horns to operate continuously;
- b) The annunciators to properly register;

All operations shall remain in the alarm mode until the system is manually restored to normal.

b. Monitoring Integrity of Installation Conductors

All system circuits shall be electrically monitored for integrity including the following:

- 1) Initiating circuits.
- 2) Evacuation alarm circuits
- 3) Battery power supply low and no voltage across the standby battery terminals and open battery circuit. Provide Class A initiating device circuits, and Class A notification device circuits as defined by NFPA 72. For Class A circuits, provide separate conduits for outgoing and return (redundant) conductors as required by NFPA 72. A ground fault condition or single break in any other circuit shall cause operation of the system trouble signals. Loss of AC power, abnormal AC voltage, a break in the standby battery power circuit, or low battery voltage shall also cause operation of system trouble signals. The abnormal position of any switch in the control panel shall also cause operation of the system trouble signals. Audible and visual equipment for supervision of the AC power supply shall be energized from the auxiliary DC power supply and vice versa. Trouble signals shall sound continuously until manually silenced or the system has been restored to normal.

c. Walk-Test Mode

Provide system with walk-test mode to allow one person to test alarm and supervisory features of initiating devices. Walk-test mode shall be enabled from the control panel by authorized service personnel. Control panel shall display a unique visual indication when system is in walk-test mode. If testing ceases while in walk-test mode, after a preset delay system shall automatically return to normal standby mode.

d. Alarm Verification Feature

System shall have a smoke detector alarm verification feature. Upon activation of any area smoke detector, system shall institute an alarm verification process prior to enabling of the alarm functions as specified herein. Activation of any initiating device other than an area smoke detector shall cause immediate enabling of system into alarm mode. If an alarm input from a smoke detector on the initial zone in alarm is present at the end of an initial delay period not exceeding 20 seconds, all alarm functions as specified herein shall be immediately enabled. If a smoke detector alarm input is not present at the end of the initial delay period, a second-stage confirmation period of one minute shall be initiated. If a smoke detector alarm input is received during the second-stage confirmation period, all alarm functions shall be immediately enabled. During the verification process, activation of any area smoke detector on any zone other than the initial zone in alarm shall also cause system to go into alarm mode immediately. If no smoke detector alarm input occurs within the second-stage confirmation period, system shall reset to normal. Any alarm input received from an area smoke detector after the second-stage confirmation period has elapsed shall cause system to institute a new verification process.

2. Primary Power

Primary power source shall be 240 volts AC service, transformed through a two winding isolation type transformer and rectified to 24 volts DC for operation of all initiating device, notification device signalling line and trouble signal. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the rated output of the system power supply modules. Obtain AC operating power as shown on contract drawings. Provide an independent enclosed circuit breaker with provisions for locking the cover and operating handle in the "POWER ON" position. Paint the enclosure red and identify it by the lettered designation "FIRE ALARM SYSTEM POWER".

3. Auxiliary Power

Provide secondary DC power supply for operation of system in the event of failure of the AC source. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and shall not cause transmission of a false alarm.

a. Storage Batteries

Provide sealed lead calcium or sealed lead acid or batteries and charger. Dry cell batteries are not acceptable. House batteries in the control panel. Provide batteries of adequate ampere-hour rating to operate the system, including audible trouble signal devices, and under supervisory conditions for 60 hours, at the end of which time batteries shall be capable of operating the entire system in a full alarm condition for not less than 15 minutes. Provide calculations substantiating the battery capacity. Provide reliable separation between cells to prevent contact between terminals of adjacent cells and between battery terminals and other metal parts.

b. Battery Charger

Provide completely automatic high/low charging rate type capable of recovery of the batteries from full discharge to full charge in 24 hours or less. Provide a trouble light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided. House charger in the control panel.

COMPONENT DESIGN

1. Control Panel

Control Panel shall comply with the applicable requirements of UL 864. Provide modular type panel installed in a surface mounted steel cabinet with hinged door and cylinder lock. Mount with panel centerline 1.5 m above finished floor elevation. Switches and other controls shall not be accessible without the use of a key. The control panel shall be a neat, compact assembly containing all parts and equipment required to provide specified operating and supervisory functions of the system. Each control panel component shall be UL listed or FM approved and approved by the control panel manufacturer for use in the control panel. Panel cabinet shall be finished on the inside and outside with factory-applied enamel finish. Provide main annunciator located on the exterior of the cabinet door or visible through the cabinet door. Provide audible trouble signal. Provide permanent engraved rigid plastic or metal identification plates, or silk screened labels attached to the rear face of the panel viewing window, for all lamps and switches. Provide panel with the following switches:

- a. Trouble silencing switch which silences audible trouble signals without extinguishing trouble indicating lamps. For non-self resetting type switch, upon correction of the trouble condition, audible signals will again sound until the switch is returned to its normal position. For silencing switch of the momentary action, self resetting type, the trouble signal circuit shall be automatically restored to normal upon correction of the trouble condition.
- b. Evacuation alarm silencing switch which when activated will silence all alarm notification devices without resetting the panel, and cause operation of system trouble signals. Subsequent alarms from additional zones not originally in alarm shall cause activation of the notification devices even with the alarm silencing switch in the "silenced" position.
- c. Individual zone disconnect switches which when operated will disable only their respective initiating circuit and cause operation of the system and zone trouble signals.

d. Reset switch which when activated will restore the system to normal standby status after the cause of the alarm has been corrected, and all activated initiating devices reset. Operation of reset switch shall restore activated smoke detectors to normal standby status.

e. Lamp test switch.

f. Drill switch which will enable test of notification devices and restoration to normal.

1) Graphic Annunciator Panel (Optional)

Provide panel located as shown. Mount with panel centerline 1.5 m above finished floor elevation. Panel shall be of the interior type, surface-mounted. Panel shall be provided with the building floor plan, drawn to scale, with alarm lamps mounted to represent the location of each initiating device. Panel graphic shall also show the locations of the control panel, and shall have a "you are here" arrow showing its location. Orient building floor plan on graphic to location of person viewing the graphic, i.e. the direction the viewer is facing shall be toward the top of the graphic display. Provide a North arrow. Lamps shall illuminate upon activation of corresponding device and shall remain illuminated until the system is reset. Panel shall have a lamp test switch.

2. Manual Pull Stations

Provide non coded single action type with mechanical reset features. Stations shall be surface semi-flush mounted and interior type as indicated. For surface mounting provide station manufacturer's approved back box. Back box finish shall match station finish. Equip each station with a terminal strip with contacts of proper number and type to perform functions required. Stations shall be a type not subject to operation by jarring or vibration. Break-glass-front stations are not permitted; however, a pull-lever break-rod type is acceptable provided presence of rod is not required to reset station. Station color shall be red. Station shall provide visible indication of operation. Restoration shall require use of a key. Keys shall be identical throughout the system for all stations and control panel. Mount stations with operating lever not more than 1.2 m above finished floor.

3. Smoke Detectors

Provide smoke detector in accordance with NFPA 101, Life Safety Code. Provide detectors designed for detection of abnormal smoke densities by the photoelectric principle. Detectors shall be 4-wire type. Provide necessary control and power modules required for operation integral with the control panel. Detectors and associated modules shall be compatible with the control panel and shall be suitable for use in a supervised circuit. Malfunction of the electrical circuits to the detector or its control or power units shall result in the operation of the system trouble signals. Each detector shall contain a visible indicator lamp that shall flash when the detector is in the normal standby mode and shall glow continuously when the detector is activated. Each detector shall be the plug-in type with tab-lock or twist-lock, quick disconnect head and separate base in which the detector base contains screw terminals for making all wiring connections. Detector head shall be removable from its base without disconnecting any wires. Removal of detector head from its base shall cause activation of system trouble signals. Each detector shall be screened to prevent the entrance of insects into the detection chambers.

a. 4-Wire Smoke Detectors (Optional)

Detector circuits shall be of the 4-wire type whereby the detector operating power is transmitted over conductors separate from the initiating circuit. Provide a separate, fused, power circuit for each smoke detector initiating circuit (zone). Failure of the power circuit shall be indicated as a trouble condition on the corresponding initiating circuit.

b. Photoelectric Detectors (Optional)

Operate on the light scattering principle using a LED light source. Detector shall respond to both flaming and smoldering fires. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268.

c. Detector Spacing and Location

Detector spacing and location shall be in accordance with the manufacturer's recommendations and the requirements of NFPA 72, except provide at least two detectors in all rooms of 54 square meters or larger in area. In no case shall spacing exceed 9 by 9 m per detector, and 9 linear m per detector along corridors. Detectors shall not be placed closer than 0.9 m from any air discharge or return grille, nor closer than 300 mm to any part of any lighting fixture.

4. Notification Devices

Provide in accordance with NFPA 72 and as indicated. Do not exceed 80 percent of the listed rating in amperes of any notification device circuit. Additional circuits above those shown shall be provided if required to meet this requirement. Effective sound levels shall comply with NFPA 72. Provide devices in addition to those shown if required in order to meet NFPA 72 sound level requirements.

a. Alarm Horns

Surface-mounted vibrating type suitable for use in an electrically supervised circuit and shall have a sound output rating of at least 90 decibels at 3 m, when tested in accordance with UL 464 while emitting a slow whoop tone.

b. Visible Devices

Surface-mounted assembly of the stroboscopic type suitable for use in an electrically supervised circuit and powered from the notification device circuits. Devices shall provide a minimum of 75 candela measured in accordance with UL 1971, but in no case less than the effective intensity required by NFPA 72 for the device spacing and location shown. Lamps shall be protected by a thermoplastic lens and labeled "FIRE" in letters at least 12 mm high. Provide visible devices within 300 mm of each audible appliance and as indicated. Visible devices may be part of an audio-visual assembly. Where more than two devices are located in the same room or corridor, provide synchronized operation.

5. Conduit

a. Intermediate Metal Conduit (IMC) UL 1242, zinc-coated steel only.

6. Outlet Boxes UL 514A, zinc-coated steel.

7. Fittings for Conduit and Outlet Boxes UL 514B, zinc-coated steel.

8. Wiring

NFPA 70, NEC and NFPA 72. Wire for 240V circuits shall be 3.5 mm² minimum copper conductors. Wire for low voltage DC circuits shall be 2.0 mm² minimum copper conductors. Insulation shall be 75 degree C minimum with nylon jacket. Color codes all wiring.

EXECUTION

INSTALLATION

Installation shall be in accordance with the requirements of NFPA 70, NEC NFPA 72 and NFPA 90A. Each conductor used for the same specific function shall be distinctively color coded. Each function color code shall remain consistent throughout the system. Use colors as directed by the Engineer. All wiring shall be in steel conduit. All circuit conductors shall be identified within each enclosure where a tap, splice or termination is made. Conductor identification shall be by plastic coated self sticking printed markers. The markers shall be attached in a manner that will not permit accidental detachment. Control circuit terminations shall be properly identified. Wire devices so that their removal will activate system trouble signals. Pigtail or "T" tap connections are prohibited. Wiring for DC circuits shall not be permitted in the same conduit or tubing as wiring for AC circuits. Paint all junction box covers red or provide them with permanent labels reading "FIRE ALARM CIRCUIT." Provide a written schedule of conductor markings identifying each wire marker, the purpose, the origin, and termination point of each conductor. The conductor wire marker schedule shall be turned over to the Engineer at the time of preliminary testing with as built drawings.

1. Additional Installation Requirements

Pull all conductors splice free. Make all conductor connections under screw terminals. Provide insulated barrier type terminal strips at junction points. Use of wire nuts, crimped connectors, or twisting of conductors is prohibited. All control panels shall be dressed out in a professional manner with all wires running in the vertical or horizontal plane, cut to exact length, making all turns at 90 degree angles, and tightly bundled and wire wrapped. Conduit may not enter the top of control panel cabinet.

FIELD QUALITY CONTROL

1. Preliminary Testing

Notify Engineer prior to performing preliminary testing. Contractor shall conduct the following tests during installation of wiring and system components. Any deficiency pertaining to these requirements shall be corrected by the Contractor prior to final acceptance testing of the system. Record results of testing. Submit all test results to the Engineer.

- a. Operation of Entire System. Operate all initiating and indicating devices.
- b. Operation of Supervisory Systems: Operate all portions to demonstrate correctness of installation.
- c. Smoke Detector Test: Clean the smoke detectors in accordance with the manufacturer's recommended procedures. Test smoke detectors using magnet-activated test switch, manufacturer provided test card, or smoke. Use of aerosol sprays to test smoke detectors is prohibited.

2. Final Acceptance Testing

The Contractor shall notify the Engineer when the system is ready for final acceptance testing. Request scheduling for final acceptance testing only after all necessary preliminary tests have been made and all deficiencies found have been corrected to the satisfaction of the equipment manufacturer's technical representative and the Engineer and written certification to this effect has been received by the Fire Protection Engineer. The system shall be in service at least 15 calendar days prior to final acceptance testing. The Contractor shall allow at least 15 calendar days between the dates final testing is requested and the date the final acceptance testing takes place. The Contractor shall furnish all equipment, instruments, devices and personnel for this test. The system shall be tested for approval in the presence of representatives of the manufacturer, the Engineer,

and the Fire Protection Engineer. All necessary tests shall be made including the following, and any deficiency found shall be corrected and the system retested.

a. Entire System

Test the entire system by operating all fire alarm initiating, notification, and signaling devices. Perform tests with the system operating on primary power and repeat the test with the system operating on battery power only. Provide necessary equipment to test smoke detectors and heat detectors.

b. Supervisory Systems

All aspects of the supervisory functions of the systems shall be operated. Introduce faults in each circuit at random locations as directed by the Fire Protection Engineer. Verify proper trouble annunciation at the control panel.

3. Additional Tests

When deficiencies, defects or malfunctions develop during the tests required, all further testing of the system shall be suspended until proper adjustments, corrections or revisions have been made to assure proper performance of the system. If these revisions require more than a nominal delay, the Engineer shall be notified when the additional work has been completed, to arrange a new inspection and test of the fire alarm system. All tests required shall be repeated prior to final acceptance, unless directed otherwise.

ITEM 22 : WIRE COMMUNICATION AND SIGNAL SYSTEM**TELEPHONE SYSTEM****GENERAL**

Electrical Works applies for this Item with the additions and modifications specified herein.

DESCRIPTION OF WORK

The telephone/data system shall consist of an interior system of conduits, outlet, boxes, and junction boxes. Moreover, Local Telephone Company as provider for PABX interconnection for data /voice, router / Wi-Fi modem with necessary Cat-5e cables.

These details as indicated in the plans should be coordinated to local telephone company as the provider. Any deviation of the plans and specification shall be brought to the attention of the Engineer for resolution.

PRODUCTS**CONDUIT AND FITTINGS**

- a. Conduit shall be polyvinyl-chloride conduit (PVC) where specified, shall be heavy wall, high impact resistant Schedule 40, with factory made bends, couplings and fittings. PVC cement for joints shall be of the same brand as for the PVC pipe.
- b. No conduits shall be used in any system smaller than 20mm (1/2") 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 as directed.
- c. No wire shall be pulled into any conduit until the conduit system is completed in all details, in the case of concealed work until all rough plastering masonry has been completed, and in the case of exposed work until the conduit work has been completed in every detail.
- d. The ends of all conduits shall have tightly plugged to exclude plaster, dust and moisture while the construction of the building is in progress. All conduits shall be reamed to remove all burrs.

OUTLETS, BOXES AND FITTINGS

- a. At all outlets whatever kind, for all system, there shall be provided a suitable fitting, which shall be either a box or other device especially designed to receive the type of fitting to be mounted thereon.
- b. The Contractor shall consult with the Engineer as to the nature of the various fittings to be used before installing his outlet fittings, and shall conform strictly in the use of fittings, to the nature of the appliance to be mounted on them, so that the work, when the completed will be a finished design.
- c. All outlets on concealed conduit work, provide galvanized pressed steel outlet boxes on standard make. These boxes shall be in all cases standard and where such boxes are not available on the market, special boxes shall be secured by the Contractor at his own expense. In general outlet boxes shall be at least 100mm diameter, 53mm deep and No. 16 minimum gauge.

JUNCTION AND PULL BOXES

- a. Junction and pull boxes, of code gauge steel, galvanized shall be provided as indicated or as required for facilitating the pulling of wires and cables. Pull boxes as finished places shall be located and installed with the permission and to the satisfaction of the Engineer.
- b. All junction and pull boxes on exposed conduit work shall be provided with hubs for threaded pipe entry and covers provided with neoprene gaskets.

LOCAL TELEPHONE COMPANY PROVIDER / INTERCONNECTION OF PABX SYSTEM

- a. All components, connections of Telephone Company shall conform to EIA/TIA standards.
- b. Cable terminals shall be the type acceptable to the Telephone Company. Terminals shall be Cat- 5e as required on the plans.

TELEPHONE INSTALLATION

The telephone installation shall be wall mounted and as indicated on the plans.

HORIZONTAL CABLE

All horizontal cabling shall be Category 5e (RJ – 45) network cables.

TELEPHONE / DATA OUTLETS

All modular jacks shall be data grade Cat- 5e.

SHOP DRAWINGS

Prepare and submit complete shop drawings for the telephone system in accordance with the latest Local Telephone Company.

ITEM 23 : MECHANICAL GENERAL REQUIREMENT**GENERAL**

This Electrical Works applies to all Item of "MECHANICAL WORKS" except where specified in each individual section.

WORK DESCRIPTION

The work shall include the furnishing of equipment, materials, tools, labor, supervision, and other services required to install, complete, test and make operational the whole system as described on the Drawings and the Technical Specifications.

Specifically the work shall involve the following:

- a. To supply, deliver, install, wires/cables, conduit, circuit breaker and make operational the split type and ceiling cassette type inverter air conditioning units including bathroom exhaust fans for toilets as shown on the Drawings.
- b. To supply and install the refrigerant piping system and condensate drain lines including necessary insulation and hangers.
- c. To supply and install the electrical wiring connections from the AC supply provided by the Electrical Contractor which is located close to the point of installation. This shall include power and control wirings and interlocks with the thermostat control.

SUBMITTALS

Submit shop drawings, manufacturer's data and certificates for equipment, materials, and finish, and pertinent details for each system where specified in each individual section, and obtain approval before procurement, fabrication, or delivery of the items to the job site. Partial submittals are not acceptable and will be returned without review. Submittals shall include the manufacturer's name, trade name, catalogue model, or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable industry, and technical society publication references, years of satisfactory service, and other information necessary to establish contract compliance of each item the Contractor proposes to furnish. Photographs of existing installations and data submitted in lieu of catalogue data are not acceptable and will be returned without approval. Submittals shall be a minimum of 5 print copies. Submittals of the contractor shall be reviewed and returned within a minimum of 21 days, each stamped with appropriate action.

1. Shop Drawings

Drawings shall be a minimum of 350mm x 500mm in size, with a minimum scale of 1:100 except as specified otherwise. Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment; and equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, drawings shall be revised to show acceptable equipment and be resubmitted.

2. Manufacturer's Data

Submittals for each manufactured item shall be manufacturer's brochure products, equipment drawings, diagrams, performance and characteristic curves, and catalogue cuts.

3. Standard Compliance

When materials or equipment must conform to the standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), Air Movement and Control Association, Inc. (AMCA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted to the Engineers for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization which is competent to perform acceptable testing and is approved by the Owner or his authorized representative. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate of compliance from the manufacturer shall be submitted for approval. The certificate shall identify the manufacturer, the product, and the referenced standard and shall simply state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the reference standards listed. The edition or the revised version of such codes and standards current at the date twenty eight (28) days prior to date of bid submission shall apply. During Contract execution, any changes in such codes and standards shall be applied after approval by the Owner.

4. Codes, Inspection, Permits and Fees

a. The work under this contract shall conform to the latest requirements of:

1) Philippine National Building Code

2) Regulations of the Local Municipality

b. Nothing contained in these specifications or shown on the drawings shall be construed as to conflict with the National and local ordinances or laws. All such laws and ordinances are made a part of these Specifications.

c. All construction permits and fees for this work shall be obtained at the expense of the Contractor. The Contractor shall furnish the Owners and Engineers the final certificates of inspection and approval from the appropriate government authorities.

OPERATION AND MAINTENANCE MANUAL

Furnish an operation and maintenance manual for each item of equipment. Furnish three (3) copies of the manual bound in hardback binders or an approved equivalent. Furnish one complete manual prior to the time that the equipment are performed and furnish the remaining manuals before the contract is completed. Inscribe the following identification on the cover: the words OPERATION AND MAINTENANCE MANUAL, the name and location of equipment or the building, the name of the Contractor, and the contract number. The manual shall include the names, addresses, and the telephone numbers of each subcontractor installing the equipment, and of the local representatives

for each item of equipment. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with data to explain detailed operation and control of each item of equipment; a control sequence describing start-up, operation and shutdown; description of the function of each principal item of equipment; the procedure for starting; the procedure for operating; shutdown instructions; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency, safety precautions, diagrams, and illustrations; test procedures; performance data; and parts list. The parts list for equipment shall indicate the sources of supply, recommended spare parts, and the service organizations which is reasonably convenient to the project site. The manual shall be complete in all respect for equipment, controls, accessories, and associated appurtenances provided.

POSTED OPERATING INSTRUCTIONS

Furnish approved operating instructions for each system and principal item of equipment for the use of the operation and maintenance personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal item of equipment. Operating instructions shall be printed or engraved and shall be framed under glass or in an approved laminated plastic and posted where directed by the Owner. Operating instructions shall be attached to or posted adjacent to each principal item of equipment and include directions for start up, proper adjustment, operating, lubrication, shut down, safety precautions, procedure in the event of equipment failure, and other areas as recommended by the manufacturer of each item of equipment. Operating instructions exposed to the weather shall be made of weatherproof materials or shall be suitably enclosed to be weather protected. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

SAFETY

1. Rotating Equipment Safety

Couplings, motor shafts, gears and other exposed rotating or rapidly moving parts shall be fully guarded. The guards shall be cast iron or expanded metal. Guard parts shall be rigid and suitably secured and shall be readily removable without disassembling the guarded unit.

INSTRUCTION TO OWNER'S PERSONNEL

When specified in other sections, the Contractor shall furnish the services of competent instructors who will give full instruction to the designated personnel in the adjustment, operation, and maintenance, including pertinent safety requirements of the equipment or system specified. Each instructor shall be thoroughly familiar with all the parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man-days (8 hours) of instruction furnished shall be as specified in other sections. When more than 4 man-days of instruction are specified, approximately half of the time shall be used for classroom instruction. All other time shall be used for instruction with the equipment or system. When significant changes or modifications in the equipment or system are made under the terms of contract, additional instruction shall be provided to acquaint the operating personnel with the changes or modifications.

DELIVERY AND STORAGE

Equipment and materials shall be handled, stored, and protected to prevent damage before, during, and after installation, in accordance with the manufacturer's recommendations and as approved. Damaged or defective items shall be replaced without cost to the Owner.

STANDARD PRODUCTS/SERVICE AVAILABILITY

1. Materials and Equipment

Materials and equipment shall be standard products of manufacturer regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for seven years prior to bid opening. The seven year use shall include applications of equipment and materials under similar circumstances and of similar size as specified for the Project. The equipment shall be soled exclusively by a single, stable distributor with after sales capability.

2. Experience Required

The five (5) years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogues, or brochures.

3. Alternative Service Record

Products having less than a five-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests can be shown.

4. Service Record

The equipment items shall be supported by service organizations. The Contractor shall submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall reasonably be convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

5. Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

SAFETY REQUIREMENTS

Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded in accordance with OSHA 29 CFR 1910.219. High temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of a type as specified herein. Items such as catwalks, ladders, and guardrails shall be provided where required for safe operation and maintenance of the equipment.

MANUFACTURER'S RECOMMENDATIONS

Where installation procedures or any part are required to be in accordance with the manufacturer's recommendations of the material being installed, printed copies of these recommendations shall be furnished to the Owners and Engineers prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

ELECTRICAL REQUIREMENTS

Electrical components of mechanical equipment and systems such as motors, starters, and controls shall be provided under this item and shall be as specified herein and as necessary for complete and operable system. Extended voltage range motors will not be permitted. Interconnecting wiring for components of packaged equipment shall be provided as an integral part of the equipment.

ELECTRICAL MOTORS

1. All electrical motors of sizes and types as specified for driving air conditioning and ventilating equipment shall be furnished and erected under this section. All motors shall be of proper power and speed to suit the specified makes of equipment. If other makes of equipment are accepted in any case, the proper adjustment of motor speed and power including affected changes in electrical system circuit breakers and wiring must be included without additional cost to the Owner. Technical data shall be submitted for approval before the equipment is purchased.
2. All motor ratings shall be as specified on the drawings.
3. Generally, all motors shall be constant speed, squirrel-cage type motors and energy efficient except as otherwise listed on plans. Single phase motors shall be capacitor start induction-run or split phase type as approved for the service.
4. All belt-connected motors shall have adjustable bases and set screws to maintain proper belt tension, and shall be provided with proper belt guards.
5. All motors and accessories shall comply in all respect with NEMA Standards. Types shall be as required by Local Code.
6. All motors shall be furnished with type "B" insulation and tropical fungus proofing according to NEMA standards.

CHANGES IN WORK DUE TO APPROVAL OF ALTERNATE MATERIALS

Assure the cost of, and the entire responsibility for any changes in the work shown on the Contract Documents which may be occasioned by approval of materials proposed by the Contractor other than those specified.

GUARANTEE

Furnish the Owner a written guarantee covering the satisfactory operation of the mechanical installation in all its parts for a period of one (1) year after date of final acceptance of work. During this period, repair or replace any defective work, materials or equipment furnished and installed without any cost to the Owner. Include with this guarantee certificate of every material supplier engaged by this trade of the project.

AS-BUILT DRAWINGS

1. The Contractor shall, during the progress of work, keep record of all deviations of the actual installation from that shown on the Contract Drawings.
2. Upon completion of work, the Contractor shall submit two (2) copies of the as-built drawings, signed by the Contractor's Registered Professional Mechanical Engineer and Owner Project Inspector, indicating the work as actually and finally installed, including new information not originally shown in Contract Drawings.

3. Approval of as-built drawings by the Engineer shall be a requirement for final acceptance of the completed works and of final payment.

QUALITY ASSURANCE

1. Surveys and Measurements:

- a. The Contractor shall base measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.
- b. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or intent of the drawings and specifications, he shall notify the Owner's representative and shall not proceed with his work until he has received instructions from the Owner's representative upon referring the matter to the Engineer.

2. Drawings and Minor Modification:

- a. Drawings are diagrammatic and indicate the general arrangement of the system and work included in the contract. Drawings are not to be scaled. The drawing and details shall be examined for exact location of fixtures and equipment by verifying actual site conditions.
- b. The Contractor shall follow drawings in laying out work and check drawing of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, Owner's representative shall be notified before proceeding with installation, if directed by the Owner's representative, the Contractor shall, without extra charge, make reasonable modifications and the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

c. Materials and Workmanship

All materials and apparatus required for the work, except as specified otherwise, shall be new of first class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of materials is given, first class standard article shall be furnished.

ITEM 24 : UNITARY AIR-CONDITIONING SYSTEMS**GENERAL**

"Mechanical General Requirements" applies to this Item with additions and modification specified herein.

GENERAL REQUIREMENTS**1. Unitary Air-Conditioning System**

Air conditioning units in retail stores shall be supplied and installed by the tenant. Capacity of equipment shall not be less than that indicated. In the NFPA standards and SMACNA manuals referred 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 Engineer.

2. Refrigerant Piping, Fittings and Accessories

Refrigerant piping assembly as used in this section includes pipes, flanges, bolting, gaskets, valves, relief devices, fittings, and the pressure containing parts of other piping components. It also includes hangers and supports and other equipment items necessary to prevent overstressing the pressure containing parts.

a. Piping

ANSI 15 and ANSI B31.5. Compatible with fluids for which they are being used and capable of withstanding the pressures and temperatures of the service that they are handling.

b. Tubing

Refrigerant piping shall be seamless copper tubing, hard drawn, type K, ASTM B88. Tubing used for refrigerant service shall be cleaned, sealed, capped or plugged prior to being shipped from the manufacturer's plant. Fittings for copper tubing shall be wrought copper or bronze, brazing or solder joint type ANSI B16.18 or ANSI B16.22. Copper flared type tubing may be made only in annealed copper tubing ASTM B280 and in nominal sizes smaller than one-inch only for connection to equipment and no larger than 1-3/8 inches diameter for other connections. Flanges shall be of bronze ANSI B16.24.

3. Corrosion Prevention

Unless specified otherwise, equipment fabricated from ferrous metals that do not have a zinc coating shall be treated for prevention of rust with a factory coating or paint system that will withstand 125 hours in a salts-pray fog test except that equipment located outdoors shall be tested for 500 hours. The salt-spray fog test shall use a 20 percent sodium chloride solution. Immediately after completion of the test, the coating shall show no signs of blistering, wrinkling or cracking, no loss of adhesion, and the specimen shall show no signs of rust creep age beyond 1/8 inch on either side of the scratch mark. The

film thickness of the factory coating or paint system applied on the equipment shall be not less than film thickness used on the test specimen.

4. Safety Standards

- a. Design, Manufacture and Installation of Mechanical Refrigeration Equipment: ASHRAE Safety Code for Mechanical Refrigeration.
- b. Machinery Guards: Fully guard drive mechanisms, or other moving parts. Provide guards fabricated of steel and expanded metal, rigidly mounted, and readily removed without disassembly.

MATERIAL REQUIREMENTS

UNITARY AIR-CONDITIONING SYSTEMS - SPLIT TYPE INVERTER

1. General

The air-conditioning systems shall be designed, constructed, and rating tested in accordance with ARI Standard 210 for unitary air-conditioning equipment of capacities below 135,000 Btu's per hour and ARI Standard 300 for unitary equipment with capacities of 135,000 Btu's per hour and greater. Units shall be ARI certified. Units with capacities below 135,000 Btu's per hour shall be listed in the ARI Directory of Certified Unitary Air-Conditioners.

2. Performance Rating

Cooling capacity of unit shall meet the sensible heat requirements and total requirements indicated. In selecting unit size, make true allowance for "sensible to total heat ratio" to satisfy required sensible cooling capacity. Submittals shall include catalogue selection data which accounts for sensible to total heat ratio, entering air-conditions at evaporator, and condenser air-conditions.

3. Air Conditioners, Ceiling Cassette Type Inverter

The air conditioning system has a 4-way air distribution with auto sweep, it can cool an adjacent room using of the 4-way airflow outlets The fresh air intake device and additional outlet grille can condition the air in an adjoining room using one of its 4-way airflow sides..

4. Compressors

Provide hermetic, semi-hermetic rotary, or screw type provided with all the minimum standard equipment and accessories listed therein. Compressor speed for compressors above 20 tons shall not exceed 1750 rpm. Provide compressors with automatic capacity reduction of at least 50 percent for units over 10 tons. Compressors shall start unloaded. Provide each compressor with devices to protect the compressor from short-cycling when shut-down by safety controls. Provide a pump-down cycle of the non-recycling start type for each compressor 20 tons and over. Provide compressors with vibration isolators. Compressor motor shall be suitable for electric power characteristics as indicated. Motor shall conform to NEMA NG-1. Motor starters shall conform to NEMA ICS. Motors shall be

constant speed, squirrel-cage induction, open type or hermetically sealed, low starting current, high-torque type, and shall be furnished with reduced voltage or and magnetic across-the-line type motor starter with weather-resistant enclosures

5. Coils

- a. Cooling coils shall conform to ARI 410 and to paragraph entitled, Cooling Coils. Coils shall be the type indicated or specified herein.
- b. The air-cooled condenser coil shall be extended-surface fin-and-tube type with seamless copper or aluminum construction. Aluminum alloy conforming to ASTM B210, alloy 1100, shall be used for the tubes, and aluminum alloy conforming to chemical requirements of ASTM B209, alloy 7072, shall be used for fins and sheets. Fins shall be soldered or mechanically bonded to tubes and installed in a metal casing. Coils shall be air tested under water for leakage. After testing, dry coils for remote type units to remove free moisture, and cap to prevent entrance of foreign matter. Evacuate and seal coils at the factory.

6. Filter Boxes

Provide filter boxes with either hanged access doors or removable panels. Filter boxes shall have racks for filters arranged for angle pattern. Filters shall be of type indicated and shall conform to paragraph hereinafter entitled, "Filters".

7. Mixing Boxes

Mixing boxes shall be of physical size to match the basic unit and include equal sized flanged openings, each sized to handle full air flow. Arrangement of openings shall be as indicated. Provide openings with dampers of opposed blade type. All damper shafts shall be connected together by one continuous linkage bar. Arrange dampers for manual operation so that when one starts to close from its opened position, the other starts to open from its closed position.

8. Controls

a. Condenser Controls

Provide load pressure control to insure condensing temperature for proper system operation at all ambient temperatures down to 40°F.

- b. Condenser Start-up Control Provide condenser with a start-up control package which permits start-up compressor regardless of low ambient temperatures. Package shall temporarily bypass system low pressure-start to permit start-up whenever minimum ambient temperature is below design evaporator coil suction temperature.

9. Refrigerant Circuits

Entire refrigerant circuit shall be dehydrated, purged, and charged with refrigerant and oil at factory. Factory oil charge shall be the full amount required for operation. Factory charge for refrigerant shall be the full amount required for operation.

10. Corrosion Protection

Units shall be factory corrosion protected in accordance with paragraph entitled, Corrosion Prevention.

COOLING COILS

1. Direct-Expansion Coils

Direct-expansion coils shall be fin-and-tube type constructed of seamless copper or aluminum tubes and copper or aluminum fins mechanically bonded or soldered or helically wound to tubes. Casing and tube support sheets shall be not lighter than 16-gauge (0.0635-inch nominal thickness) galvanized steel, formed to provide structural strength. Suction header shall be seamless copper tubing or seamless or resistance welded steel tube with copper connection. Supply header shall consist of a distributor to distribute the refrigerant liquid through seamless copper tubing, equally to all the circuit in the coil. Tubes shall be circuited to insure minimum pressure drop and maximum heat transfer. Circulating shall permit refrigerant flow from liquid inlet to suction outlet without causing oil staging or restricting refrigerant flow in coil. Rack coil shall be tested at the factory under water at not less than 300 psi air pressure and shall be suitable for 200 psi working pressure. Each coil shall be completely dehydrated and scaled at the factory upon completion of pressure tests. Coil shall be mounted for counter flow service.

2. Filters

Filter shall be of the sectional or panel cleanable type and be capable of filtering the entire air supply.

3. Manometers

Provide inclined-type manometers for filter stations of 2,000 cfm capacity or larger including filters furnished as integral parts of air handling units and filters installed separately. Manometers shall be of sufficient length to read at least one inch of water column, shall be graduated in 1/10 inches, and equipped with spirit level. Equip each manometer with over-pressure safety traps to prevent loss of oil, and two three-way vent valves for checking zero setting.

CLEANING, PAINTING AND IDENTIFICATION

Cleaning, painting and identification of piping shall be as specified under, "Painting" of "Building Works".

IDENTIFICATION TAGS AND PLATES

Provide equipment, thermometers, valves, and controllers with tags numbered and stamped for their use. Plates and tags shall be of brass or suitable non-ferrous material, securely mounted or attached. Minimum letter and numeral size shall be 1/8 inch.

EXECUTION

INSTALLATION

Application and installation practices for unitary air-conditioning systems shall conform to the requirements of an acceptable industry standard for installation of unitary systems.

1. General

Install equipment and components in a manner to insure proper and sequential operation of the equipment and its controls. Installation of equipment not covered herein or in manufacturer's instructions shall be installed as recommended by manufacturer's representative. Provide proper foundations for mounting of equipment, accessories, appurtenances, piping and controls including, but not limited to, supported vibration isolators, stands, guides, anchors, clamps, and brackets. Foundations for equipment shall conform to equipment manufacturer's recommendation, unless otherwise shown in the drawings. Set anchor bolts and sleeves accurately using properly constructed templates. Anchor bolts shall be of adequate length and provided with welded-on plates on the head end embedded in the concrete. Level equipment bases, using jacks or steel wedges, and neatly grouted-in with a non-shrinking type of grouting mortar. Locate equipment so that working space is available for all necessary servicing such as shaft removal, disassembling compressor cylinders and pistons, replacing or adjusting drives, motors, or shaft seals, access to water heads and valves of shell and tube equipment, tube cleaning or replacement, access to automatic controls, refrigerant charging, lubrication, oil draining and working clearance under overhead lines. Provide electric isolation between dissimilar metals for the purpose of minimizing galvanic corrosion.

2. Unitary Air-Conditioning System

Install system as indicated, in accordance with the requirements of ASHRAE 15-76 and as recommended in the manufacturer's installation and operational instructions.

3. Electrical Work

Electric motor driven equipment specified herein shall be provided complete with motors, motor starters, and controls. Electrical equipment and wiring shall be in accordance with "Electrical General Requirements". Motor starters shall be provided complete with properly sized thermal overload protection and other appurtenances necessary for the motor control wiring required for controls and devices but not indicated.

4. Piping

a. Piping Sleeves

Pipe sleeves shall be as Galvanized Iron, Schedule 20.

b. Provide refrigerant driers, sight glass liquid indicators, moisture indicators, and strainers in refrigerant piping for remote installations when not furnished by the manufacturer as part of the equipment.

c. Locate strainers close to equipment they are to protect. Provide a strainer in the common refrigerant liquid supply to two or more thermal valves in parallel when

each thermal valve has a built-in strainer. Install strainers with screen down and in direction of flow as indicated on strainers body.

- d. Solenoid valves shall be installed in horizontal lines with stem vertical and with flow in direction indicated on the valve. If not incorporated as internal part of the valve, provide strainers upstream of the solenoid valve. Provide service valves upstream of the solenoid valve, upstream of the strainer, and downstream of the solenoid valve. Remove the internal parts of the solenoid valve when brazing the valve.

5. Auxiliary Drain Pans, Drain Connections, and Drain Lines

Provide auxiliary drain pans under all drain pans of the units located above finished ceilings or over mechanical or electrical equipment where condensate overflow over unit drain pan may cause damage to ceilings, piping, and equipment below. Provide drain lines for all drain and auxiliary drain pans. Trap the drain from bottom pan of air-conditioning units to insure complete pan drainage. Drain lines shall be full size of opening.

6. Air Filters

Provide access panels for all concealed valves, controls, dampers, and other fittings requiring inspection and maintenance.

7. Inspection Plates and Test Holes

Inspection plates and test holes where required in casings for air balance measurements shall conform to SMACMA High Pressure Low Velocity Duct Construction Standards. Test holes shall be a factory-fabricated, air-tight, non-corrosive test hole with screw cap and gasket. Extend cap through insulation.

8. Flashing and Pitch Pockets

Provide flashing and pitch pockets for equipment support and roof penetrations and flashing where piping or ductwork passes through exterior walls.

FIELD TESTS AND INSPECTIONS

1. Tests

All tests shall be performed and materials and equipment required for test shall be furnished by the Contractor. Tests after installation and prior to acceptance shall be performed in the presence of a representative of the Owner and subject to his approval. Equipment and material certified as having been successfully tested by the manufacturer in accordance with referenced specifications and standards will not require retesting before installation. Equipment and materials not tested at the place of manufacturer will be tested before or after installation, as applicable, where necessary to determine compliance with referenced specifications and standards.

2. Leak Testing

Upon completion of installation of the air-conditioning equipment, test all factories as well as field refrigerant piping with an electronic-type leak detector to acquire leak tight refrigerant systems. If leaks are detected at the time of installation or during the guarantee period, remove the entire refrigerant charge from the system, correct the leaks and retest the system.

3. Evacuation, Dehydration, and Charging

After system is found to be without leaks, evacuate the system using a reliable gauge and a vacuum pump capable of pulling a vacuum of at least 1 mm lig absolute. Evacuate system in strict compliance with the triple evacuation and blotter method or in strict accordance with equipment manufacturer's printed instructions. System leak testing, evacuation, dehydration, and charging with refrigerant shall comply with the requirement contained in an acceptable industry standard.

4. Start-Up and Operation Tests

The air-conditioning system and its components shall be started and initially placed under operation and checked to see that it is functioning correctly. Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence. The operational test shall be not less than 8 hours.

5. Performance Tests

Upon completion of evacuation, charging, start-up, final leak testing, and proper adjustment of controls, the system shall be performance tested to demonstrate that it complies with the performance and capacity requirements of the specifications and plans. Test the system for not less than 8 hours, during which time hourly readings shall be recorded. At the end of the test period, the readings shall be averaged and the average shall be considered to be the system performance.

6. Sound Tests, Air-conditioners, Unitary, Split Type

Sound pressure level measurements shall be conducted on units designated by the Owner. Calculate sound power levels by ASHRAE Systems Handbook and Product Directory. Submit test results and calculations.

ITEM 25 : EXHAUST EQUIPMENT

EXHAUST EQUIPMENT

GENERAL

"Mechanical General Requirements" applies to this Item with additions and modification specified herein.

SCOPE OF WORK

1. Furnish materials that are new, of first-class quality.
2. Install all materials in strict accordance with the manufacturer's instructions and specifications.

PRODUCTS

MATERIAL REQUIREMENTS

1. Bathroom Ceiling Mounted Exhaust Fan

The exhaust fans shall be of the built-in ceiling type, ceiling mounted, suitable for operation. Sizes and capacities are based on models or approved equal. Brand and models indicated herein is for the purpose of establishing product quality, capacities and dimensions. Other brands satisfying the same shall likewise be accepted, subject to the approval of the owner and Engineer In-Charge. The capacities of the units shall be as shown on the Drawings.

2. Wall Mounted Propeller Exhaust Fan

The wall-mounted propeller exhaust fan shall be direct-drive three blade type with a steel mounting plate. Capacity of the fan shall be as shown on the drawings. Fan blades shall be constructed of steel or aluminum. The fan hub shall be of heavy construction and shall be of steel or semi-steel, and the blades shall be riveted to the hub. Fan blade shall be quiet in operation and shall be statically and dynamically balanced at the factory. Motor and Drive shall be of the condenser motor type, tightly sealed and dust proof with non-lubricating ball bearings. The fan shall be provided with automatic shutters to prevent air from re-entering the fan when fan is off. The fan control switch shall be located as near as possible to the fan.

EXECUTION

1. Install the fan securely to the ceiling.
2. Install back-draft dampers and check to make sure they are free to open and close.
3. Connect power and check rotation of fan.

ITEM 26 : DISTRIBUTION TRANSFORMER

SCOPE OF WORK

The work to be done shall consist of supply, and delivering and installing distribution transformer completed in accordance with all the materials submitted by Local Electric Cooperative of Southern Leyte, including labor, tools and equipment and all incidental works as found necessary.

GENERAL REQUIREMENTS

- a) All works shall be done in accordance with the requirements of the publications and agencies having jurisdiction, as well as the requirements of the approved standards.

1. American National Standard Institute - (ANSI)
2. Institute of Electrical and Electronics Engineers - (IEEE)
3. National Electrical Manufacturer Association - (NEMA)
4. Philippine Electrical Code - (PEC)
Philippine National Standard - (PNS)

- b) Materials Requirements

- o Distribution Transformer,
- o Conventional
- o Pole Type
- o Oil Immersed
- o Self -Cooled
- o Single Phase , 1Ø , 60hz
- o 65 °C Temperature rise

Capacity	:	KVA
Primary Voltage	:	7.62 / 13.2 Y kV 2-2.5% taps FCAN and 2-2.5% taps FCBN Available on tap changer for de-energized operation
Primary BIL Rating	:	95kV
Secondary Voltage	:	120 /240V
Secondary BIL Rating	:	30kV
Percent Impedance	:	ANSI Standard
HV/LV Conductor	:	Copper / Aluminum
Insulating Fluid:	:	Mineral Oil
Core	:	Silicon Core
NLL	:	190W
LL	:	650W

c) **Standard Test Reports:**

1. Routine Tests

- Turn Ratio Test
- Voltage Ratio Test
- No Load Loss & Load Loss Test
- Impedance Voltage Test
- Applied Potential Test
- Induced Potential Test

2. Type of Test

- Impulse test
- Temperature Rise Test

PRODUCTS (DISTRIBUTION TRANSFORMER)

External Features

- High Voltage Bushing
- Low Voltage Bushing
- Tank and Cover
- Pressure Relief Valve
- Tank and Low Voltage Grounding Provision
- Externally Operated No-Load Tap Changer
- Radiators

Internal Features

- Core Coil Assembly
- Winding Material
- Insulating Di-Electric Fluid
- Coil Support

PRODUCTS (GENERAL DESCRIPTION)

1. **High Voltage Bushing**, the cover mounted and tank - wall high voltage bushing are made of wet process porcelain suitable for both copper and aluminum conductors.
2. **Low Voltage Bushing**, single or double eyebolt or spade terminal made of wet process porcelain.
3. **Tank and Cover**, manufactured from hot-rolled steel sheets and pressure tested to ensure a leak free enclosure. Grit blasted or chemically treated to remove every trace of scale, rust or oil, for better paint adhesion. Outer and inner surfaces are primed with epoxy primer for rust prevention and the outer surface is coated with polyurethane.
4. **Pressure Relief Valve**, gradually releases excess pressure and designed for outdoor condition.
5. **Tank and Low Voltage Grounding Provisions**, provided to help prevent damage to the transformer during electrical surges.
6. **Externally Operated No-Load Tap Changer**, provides up to five (5) primary voltage for convenient changing of high voltage tap connection at no -load.
7. **Radiators** made of hot-rolled steel sheets these are provided for higher KVA units for added cooling surface.

8. **Core Coil Assembly**, uses a superior transformer insulation system and is permanently centered in the tank using a close fitted steel frame. Materials used for our coils, are wither silicon-iron for our Blue and Silver series or amorphous metal for our gold line.
9. **Winding Material**, distribution transformer uses a combination of standard copper-aluminum or copper-copper winding materials.
10. **Insulating –Di- Electric Fluid**, uses are either mineral oil or an environment friendly high fire point fluid.
11. **Coil Support**, used compatible materials to hold the coil in place and restraint it during short circuit-circuit conditions. Core clamps and clamp angles are also used to ensure that the core and windings are effectively secured even during mechanical stresses.

EXECUTION

INSTALLATION

The installation of the distribution transformer and its accessories shall be in accordance with the standards required by the local electric supply cooperative.

GROUNDING

Ground all exposed non-current-carrying metallic parts of electrical equipment.

WORKMANSHIP

The work throughout shall be executed in the best and most thorough manner under the direction of and at the satisfaction of the Registered Electrical Engineer or Master Electrician, who will interpret the intent meaning of the drawings and specification and shall have the power to reject any work and materials which in his judgment, are not in full accordance therewith.

TESTING OPERATIONS

When the electrical installation is completed, the Contractor shall test the installed electrical materials and equipment in the presence of Registered Electrical Engineer or Master Electrician. The system shall be free from any defects, shorts or grounds. The Contractor at no extra cost shall furnish all necessary instruments and personnel required for the testing.

GUARANTEE

Upon completion and before final acceptance of the work, the Contractor shall furnish the Engineer a written guarantee stating that all works executed are free from defects on materials and workmanship. The guarantee shall be for a period of one year from the date of the final acceptance. Any work that becomes defective during the said period shall be corrected / replaced by the Contractor at his own expense in a manner satisfactory to the Authority.

ITEM 27 : CONCRETE WORKS

GENERAL

General Requirements contain provisions and requirements essential to these specifications; and apply to this Section, whether or not referred to herein.

SCOPE OF WORK

The work shall include reinforced concrete structures such as reinforced concrete footings with or without tie-beams, reinforced concrete columns girders, slabs, other cast-in-place and precast concrete including excavation and backfilling work.

The work shall consist of furnishing of all labor, materials, equipment and other incidentals necessary for the supply of concrete materials and the complete construction of the concrete structures for the building shown on the drawings in accordance with these specifications and as directed by the Engineer.

GENERAL REQUIREMENTS

Concrete works shall conform with the requirements of "Reinforced Concrete" except noted otherwise in this Section.

SHOP DRAWINGS

Together with requirements, the Contractor shall show the following in the shop drawings:

1. Surface finish
2. Fitting to be embedded

MATERIAL REQUIREMENTS

1. Concrete shall consist of Portland cement, fine and coarse aggregates and water and shall conform with the requirements of "Reinforced Concrete".
2. Deformed bars to be used shall conform with the reinforcement requirements in Section of "Reinforced Concrete". The size shall be as shown on the drawings.
3. In lieu of the temperature bars on concrete ground slab, monofilament polypropylene synthetic fibrin fibers shall be used as admixture to prevent the formation of temperature / shrinkage cracks and increase impact resistance of ground slabs. The dosage rate shall be 0.91 kg. per cubic meter of concrete.

The supplier is required to submit a "Mill Certificate" that the materials delivered to site shall be proven to meet or exceed the following properties:

TECHNICAL PROPERTIES	Unit	Minimum
A. Physical Characteristics:		
Length	Mm	12
Shape	Microns	18
Density	gm nominal	0.91

FORMWORKS**GENERAL REQUIREMENTS**

Materials and construction of formwork shall be in accordance with formwork requirements in Reinforced Concrete.

REMOVAL OF FORMWORK

The minimum stripping and striking time for formwork shall be as follows unless otherwise approved by the Engineer.

Conditions	Minimum Period
Vertical sides of beams, wall, piles, pile caps and columns lift not exceeding 1.2m	24 hours
Vertical sides of beams and walls, lift exceeding 1.2m	48 hours
Soffits of main slabs and beams (props left under)	5 hours
Removal of props from beams and main slabs and other works	10 days

CONCRETE**CLASSES OF CONCRETE AND USAGE****1. Strength Requirement**

Concrete strength shall conform with the requirements in Section of "Reinforced Concrete".